



New Hampshire ENERGY STAR[®] Products Program

2016 EVALUATION REPORT

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Prepared for:

New Hampshire ENERGY STAR Products
New Hampshire Evaluation Measurement &
Verification Working Group

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Executive Summary

The New Hampshire gas and electric utilities (Eversource, Unitil, New Hampshire Electric Co-op, and Liberty Utilities) contracted with Cadmus to evaluate the 2016 New Hampshire ENERGY STAR Products program. The ENERGY STAR Products program encourages residential New Hampshire Utility customers to purchase products that meet or exceed the requirements for ENERGY STAR certification.

This report details the objectives, methods, and findings from the impact and process evaluations of the New Hampshire ENERGY STAR Products program during the implementation period beginning January 1, 2016, and ending December 31, 2016, and also provides a review of prospective savings assumptions for the 2018–2020 program cycle.

Evaluation Objectives

The evaluation, measurement, and verification objectives included the following:

- Verify electric and gas energy savings, water savings, and electric demand reduction associated with the ENERGY STAR Products program in 2016
- Review the 2018–2020 energy savings calculations for accuracy and appropriateness
- Assess the current and proposed design and implementation of the ENERGY STAR Products program
- Identify opportunities for increasing the program’s effectiveness and the satisfaction of participants and partners (e.g., retailers, suppliers, others)

For the purpose of the 2016 evaluation, demand savings are reported for the Independent System Operator New England (ISO-NE) summer and winter peak periods.¹ Cadmus used the peak coincidence factors recorded in the utility B/C models to evaluate demand savings.

Evaluation Results

The New Hampshire joint utilities claim electric and natural gas energy savings, as well as reductions in electric demand, based on the estimated performance of products rebated through the program compared to the equipment replaced by those products. These *ex ante* savings are based on prior evaluations of energy efficiency programs in New Hampshire, evaluations of similar programs in neighboring jurisdictions, and engineering calculations developed by the utilities and the third-party vendors hired to help support the program. Cadmus performed a number of evaluation activities to develop verified savings (*ex post* savings) for the products incentivized or rebated through the program. These evaluation activities included on-site metering and data collection, utility bill analysis, engineering

¹ The summer peak period is defined as “non-holiday weekdays, 1:00 p.m. to 5:00 p.m., during June, July, and August” and the winter peak period is defined as “non-holiday weekdays, 5:00 p.m. to 7:00 p.m., during December and January”.

desk reviews, and surveys of program participants. Both the *ex ante* and *ex post* savings include the impact of in-service rates, which Cadmus attempted to verify through participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

In 2016, the New Hampshire joint utilities claimed 7,905,902 *ex ante* kWh savings, 852.3 *ex ante* kW coincident with the ISO-NE summer peak, 2,446.6 *ex ante* kW savings coincident with the ISO-NE winter peak, and 138,201,987 *ex ante* lifetime kWh savings attributable to the ENERGY STAR Products program. *Ex ante* and *ex post* savings for the lighting measures are provided in Table 1 and non-lighting measure savings are provided in Table 2.² Program realization rates—the ratio of *ex post* savings to *ex ante* savings—are also presented in Table 1 and Table 2 and reflect the impact of Cadmus’ evaluation findings.³

Table 1. 2016 ENERGY STAR Lighting Savings

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	7,905,902	138,201,987	852.3	2,446.6	0	0
<i>Ex Post</i>	7,284,885	125,709,927	924.6	2,653.5	0	0
Realization Rate	92.1%	91.0%	108.5%	108.5%	--	--

Ex post demand savings are based on findings from the in-home lighting study and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models. Note: Values in table may not match exactly due to rounding.

The 2016 New Hampshire ENERGY STAR Products program claimed 2,274,685 *ex ante* kWh savings, 398.4 *ex ante* kW coincident with the ISO-NE summer peak, 510.0 *ex ante* kW savings coincident with the ISO-NE winter peak, and 24,238,893 *ex ante* lifetime kWh savings attributable to appliances, water heating, and space heating and cooling products. In addition, the program claimed 23,182 annual MMBtu savings and 399,538 lifetime MMBtu savings.

² The term *ex ante* refers to the savings reported by the utilities in their B/C models and formal filings for the NHPUC. The *ex ante* savings include in-service rates assumed by the utilities. The term *ex post* refers to the savings determined through the evaluation, which include the effects of in-service rates found through the evaluation.

³ Where appropriate, Cadmus recommends the utilities update savings inputs rather than applying measure-level realization rates for future program planning. Savings inputs developed through the evaluation include lighting hours of use, billing analysis results, and in-service rates. These are highlighted throughout the report.

Table 2. 2016 ENERGY STAR Appliances, Water Heating, and Space Heating and Cooling Products Savings

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	2,274,685	24,238,893	398.4	510.0	23,182	399,538
<i>Ex Post</i>	2,256,451	24,045,661	393.7	507.7	20,223	346,397
Realization Rate	99.2%	99.2%	98.8%	99.5%	87.2%	86.7%

Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.
 Note: Values in table may not match exactly due to rounding.

Savings are further broken out for the electric and gas appliances, water heating, and space heating and cooling products in Table 3 and Table 4.

Table 3. 2016 ENERGY STAR Appliances, Water Heating, and Space Heating and Cooling Products Savings—Electric Measures

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	2,189,688	22,844,463	381.4	507.7	1,869	20,559
<i>Ex Post</i>	2,171,454	22,651,231	376.7	505.4	2,099	23,084
Realization Rate	99.2%	99.2%	98.8%	99.5%	112.3%	112.3%

Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Table 4. 2016 ENERGY STAR Appliances, Water Heating, and Space Heating and Cooling Products Savings—Gas Measures

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	84,997	1,394,430	17.0	2.3	21,313	378,979
<i>Ex Post</i>	84,997	1,394,430	17.0	2.3	18,124	323,313
Realization Rate	100.0%	100.0%	100.0%	100.0%	85.0%	85.3%

Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Realization rates are primarily driven by differences in in-service rates as determined through participant surveys, findings from the lighting site visits, and billing analysis for the furnace and boiler measures. In-service rates determined through the evaluation that differ from the in-service rates assumed by the utilities are provided in Table 5. For measures that achieved fewer than 10 survey responses, *ex post* in-service rates were deemed at 100% due to insufficient sample points.

Table 5. In-Service Rates from the 2016 Evaluation

Measure	<i>Ex Ante</i> ISR ¹	<i>Ex Post</i> ISR	<i>Ex Post</i> Precision at 90% Confidence	Source
LED Bulbs ¹	95.0%	97.0%	3.8%	Participant Survey
Efficient Lighting Fixtures ²	Interior: 96.4% Exterior: 100.0%	97.7%	6.4%	Participant Survey
ENERGY STAR Clothes Washers	100.0%	98.2%	3.0%	Participant Survey
ENERGY STAR Room Air Conditioners	100.0%	84.6%	16.6%	Participant Survey

¹Unitil assumes an ISR of 96.4% for LED bulb multi-packs

² The New Hampshire Electric Co-op assumes an ISR of 95.0% for both interior and exterior lighting fixtures. The evaluation was not able to assess separate ISRs for interior and exterior fixtures. Cadmus applied the same ISR of 97.7% to both interior and exterior fixtures when evaluating *ex post* savings.

Cadmus recommends the utilities apply the in-service rates listed in Table 5, update the lighting hours of use (HOU), and update savings assumptions for furnace and boilers for the 2018–2020 program cycle to reflect the results of the utility bill analysis. Additional information is provided in the Hours of Use and Utility Billing Analysis sections, respectively.

The process evaluation found that communication and collaboration among the utilities was effective and positive. Overall customer satisfaction was high, with both the program and incented equipment, but some customer feedback suggested the program could be improved with additional outreach regarding the incentives offered and simplification of the rebate process. Both retailer and contractor staff suggested more communication from utilities and that additional support for customer education could help increase the number of customers able to take advantage of rebates and provide a more seamless customer experience.

Introduction

The New Hampshire gas and electric utilities (Eversource, Unitil, New Hampshire Electric Co-op, and Liberty Utilities) contracted with Cadmus to evaluate the 2016 New Hampshire ENERGY STAR Products program. This report details the results from the 2016 program year (PY2016) evaluation (January 1, 2016, through December 31, 2016), and provides recommendations for the 2018–2020 program cycle.

Background

The design of the New Hampshire ENERGY STAR Products program centers on saving energy and capturing lost opportunity by providing incentives for the purchase of high-efficiency ENERGY STAR-certified equipment and lighting products. This is accomplished by encouraging customers to recognize and purchase ENERGY STAR-certified lighting, appliances, water heating, and space heating and cooling products. The program is offered by both gas and electric utilities in New Hampshire and offers in-store, online, and mail-in rebate incentives as well as markdowns for specific products. The program also offers recycling services for old appliances.

A large network of partners promote and deliver the ENERGY STAR Products program; these partners include over 140 retail locations, equipment suppliers, distributors, and installation contractors. The New Hampshire utilities employ a circuit rider to ensure the availability and visibility of qualifying ENERGY STAR products and promotional materials at retail partner locations. In addition, the circuit rider is responsible for updating point-of-purchase materials and incentive coupons, processing incentives, and developing cooperative marketing. The circuit rider also provides training for retail partner staff to familiarize them with the products and help the retail staff explain the benefits of program-qualified products to customers.

The initiative is supported by both an electric initiative and a gas initiative. The electric initiative is administered by the electric program administrators, and GasNetworks is administered by the gas program administrators. The initiatives use the same circuit rider, who is responsible for outreach, education, and support for contractors, distributors, and retailers as well as for a rebate processing vendor.

The natural gas initiative (GasNetworks) provides rebates and incentives for high-efficiency furnaces with ECM fan systems, hot water boilers, water-heating equipment, and heating system controls, such as programmable thermostats and heat recovery ventilators. The initiative also supports an early replacement promotion and provides incentives to contractors for quality installations.

The program uses mix of point-of-purchase markdowns and rebate coupons for qualified lighting products that allow the utilities to deliver incentives based on the needs of the retailers involved in the program. Smaller retailers tend to use rebate coupons at checkout, whereas larger retailers prefer to use markdowns in their billing system to pass savings on to lighting customers. Incentives for qualified appliances and heating and cooling equipment are available through mail-in and online rebates, and appliance recycling rebates are mailed to customers after the equipment is picked up or dropped off at planned recycling events. In 2016, the New Hampshire utilities sponsored an online catalog, available

through the NHSaves Online Marketplace (NHSaves.com), that allowed customers to make direct online purchases of certain qualified products at discounted prices. New Hampshire utilities have since shifted their focus away from the online catalog and are increasingly focused on ENERGY STAR product markdowns.

Beginning January 1, 2018, the New Hampshire Public Utilities Commission’s (NHPUC) Energy Efficiency Resource Standard (EERS) took effect. A policy framework designed to achieve cost-effective energy savings, the EERS sets specific energy-savings goals for the New Hampshire utility programs. The design of the EERS seeks to help New Hampshire achieve the objectives set out in its 10-year State Energy Strategy and New Hampshire’s Energy Policy, RSA 378:37,⁴ which is intended to achieve incremental increases in cost-effective energy savings.

For the three-year period of 2018–2020, the EERS outlines a cumulative electric savings target equivalent to 3.1% of delivered 2014 kWh sales, with interim annual savings goals of 0.80%, 1.00%, and 1.30% for 2018, 2019, and 2020, respectively. The gas programs have a cumulative gas savings target of 2.25% of delivered 2014 MMBtu sales, with interim annual savings goals of 0.70%, 0.75%, and 0.80% for 2018, 2019, and 2020, respectively. In September 2017, the New Hampshire utilities filed their 2018–2020 plans to meet these stated goals. The 2016 evaluation results will inform additional program planning for meeting the savings targets outlined by the EERS.

The 2018-2020 plan established a formalized Evaluation, Measurement and Verification Working Group (EM&V Working Group), consisting of Commission Staff members, independent EM&V consultants hired and supervised by the Commission (Skumatz Economic Research Associates), representatives of the Utilities (NHEC, Liberty, Unitil, and Eversource), and a representative of the NH Energy Efficiency and Sustainable Energy (EESE) Board. The parties comprising the EM&V Working Group are shown in Table 6.

Table 6. Organizations and Individuals Comprising the EM&V Working Group

EM&V Working Group Party	Associated Organizations and Individuals
NHPUC	NHPUC Staff Members
NHPUC-Hired Independent Consultants	Skumatz Economic Research Associates
NH Utilities	Liberty Utilities (Liberty) Eversource NH (Eversource) Unitil Energy Systems, Inc. (Unitil) New Hampshire Electric Cooperative (NHEC)
Representative from the NH Energy Efficiency and Sustainable Energy (EESE) Board	Brian Buckley from the NH Office of Consumer Advocate

⁴ The New Hampshire General Court. “Title XXXIV Public Utilities. Chapter 378: Rates and Charges, Least Cost Energy Planning, Section 378:37.” Available online: <http://www.gencourt.state.nh.us/rsa/html/xxxiv/378/378-37.htm>

As approved by the NHPUC, the EM&V Working Group directs and oversees the evaluation of New Hampshire’s energy efficiency programs annually and sponsors this evaluation.

PY2016 Measures

The New Hampshire ENERGY STAR Products program included many energy efficiency measures offered through retail, online, and via installers, as well as appliance recycling. Table 7 lists the measures available through the programs in 2016.

Table 7. PY2016 New Hampshire ENERGY STAR Products Program Measure Offerings

Lighting	
LED Exterior Fixtures	CFL Interior Fixtures
LED Interior Fixtures	CFL Multipacks
LED Multipacks	CFL Single-Packs
LED Single-Packs	
White Goods	
Advanced Power Strip	ENERGY STAR Refrigerators
ENERGY STAR Clothes Washers	ENERGY STAR Room Air Conditioners
ENERGY STAR Freezers	ENERGY STAR Room Air Purifier
Appliance Recycling	
Secondary Refrigerator Recycling	Secondary Freezer Recycling
Heating and Cooling	
Electric Measures	Gas Measures
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	Boiler Early Replacement: 90% AFUE replacing 65% AFUE
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	Boiler Early Replacement: 90% AFUE replacing 80% AFUE
ENERGY STAR Central AC (3 Ton)	Furnace ≥ 95% AFUE w/ECM
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	Furnace ≥ 97% AFUE w/ECM
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	Heat Recovery Ventilator
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	Thermostat: Standard 7-day Programmable
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	Thermostat: Wi-Fi (Cooling & Heating)
ENERGY STAR Ductless AC (Cooling only)	Thermostat: Wi-Fi (Heating Only)
Wi-Fi Enabled Thermostats for Air Conditioners	
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	
Domestic Hot Water	
Electric Measures	Gas Measures
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	Water Heater: Indirect, attached to boiler, combined eff rating ≥85% (EF ≥ 0.82)
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE
	Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE
	Water Heater: Stand Alone Storage Tank (EF ≥ 0.67)
	Water Heater: Tankless, On Demand, EF ≥ 0.82
	Water Heater: Tankless, On Demand, EF ≥ 0.94

PY2016 Evaluation Objectives and Tasks

Cadmus used a combination of the research activities described below to evaluate the cross-cutting aspects of the ENERGY STAR Products program. Detailed research methods and findings are provided in the subsequent sections.

Impact Evaluation

Impact Evaluation Objectives

The impact evaluation sought to achieve three objectives:

- Measure and verify electric and gas energy savings, electric demand savings, and water savings for the New Hampshire 2016 ENERGY STAR Products program
- Analyze program-savings impact factors and document discrepancies between *ex ante* and *ex post* savings
- Review the updated 2018–2020 savings calculation baseline assumptions, input values, and algorithms

Impact Evaluation Tasks

Cadmus used a combination of primary and secondary data to assess program savings impact factors. Where impact factors proved to be incorrect or out of date, the team documented the discrepancies and their relative contributions to savings. Finally, the team reviewed the 2018–2020 energy savings calculations.

Site Visits

Cadmus performed site visits to develop savings inputs for high-impact measures, including lighting and natural gas furnaces and boilers. Cadmus conducted site visits and data logging spanning the period from late January 2018 through May 2018 to confirm key measure savings parameters, including baseline wattages for lighting, lighting hours of use (HOU), and equivalent full load hours (EFLH) of operation for natural gas furnaces. All metering equipment and processes Cadmus employed were compliant with the ISO M-MVDR (Measurement and Verification of Demand Reduction).

In total, Cadmus recruited 48 households that had participated in the ENERGY STAR Products program including 16 households that had installed a natural gas furnace or boiler. The households were recruited from all facets of the program (appliances, HVAC, etc.) and, excepting the homes that received a gas furnace or boiler, could be considered non-participant site visits for the purpose of evaluating lighting and thermostat data. Because the program includes an upstream lighting channel—which does not collect participant information—it was not clear whether the recruited households had purchased program-incentivized lighting products.

Table 8 lists evaluation activities for each measure group and the sample sizes for each activity.

Table 8. Evaluated Savings Activities and Sample Sizes

Measure Type ¹	File	Surveys	Site	Metering	Notes
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	Review		Visits		
White Goods	✓	95	–	–	
HVAC	✓	32	16	16	For HVAC measures, Cadmus metered indoor temperatures, runtimes and completed a billing analysis
Domestic Hot Water	✓		–	–	
Lighting	✓	83	48	48	Installed up to 10 light meters per house
Thermostats	✓		48	48	Installed one temperature meter per house
Appliance Recycling	✓	4	–	–	

¹ Smart strips and heat recovery ventilators were not included as targeted measures for evaluation due to low program presence in 2016.

Customer Surveys

Cadmus conducted participant surveys to gather information on energy efficiency measures purchased (i.e., key parameters needed to verify assumptions for estimating *ex post* energy savings) as well as baseline data, such as space heating and water heating fuel types. The surveys collected information on the following metrics to inform the impact evaluation:

- Measure verification (regarding measure installation, retention, removal)
- Home and equipment specifications (occupancy, home size and age, informing input savings assumptions analysis)

Savings Analysis

Table 9 provides an overview of Cadmus’ approach for evaluating savings. All methods are based on standard measurement and verification methods established by the International Performance Measurement and Verification Protocol (IPMVP).

Table 9. High-Level Overview of Determining *Ex Ante* and *Ex Post* Savings

Savings Estimate	Step	Action
<i>Ex Post</i> Savings	1	Compare claimed savings against reported savings to ensure accuracy
	2	Review engineering estimates for accuracy, including algorithms, engineering models, and/or calculation spreadsheets and their assumptions and parameters
	3	Collect data, capturing key details and data elements that contribute to the evaluation. Data collection includes on-site verification and metering, billing analysis, and surveys
	4	Analyze energy-savings impacts and demand reduction with appropriate rigor levels

Cadmus calculated energy, demand, and water savings on a statewide basis. Results are provided by measure for each utility in Appendix A.

2018–2020 Baseline Assumptions Review

Cadmus conducted a review of all 2018–2020 input savings assumptions for program measures. Cadmus offered suggestions for revising input assumptions and provided rationale for updating the measures, such as reviewing offerings and market trends in other jurisdictions. Additional information is provided in the section on 2018–2020 Baseline Assumptions Review.

Process Evaluation

Process Evaluation Objectives

The process evaluation’s objectives included the following:

- Identify opportunities for increasing program effectiveness
- Evaluate program satisfaction

Process Evaluation Tasks

To assess the effectiveness and customer satisfaction of the ENERGY STAR Products program, the team used a combination of the following primary and secondary research activities:

- Review program materials
- Conduct stakeholder and partner interviews
- Survey program participants (online surveys and in-home interviews)
- Conduct in-store intercept surveys
- Assess lighting prices
- Perform a jurisdictional scan of similar programs in the Northeast

Following interviews with the New Hampshire utilities’ stakeholders, Cadmus tailored the evaluation methodology to achieve specific objectives.

Table 10 presents the process evaluation’s elements and evaluation activities.

Table 10. Process Evaluation Objectives and Corresponding Evaluation Activities

Process Evaluation	Program Materials Review	Stakeholder Interviews	Partner Interviews	Participant Survey	In-Store Intercept	Pricing Assessment
Assess program design and implementation to determine satisfaction levels among participants and partners						
<ul style="list-style-type: none"> • Establish the extent that the program adhered to ENERGY STAR design processes and the effectiveness of its design 	✓	✓	✓	✓	✓	
<ul style="list-style-type: none"> • Conduct a general process review to assess how successfully the consumer program was administered and delivered to the market 	✓	✓	✓	✓	✓	
<ul style="list-style-type: none"> • Gain perspectives on the lighting market, prices, and bulb availability relative to the program 		✓		✓		✓
Survey program participants and partners (e.g., retailers, suppliers, distributors, installation contractors): assess and identify opportunities for increasing the categories below						
<ul style="list-style-type: none"> • Program effectiveness 	✓	✓	✓	✓	✓	
<ul style="list-style-type: none"> • Partner satisfaction (e.g., retailers, suppliers, contractors) 		✓	✓			
<ul style="list-style-type: none"> • Participant satisfaction 		✓		✓		
<ul style="list-style-type: none"> • Determine non-energy benefits experienced by participants 			✓	✓		
<ul style="list-style-type: none"> • Review programs in neighboring states, and identify possible improvements to the New Hampshire program’s marketing and 	✓	✓	✓			

implementation						
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Table 11 provides data types and planned sample sizes for each process evaluation activity. Process evaluation activities are discussed in detail in the Cross-Cutting Process Evaluation section of this report.

Table 11. Process Data Collection Efforts

Data Type	Activity	Planned Sample Size	Achieved Sample
Primary	Interviews with program staff and stakeholders	8–14	7 ¹
	Partner interviews	4–10 (email invitations sent to all identified partners)	4
	Email surveys of program participants	220	214 ²
	In-Home Lighting Inventory Study Survey	40	48
	Intercept surveys	Up to 20 stores (up to 3 surveys per store), targeting top sellers	11 stores; 33 surveys ³
Secondary	Review of program materials	All program guidelines and educational materials	Completed
	Jurisdictional scan	Review of up to 5 programs	16 Programs
	Lighting pricing assessment	Websites of two major retailers representing 43 brick-and-mortar store locations (25 for Retailer 1; 18 for Retailer 2) in New Hampshire and Massachusetts	Completed

¹ Cadmus spoke with all program staff and stakeholders relevant to the 2016 program (less than planned sample size).

² Through data cleaning and validation, six of the 220 survey completions were removed from the final analysis.

³ Due to delays in the program’s launch, Cadmus could not achieve an adequate sample and replaced the remaining surveys with a lighting pricing assessment.

Cross-Cutting Program Evaluation

Cadmus conducted cross-cutting process activities that provide insight into the design and delivery of the program, participant experience and satisfaction, and vendor and contractor experience for multiple measure categories or the program as a whole. In addition, Cadmus performed a jurisdictional scan to compare the New Hampshire ENERGY STAR Products program to other, similar programs in New England, and performed a review of the prospective savings assumptions planned for the 2018-2020 program cycle.

The methodology and findings for these activities is discussed in the following sections.

Cross-Cutting Process Evaluation

The primary objectives of the cross-cutting process evaluation were to identify opportunities for increasing program effectiveness and to assess program satisfaction.

Process Evaluation Methodology

To assess the effectiveness and customer satisfaction of the ENERGY STAR Products program, the team used a combination of the following primary and secondary research activities:

- Review program materials
- Conduct stakeholder and partner interviews
- Survey program participants (online surveys and in-home interviews)
- Perform a jurisdictional scan of similar programs in the Northeast

Table 12 presents the plan, sample, and results for conducting participant and store intercept surveys. Cadmus ensured that, where applicable, surveys included gas and electric participants. The achieved sample sizes reflect the final number of participant responses included in the evaluation’s analysis. The data collection instrument for the participant survey is provided in 0.

Table 12. Preliminary Participant Survey Plan

Measure	Format	Planned Sample Size	Achieved ¹
White Good Appliances	Online Survey	Up to 50	94
Heating and Cooling	Online Survey	Up to 60	46
Lighting and Thermostats (Rebate and Online Marketplace)	Online Survey	Up to 60	86
Appliance Recycling	Online Survey	Up to 50	4
Markdown Measures (LEDs and CFLs)	Store Intercept Survey	Up to 20 stores	11 stores

¹Low response for heating and cooling and appliance recycling was due to low participation and a low sample for those measures. Due to delays in the deployment of a new third-party fulfillment vendor in certain stores, Cadmus could not achieve an adequate sample for lighting intercept and replaced the remaining surveys with a lighting pricing assessment.

Program Materials Review

Cadmus reviewed program materials to gain a thorough understanding of program processes and to identify trends in measures, savings, and overall program performance. These materials included

operation manuals, marketing materials, the program website, and program participant data. Information gathered through the materials review activity served to develop interview and survey guides and to inform subsequent tasks.

Stakeholder Interviews

Cadmus conducted interviews with seven key program staff, including from the New Hampshire utilities and the third-party vendors who help deliver the program, to gain information that could not be derived from analysis of the program's quantitative metrics. Interviews focused on the following key topics:

- Roles and responsibilities in the program
- Research priorities for evaluation efforts, including participant surveys
- Program goals and objectives
- Program design and implementation
- Program administration
- Marketing and outreach
- Program tracking
- Market barriers
- Program participation

Cadmus incorporated research priorities and content captured during initial meetings with stakeholders into the development of subsequent research instruments for program partners and participants.

Partner Interviews

Cadmus randomly sampled and conducted phone interviews with two HVAC installation contractors and the managers of two big-box retail partners involved with the New Hampshire program. These interviews assessed the trade allies' views of the program, gauged the helpfulness of existing training, identified market barriers, gathered insights into customer awareness and interest in products, and obtained overall feedback on respondents' experiences with the program. Cadmus also asked partners about experiences they had with other, similar programs in other jurisdictions (if applicable), and included questions to inform the jurisdictional scan.

Participant Survey

Cadmus conducted 214 residential participant surveys over the course of April and May 2017, deriving the sample from program participation data provided by the New Hampshire utilities and attempting to stratify the sample by program measure type. Table 13 shows survey respondents by utility and Table 14 shows survey respondents by measure.

Table 13. Online Survey Respondents by Utility

Utility	Respondents	Percent of Total
Eversource	117	55%
Liberty	17	8%
NHEC	59	28%
Unitil	21	10%
Total	214	100%

*Totals may not sum to 100% due to rounding

Table 14. Online Survey Respondents by Measure

Measure Name	Survey Participants
Advanced Power Strip	2
Boiler	4
CFL	1
Clothes Washer	1
Condensing Boiler	2
Ductless Mini Split Heat Pump	12
Efficient Lighting Fixture	15
Energy Star Clothes Washer	55
Energy Star Refrigerator	21
Energy Star Room Air Conditioner	13
Energy Star Room Air Purifier	3
Freezer Recycling	2
Furnace	4
Heat Pump Water Heater	8
LED	54
Programmable Thermostat	3
Refrigerator Recycling	2
Tankless Water Heater	2
Wi-fi Thermostat	10
Total	214

The surveys were conducted using an online survey tool and addressed the following topics:

- Awareness of incentives for lighting, appliance, HVAC, hot water system, or thermostat purchases or recycled appliances
- Confirmation that program measures remained installed and operated as planned (in-service rate)
- Motivations for purchasing efficient equipment and the influence of the incentive on the decision to purchase
- Satisfaction with equipment purchased, including operating experiences and perceived energy or cost savings
- Satisfaction with the program (where applicable)

- Barriers encountered in installing the efficient equipment
- Drivers for program participation
- Demographic information, including home size, owned or rented home, income, and level of education

The survey instrument is provided in Appendix G.

Jurisdictional Scan

Cadmus conducted a benchmarking review that compared the New Hampshire ENERGY STAR Products program to similar efficient product programs in the Northeast. Benchmarking included the following:

- Review publicly available evaluation reports and proposed program plans for similar products programs, including lighting, appliance, and gas and electric HVAC programs
- Seek to understand other programs' approaches for engaging partners and participants
- Catalog programs and measures available
- Provide context for the New Hampshire utilities' program design and performance

Cadmus also incorporated questions into interviews with program partners to gather perspectives on various program designs. Some partners had experience with programs in neighboring states or in prior program years, and they shared their insights regarding benefits or challenges involved in midstream or upstream programs in comparison to downstream rebate models.

Process Evaluation Findings

The following sections detail Cadmus' findings on how the program has been designed and delivered; program participation; customer experience, including satisfaction, energy bill reductions, non-energy impacts, and outreach strategies; and contractor and vendor experience.

Program Design

The New Hampshire ENERGY STAR Products program is sponsored jointly by Eversource, Unitil, New Hampshire Electric Co-op, and Liberty Utilities. The design of the program centers on saving energy and capturing lost opportunity by providing incentives for the purchase of high-efficiency ENERGY STAR equipment. The program offers in-store, online, and mail-in rebate incentives as well as product markdowns for specific products.

A large network of partners promote and deliver the ENERGY STAR Products program; these partners include more than 140 retail locations, equipment suppliers, distributors, and installation contractors. The New Hampshire utilities contract with vendors to ensure the availability and visibility of qualifying ENERGY STAR products and promotional materials at their locations in addition to updating point-of-purchase materials and incentive coupons, processing incentives, and developing cooperative marketing.

In 2016, the New Hampshire utilities sponsored an online catalog, available through NHSaves.com, that allowed customers to make direct online purchases of certain qualified products at discounted prices. The New Hampshire utilities have since shifted away from the online catalog and are increasingly focused on ENERGY STAR lighting markdowns, though coupons and rebates are still used for non-lighting products. By 2016, the Appliance Recycling component had become a well-established program, with the current third-party implementer taking over its delivery in the middle of the year after the previous implementer went out of business. The appliance recycling service experienced a good level of demand, and potential may exist for expanding into additional products, such as dehumidifiers.

Utility and implementer staff reported that the four utilities collaborate effectively to implement all aspects of the program and regularly communicate with one another regarding program offerings and performance.

Program Marketing

Each utility developed and used program marketing materials, incorporating a combination of utility-specific information and the NHSaves brand; these included promotional materials displayed in retail stores, bill inserts, newsletters, and social media posts regarding the availability of rebates, discounts, and appliance recycling services.

Retail staff were an important component in successfully marketing appliances, as were installation contractors, especially for gas measures such as HVAC and water heating equipment. Implementation staff reported that training generally helped retail staff explain benefits to customers. Interestingly, sales staff reported that additional features of appliances such as Wi-Fi connectivity tended to be packaged with energy efficiency, which helped them sell ENERGY STAR products. However, the number of training sessions provided to retail staff were dictated by the volume of sales at each retail location; the number of store visits by implementation staff was relative to the volume of sales.

Targets and Program Performance Challenges

Overall, the lighting component exceeded its participation goal in 2016, helping compensate for the program falling short of its non-lighting measure installation targets. One challenge was maintaining the upstream lighting year-round promotions at all retailers without exceeding the budget. Additionally, program implementers noted that attribution has been difficult to establish for lighting because customers paid more attention to branding (i.e., NHSaves) when purchasing white goods. Program implementation staff suggested “more flexibility” around incentive levels in general, based on the current market.

The program also experienced challenges in meeting the planned targets for appliance rebates, due to lower than anticipated customer demand. The saturation of ENERGY STAR products in some categories was found to be quite high, necessitating a push toward higher efficiency tiers and the search for additional measures. This phenomenon is common: as program requirements increase, there tends to be an associated drop in the number of program participants because of the perceived cost-benefit ratio. One implementer suggested that additional savings and efficiency could be realized by introducing additional activities during visits to participant’s homes, similar to the HPwES, such as energy audits or

direct install of additional measures. Another implementer pointed out that nearly 90% of water heater replacements are emergency replacements, with participants going with whatever unit their installer recommended. Further coordination with program implementers could yield insights into additional program opportunities.

Other program-performance and monitoring-related challenges included changing baselines and ensuring that measures continued to be cost-effective. One implementer also noted there are challenges to marketing high-efficiency gas equipment, including warmer winters and lower gas bills, which reduce customer interest in energy efficiency. Cadmus found that gas program administrators experienced initial success in promoting Wi-Fi thermostats (which were cost-effective) but subsequently saw sales of this measure taper off.

Program Changes

The design of the ENERGY STAR Products program has evolved since 2016. Most notably, the lighting markdown program has expanded, and coupons are now available only at smaller retailers. The following lists differences in the current 2018 program offerings compared to 2016:

Lighting Changes

- The coupon component was discontinued at large retailers because these retailers found it too expensive and burdensome to administer, and the implementation team identified the program as one of several that could be switched to a markdown model.
- The utilities moved to a system in which each utility took a deemed share of markdowns, rather than claiming their own specific territory sales, and entered into statewide contracts with The Home Depot and other retailers.
- CFLs were discontinued as a measure offering in 2017.
- The program shortened lighting fixture measure lives from 20 years to eight years in 2017, then further reduced the measure lives to five years in 2018.
- Program per-unit savings, based on the decrease in baseline wattage over time, resulted in reduced deemed kWh per bulb in 2017, 2018, 2019, and 2020.
- The utilities reduced the per-bulb rebate to reflect the change in incremental cost. A low in-service rate was applied in 2017 for LED multipacks (equivalent to the CFL multipack in-service rate); a higher in-service rate for multipacks was applied in 2018–2020 based on a detailed review of all the lighting assumptions.
- The program has moved away from promoting the NHSaves online store and instead focuses its efforts on discounting lighting in retail stores.

Appliance Changes

- Pool pumps and electric clothes dryers were added in 2017.
- In 2018, program administrators introduced tiered incentives for certain measures, such as refrigerators and clothes dryers.
- ENERGY STAR dishwashers were discontinued in 2017.

HVAC Changes

- The program administrators introduced financing options for gas heating system measures in 2017 but Liberty has subsequently discontinued financing for HVAC systems because of their negative impact on cost-effectiveness.
- Since 2016, the utilities have offered ductless mini-split heat pump rebates only for high efficiency cold-climate qualified units.

Program-Wide Changes

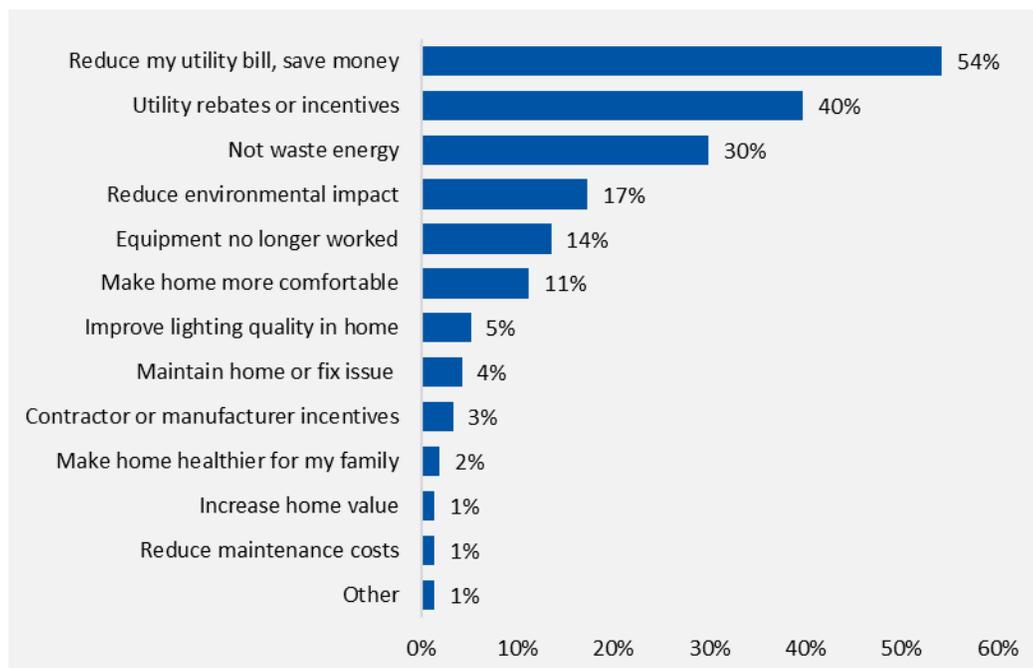
- The utilities went out to bid for a new program circuit rider in 2017. The circuit rider ensures the availability and visibility of qualifying electric and gas ENERGY STAR products and promotional materials at retail partner locations
- The program’s marketing approach and investment via the NHSaves website and social media have changed since 2016 as well, which has had the greatest impact on lighting and appliances.

Program Participation and Motivation

Understanding customer motivations for participating can help the ENERGY STAR Products program target marketing and outreach messages for the 2018–2020 program cycle. Online survey respondents were asked to report their two most important reasons for participating in the program.

As shown in Figure 1, the five most common motivations respondents provided for participating were utility bill reductions or saving money (54%), utility rebates or incentives (40%), to stop wasting energy (30%), to reduce environmental impact (17%), and because equipment no longer worked (14%).

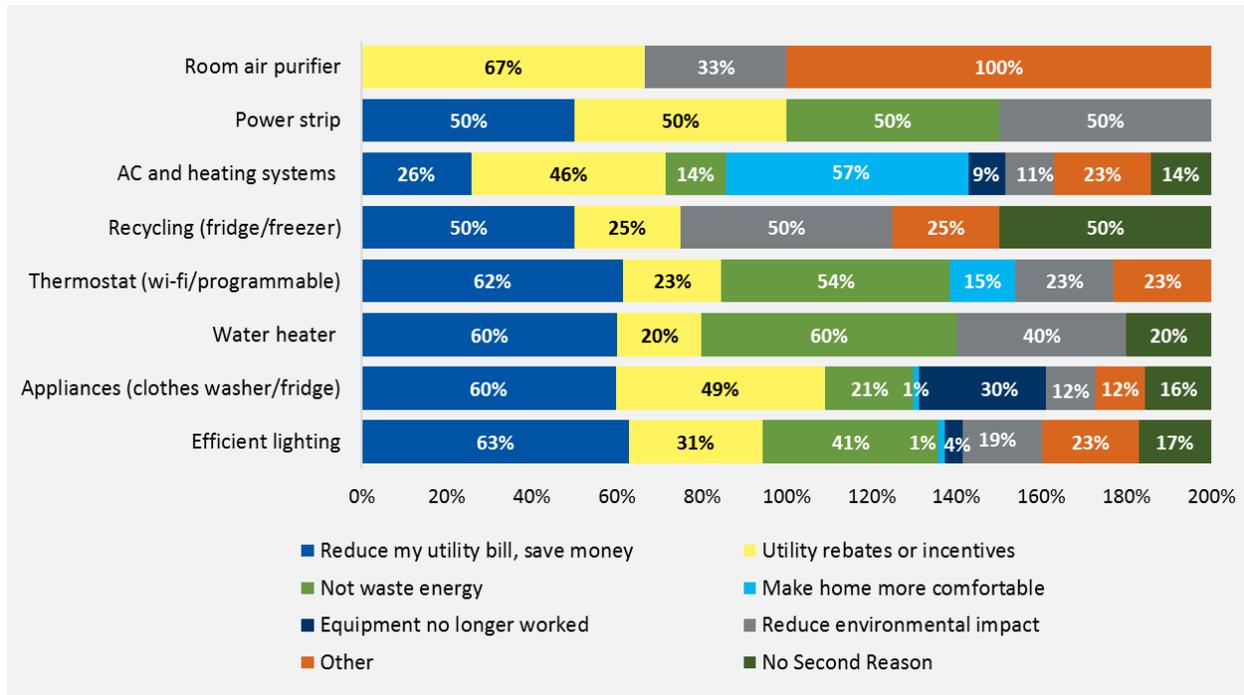
Figure 1. Motivations for Participating, All Respondents



Source: Participant Survey Question D1. "What were the two most important reasons you decided to participate in the New Hampshire ENERGY STAR Products program in 2016?"
(n=214, multiple responses)

Figure 2 shows respondents' motivations for participating in the program by measure type. Generally, motivations were consistent across measures; however, respondents for some categories of measures did vary in their top reported motivations.

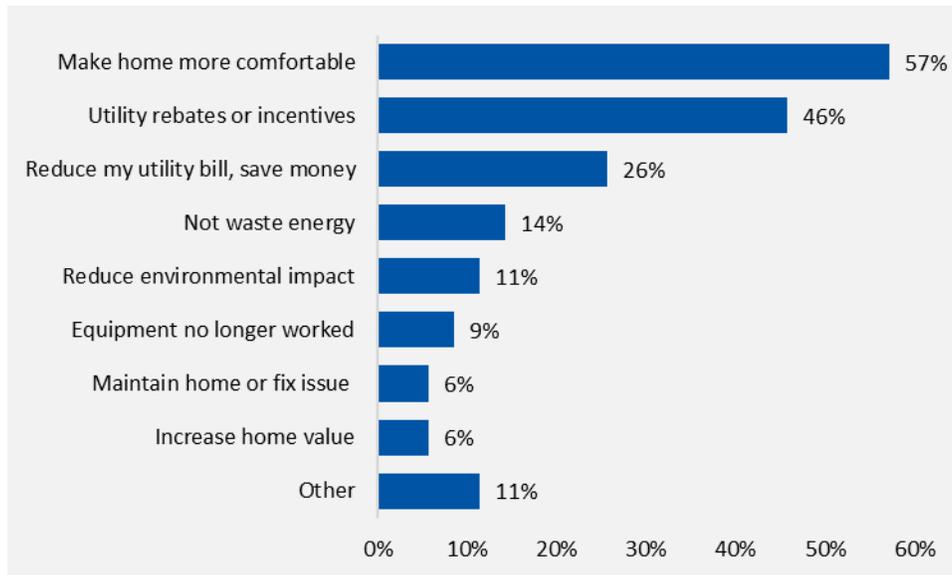
Figure 2. Motivations for Participation by Measure Type



Source: Participant Survey Question D1. "What were the two most important reasons you decided to participate in the New Hampshire ENERGY STAR Products program?" (n=214, multiple responses)

Home comfort was the top motivator for respondents who installed heating or cooling systems. Figure 3 shows that 57% of air conditioning and home heating systems respondents (n=35) reported home comfort as their top motivation. Additionally, 15% of respondents who installed Wi-Fi or programmable thermostats reported home comfortable as a top motivator (n=13).

Figure 3. Motivations for Participating, Air Conditioning and Heating System Respondents



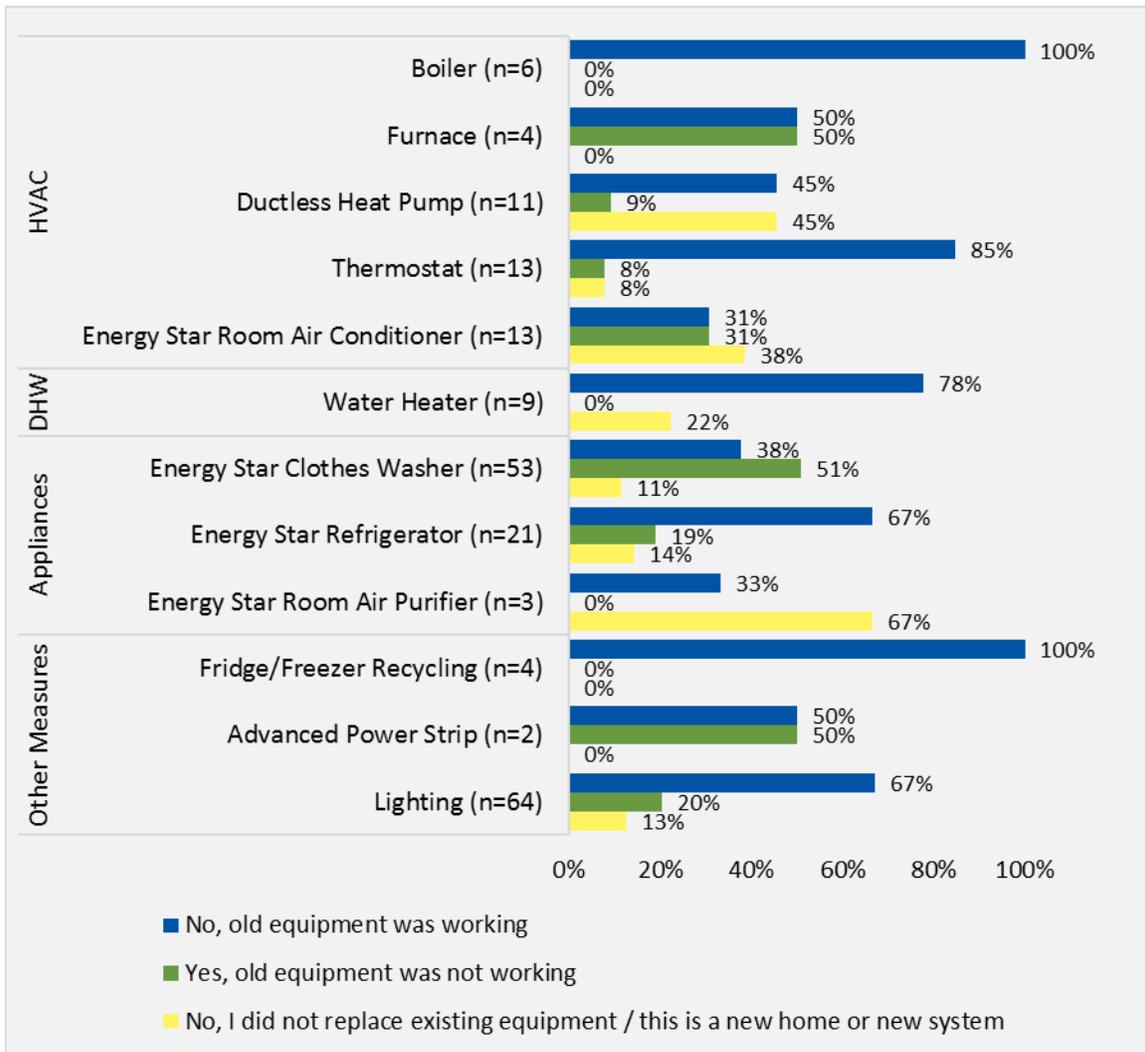
Source: Participant Survey Question D1. "What were the two most important reasons you decided to participate in the New Hampshire ENERGY STAR Products program in 2016?" (n=35, multiple responses)

Energy-efficient lighting respondents (n=70) most commonly reported being motivated to reduce their utility bill (63%) and to save energy (41%); only 16% reported "improve lighting quality in home" as a top reason for participation.

Whether respondents replaced non-working equipment or upgraded their existing working equipment varied by measure type (Figure 4). Most online survey respondents (n=203) replaced existing working equipment (58%) or purchased new equipment they did not previously have (16%); the remaining 26% reported they replaced non-working equipment. Customers were not asked about the age or efficiency of the equipment that was replaced.

Over half of online survey respondents indicated that they had replaced existing equipment that was in working order, which may indicate the utilities are displacing inefficient equipment and under-claiming savings

Figure 4. Replacement of Working Equipment versus Non-Working Equipment



Source: Participant Survey Question D2. "Did you replace non-working equipment?" (n=203)

Stakeholder and Partner Interviews

Program Performance

Overall, the four utilities communicated regularly with one another and program implementers regarding measure offerings and performance. Implementers reported that all of the utilities seem equally invested in program success, which the implementers perceived as very important to the success of the program.

Generally, implementers felt that the program targets for appliances were high relative to the market, resulting in challenges meeting the goals for the non-lighting measures. This sentiment was echoed by a couple of the program administrators, who indicated that the non-lighting measures can face participation challenges because of lower demand for these equipment.

On the other hand, implementers reported lighting goals were much easier to achieve, with implementers attempting to exceed targets for lighting measures to offset shortfalls for appliances. The appliance recycling contractor indicated they believe there is still room for the program to grow, especially with regards to new measures, and identified remoteness and weather as the primary challenges faced by the program.

Gas program administrators expressed concern about hitting targets going forward, citing warmer winters and lower bills as potential drivers for low interest in energy efficient gas measures, and high baselines as challenges to program cost-effectiveness. Liberty noted that while they had high participation in wi-fi thermostats initially (their most cost-effective measure offering), participation in the measure has dropped off, though it is not clear whether the drop is due to the measure reaching saturation, or if the initial wave of early adopters has come to an end. Both gas administrators noted that they are trying to increase participation in their thermostat measure offerings.

Program Delivery and Marketing

The lighting incentive model was largely converted to an upstream markdown model in 2016, though lighting coupons were still available at some smaller retailers. Ultimately, the conversion was brought about at the insistence of one of the program's retail partners, which no longer wanted to record rebate information in their tracking systems. Implementers generally seemed to favor the upstream model for program delivery because of the lower administrative burden. Implementation staff reported that coupons were more difficult to administer relative to the volume of products sold through the channel. However, coupon offerings ensured the program's presence in smaller retailers who sometimes are unwilling or unable to participate in the upstream model.

Implementers noted that program-branded or utility-branded equipment may be a consideration when customers are purchasing white-goods or HVAC equipment, but program-branding was not perceived by the implementer as an important factor for lighting purchases. The implementers also reported that sales of white-goods and HVAC equipment are aided by the customer's perception of increased comfort or convenience. To this end, implementers focus portions of their training on the additional value provided by program-qualified equipment, such as increased home comfort.

Program administrators expressed some concerns about the transition to an upstream model regarding leakage, especially for stores near state borders, and free-ridership. Concerns about free-ridership were part of the reason behind the slow transition to a markdown program model—the coupon program was assumed to limit free-ridership for lighting because of the relatively low incentive relative to the effort of completing the coupon. Program implementers noted that they excluded some stores from the program to limit the potential for leakage. The team investigated leakage through the in-store **Lighting Intercept Survey**.

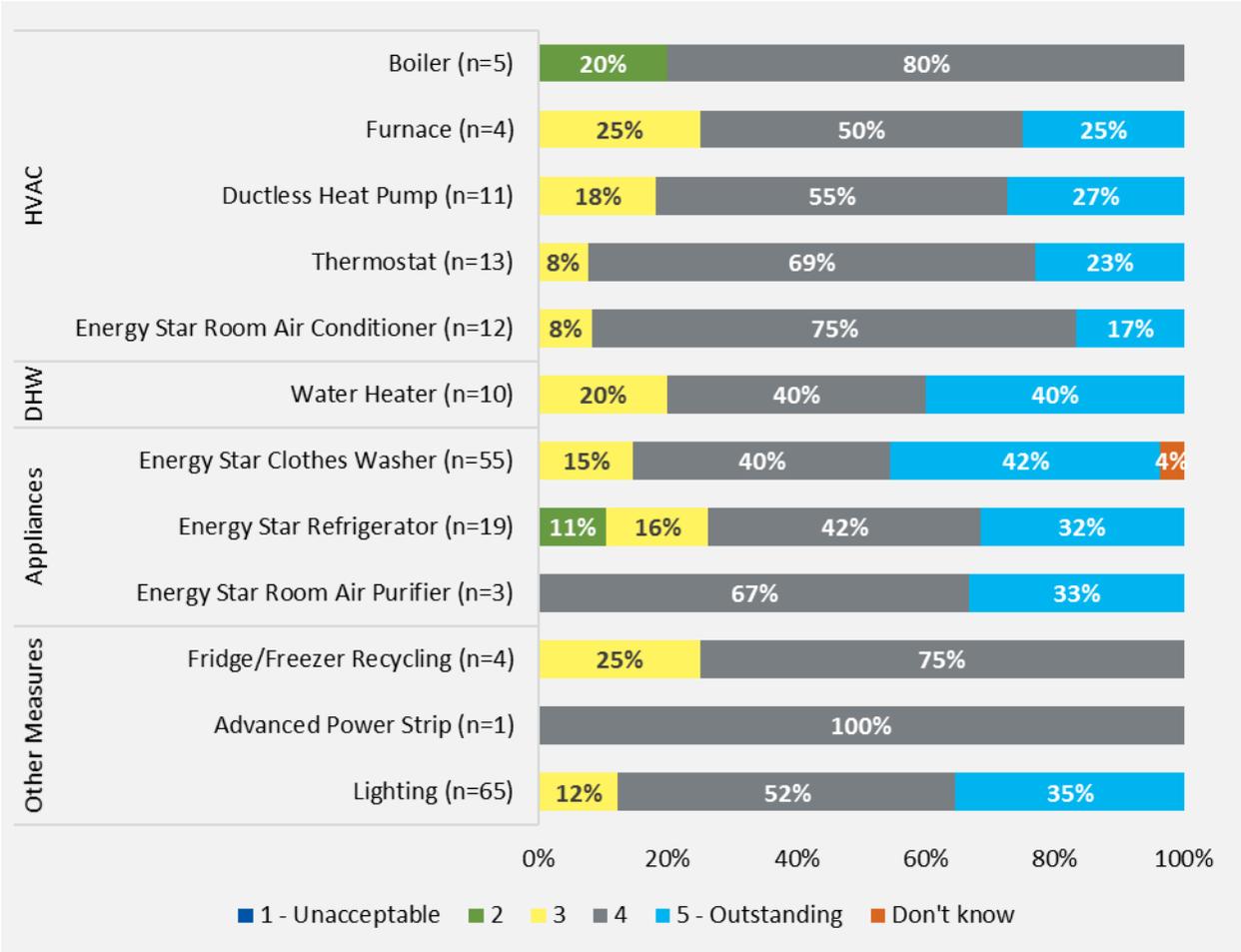
Customer Experience

Program Satisfaction

Cadmus asked online survey respondents to rate their overall experience with the New Hampshire ENERGY STAR Products program on a scale from 1 to 5, where 1 is *unacceptable* and 5 is *outstanding*. The average score among all respondents (n=200) was 4.2. No respondents found their experiences to be unacceptable. Figure 5 illustrates satisfaction levels for all respondents.

Online survey program participants were extremely likely to recommend the program to others. Cadmus asked online survey respondents to report how likely they would be to recommend the program to a friend, again rated on a scale from 1 to 5, where 1 was *extremely unlikely* and 5 was *extremely likely*. The average rating among all respondents (n=200) was 4.4, with most respondents reporting a 5 (*extremely likely*, 57%) or a 4 (28%). No respondents said they would be *extremely unlikely* to recommend the program.

Figure 5. Overall Program Satisfaction



Source: Participant Survey Question G2. "Taking everything into consideration, how would you rate your overall experience with the New Hampshire ENERGY STAR Products Program?" (n=214)

Cadmus also asked online survey respondents to rate key program aspects on a scale from 1 to 5, where 1 was *extremely burdensome* and 5 was *extremely easy*. Table 15 shows the average ease-of-use ratings provided by respondents for each of the program’s key aspects. Respondents considered the easiest part of the program was submitting the applications and the most burdensome was waiting for the rebate to arrive in the mail. With the move towards a markdown-only model, the program is already removing the most burdensome portion of the customer experience.

Table 15. Customer Ease of Program Use

Program Aspect	1	2	3	4	5	Average Score
Completing the application form	2	3	38	59	98	4.2
Obtaining the supporting documentation required for the rebate (e.g., copy of sales receipt)	4	3	28	60	100	4.3
Submitting the application form	2	2	27	56	111	4.4
Submitting the supporting documentation	3	3	31	63	96	4.3
Waiting for the rebate to arrive in the mail	8	11	46	39	88	4.0

Source: Participant Survey Question D5. "On a scale of 1 to 5, where 1 is extremely burdensome and 5 is extremely easy, how would you rate the following aspects of the application process?" (n=214)

Similarly, Cadmus asked online survey respondents to rate the time required to receive the rebate, using a scale from 1 to 5, where 1 was *unacceptable* and 5 was *outstanding*. Most respondents (n=190) rated the time required as a 4 (39%) or a 3 (31%), with an average score of 3.8. Only eight respondents considered the length of time *unacceptable* and the measures these individuals received are shown in Table 16 below.

Table 16. Measure Distribution for Respondents Reporting the Time to Receive Their Rebate was Unacceptable

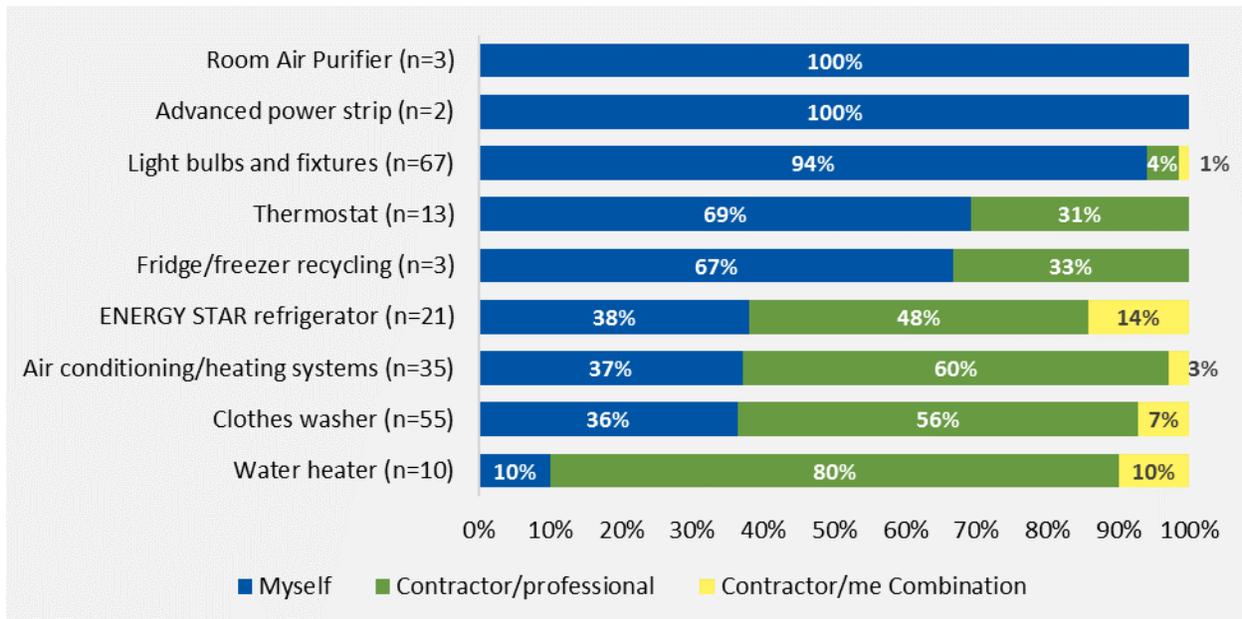
Measure	Participants
Boiler	2
Fridge/Freezer Recycling	2
Energy Star Refrigerator	1
Energy Star Clothes Washer	2
Ductless Heat Pump	1

Source: Participant Survey Question D5. "On a scale of 1 to 5, where 1 is extremely burdensome and 5 is extremely easy, how would you rate the following aspects of the application process?" (n=214)

Satisfaction with Contractors

As shown in Figure 6, most online survey respondents (58%, n=209) installed the energy-efficient product for which they received a rebate or incentive themselves. The remaining participants relied on a professional for installation (or to assist them in the installation). Of these 86 respondents, most selected the contractors or service providers based on retailer or store promotions or advertising, such as a sign in the store (29%); a previous or ongoing experience with the contractor (20%); or a referral from a friend, family member, or neighbor (19%).

Figure 6. Equipment Installation by Measure Type



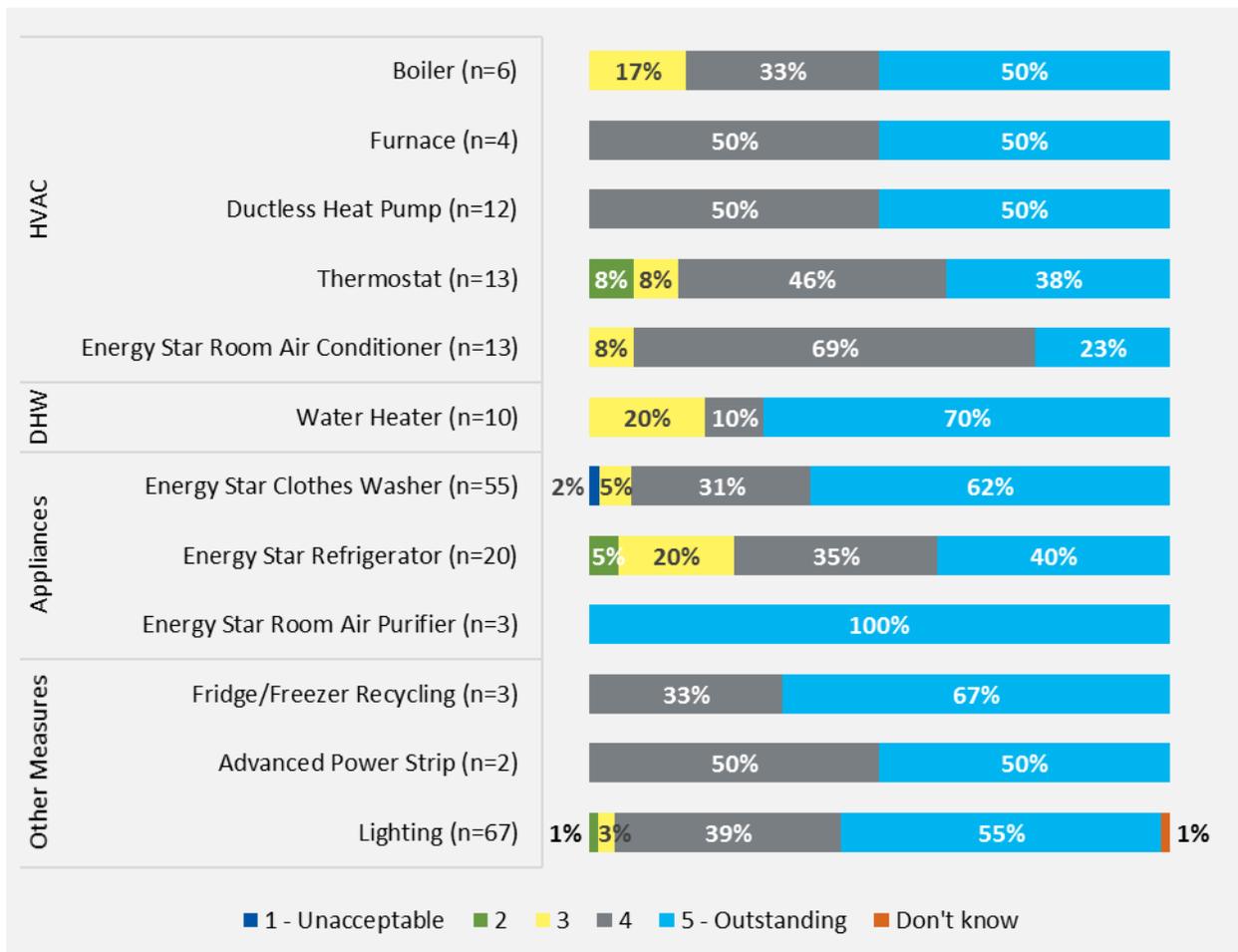
Source: Participant Survey. Question D7: “Who installed your...? Please select only one.”
(n varies by equipment type installed)

Respondents rated their satisfaction with their contractors on a scale from 1 to 5, where 1 was *unacceptable* and 5 was *outstanding*, for an average score among all respondents (n=85) of 4.3. Most respondents (51%) rated their contractors as *outstanding*; no respondent believed their interactions were *unacceptable*.

Satisfaction with Product Performance

Online survey respondents rated their satisfaction with the performance of the purchased products on a scale from 1 to 5, where 1 was *unacceptable* and 5 was *outstanding*. The average score between all respondents (n=208) was 4.4. Most respondents rated their product’s performance as a 5 (53%) or a 4 (38%); only one respondent who received an Energy Star Clothes Washer found the product performance *unacceptable*. Figure 7 shows the distribution of product satisfaction by measure.

Figure 7. Product Satisfaction by Measure

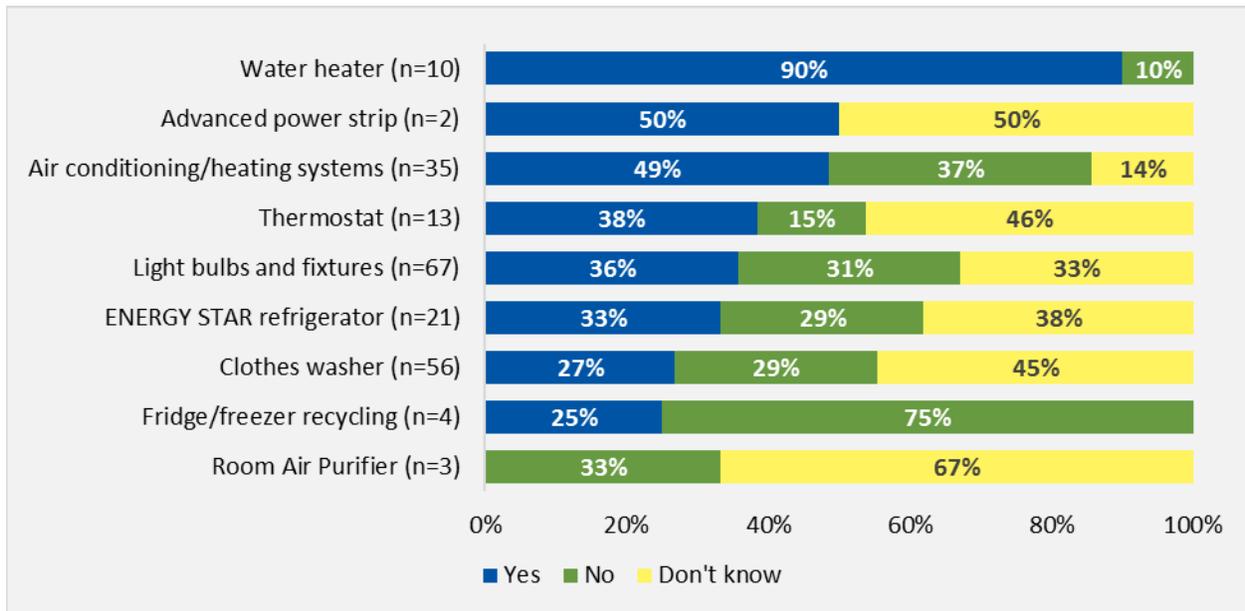


Source: Participant Survey. Question D9: “On a scale of 1 to 5, where 1 is unacceptable and 5 is outstanding, how would you rate the following? - The performance of the product(s) you purchased.”
(n varies by equipment type installed)

Energy Bill Reduction

More than one-third (37%) of online survey respondents (n=211) noticed reductions in their energy bills since installing the measures for which they received a rebate or discount, 30% did not notice a reduction, and 33% were unsure. Figure 8 shows how the perceptions of energy savings varied by the type of equipment installed. Ninety percent of respondents who installed water heaters and 49% who installed heating and cooling systems noticed a reduction in their energy bills. Participants who installed appliances such as air purifiers, clothes washers, and refrigerators were less likely to report an energy bill reduction than other participants.

Figure 8. Perceptions of Energy Bill Reduction by Equipment Installed

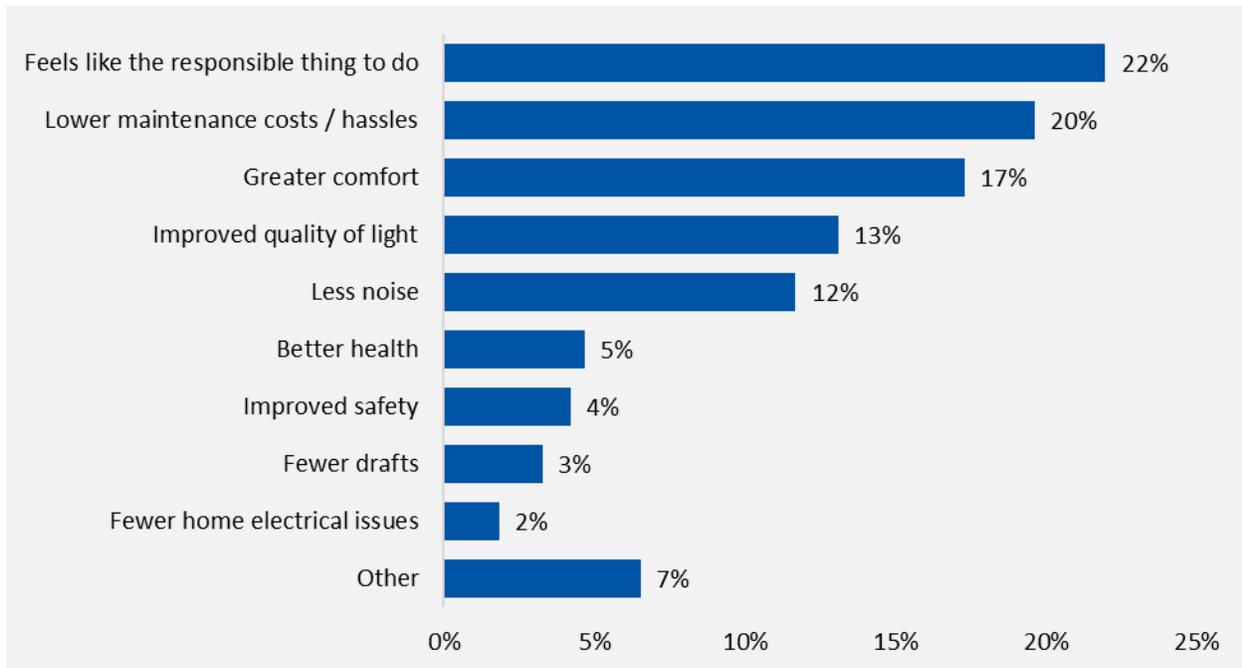


Source: Participant Survey. Question D3: “Have you noticed a reduction in your energy bill since you installed the...”
(n varies by equipment type installed)

Non-Energy Impacts

Many respondents noticed other positive, non-energy impacts resulting from the energy efficiency improvements made to their homes, with 48% (n=214) reporting one or more positive impacts. The most common of these were that making energy-efficient improvements felt like the responsible thing to do (22%), lowered maintenance costs (20%), and produced greater comfort (17%). Figure 9 shows the distribution of positive impacts reported by survey respondents and Figure 43 in Appendix C shows the positive impacts reported by measure type.

Figure 9. Positive Impacts Resulting from Improvements



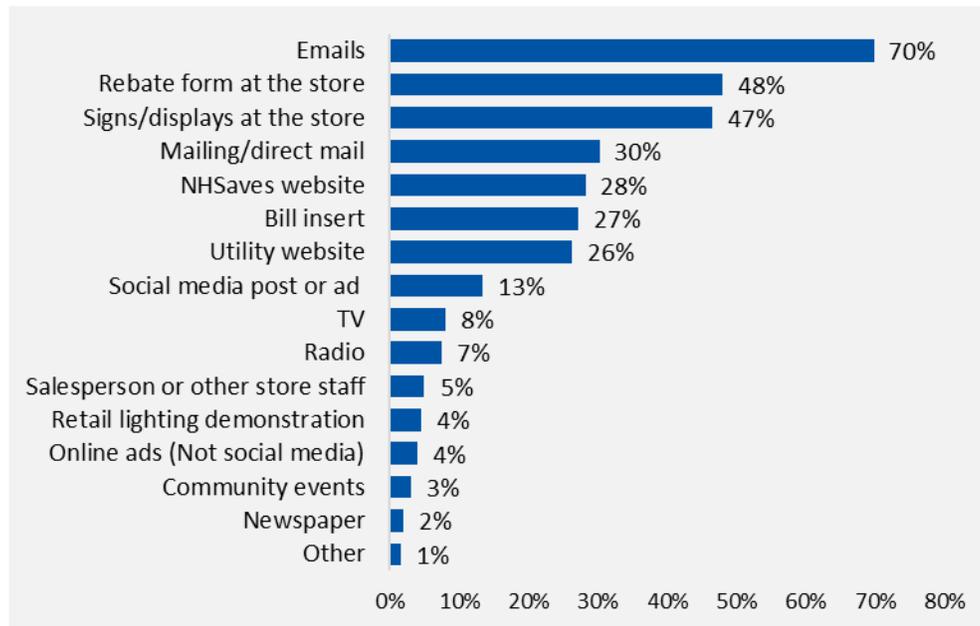
Source: Participant Survey. Question D4: “Have you noticed any other positive impacts resulting from the energy efficiency improvements made to your home? What are they?” (n=214, multiple responses)

Program Outreach

Online survey and in-home lighting inventory survey respondents were asked to select the best ways for their utility to inform them about energy efficiency offerings. Respondents from both surveys provided the same top outreach strategies: email, rebate forms, and signs or displays at stores. Findings from the in-home survey are presented in the Process Evaluation Findings section of the ENERGY STAR Lighting section.

Online Survey Outreach. Respondents (n=202, multiple responses) most commonly identified emails from the utility (70%), rebate forms at stores (48%), and signs or displays at stores (47%) as effective outreach strategies for informing them of future program offerings. Figure 10 shows additional methods of informing customers about energy efficiency offerings.

Figure 10. Online Survey: Best Ways to Inform Customers about Energy Efficiency Offerings



Source: Participant Survey. Question G1: “What are the best ways for your utility to inform you about energy efficiency offerings?” (n=202, multiple responses)

Participant Recommendations for Program Improvement

At the close of the online survey, Cadmus asked respondents to recommend improvements to the New Hampshire ENERGY STAR Products program. Respondents (n=51) provided feedback that mostly fit into four broad topics areas: increase awareness (25%), improve rebate or incentive processes (25%), expand product selection (20%), and ensure the program is funded (16%).

Participants recommended four areas of improvement:

- Increase awareness of program
- Improve rebate or incentive processes
- Expand product selection
- Ensure program is funded

Increase awareness. Respondents said the program should focus on increasing awareness of the program and on encouraging greater marketing and outreach at stores during point-of-purchase, through direct mail, and through email.

Improve the rebate or incentive process. Respondents identified aspects of the rebate or incentive process that needed enhancement for greater customer satisfaction. Common feedback included providing rebate status updates so participants could track their rebates and improving the website’s usability so participants could quickly find necessary rebate information. Participants also requested speeding up the rebate process, reducing upfront costs of products in lieu of the mail-in rebate, and making online submittal an option for all rebates. Specific feedback included the following:

- “My plumbing contractor had nothing to gain by helping me with the paperwork (his portion of it), so it was difficult for me to [complete the] application... It took me three tries to get the

correct paperwork. Suggestion: design an application process which doesn't involve the third party.”

- “We have purchased, along with the air purifier, a new fridge, a new air conditioner, a new hot water heater, a new stove, and a new dishwasher in the last year and a half. I've had trouble redeeming the rebate on all of the others that qualified, and I believe most of them did. I don't think the system is that easy to use, and I use rebate systems all the time. The air purifier was the only one that went through all the way. So that stinks. We've pretty much remodeled our entire house. But I do appreciate that the program exists, I know I'm not entitled to any money back; it was just a nice thought to see along with the purchase of these major appliances. They can become quite expensive fairly fast. It sometimes seems that those who can afford the energy-efficient items are those who need it the least.”

Expand product selection. Respondents requested that the program expand its selection of products. Although most respondents did not provide specific product requests, some suggested products with solar and renewable energy applications and new window installations.

Ensure program is funded. Several respondents missed out on the rebate or incentive opportunities extended to them because of a lack of funding. Specific feedback included the following:

- “Ensure that the program is fully funded, and that rebate applications are acknowledged when received, then promptly issued. The wait and then uncertainty of whether the rebate would actually be issued does not encourage future participation in the program.”
- “I felt misled. I applied for the rebate for my high-efficiency furnace. I received nothing, only a message that the fund was depleted. Kinda like, tough luck!”

Vendor and Contractor Experience

Cadmus interviewed store management staff from two participating retailers and administrative staff from two installation contractors.

Vendor Experience

Interviews with staff from two retailers indicated that program rebates helped sell efficient products, especially when convincing late adopters to replace their existing equipment; nevertheless, the program could benefit from more communication with and regular training of retail staff. One respondent said that broader outreach to store staff—including those not directly involved with selling specific products—would help when customers do not seek assistance from appliance sales staff.

For example, one retail staff respondent said that if cashiers and service desk staff do not know about program rebates, they cannot answer questions from customers or help make customers who are purchasing certain equipment aware of rebates on efficient options. This respondent added that, although the vendor did a good job of educating staff it interacted with, the store did not incorporate education about the program into its regular curriculum. Both respondents said customers exhibited low awareness of program rebates in 2016, before the retail staff received education about the program, but that customers tended to want efficient products in general.

Both retail staff respondents said additional training and clear signage would help eliminate customers' confusion about program eligibility criteria and the rebate process. They also said customers did not want to be told to go online to apply for a rebate later and, instead, wanted an instant rebate at the register to be certain they received it. Both respondents agreed rebates were helpful (one specifically mentioned the attraction of instant discounts) and should continue but with additional or more integrated education and support for retail staff.

Contractor Experience

The interviewed contractor staff also thought contractors could benefit from additional communication and education about program incentives as well as support in educating customers about energy use of the equipment. One specifically mentioned sometimes hearing about renewed incentive offerings from customers rather than from the utility or program implementation staff. Both said they had not had any interaction with program representatives.

Both contractors said they helped customers fill out the rebate applications. One said the application process was time-consuming and thought determining eligibility for rebates was complicated, especially for HVAC equipment, because required inputs varied for different system components. This respondent suggested a way to verify eligibility and submit the applications using only model numbers. The other respondent said the application was simple enough but rebates took too long to get to customers. Both contractors agreed rebates were important and helped them market and sell efficient equipment to customers.

Jurisdictional Scan

Cadmus performed a jurisdictional scan to compare the New Hampshire ENERGY STAR Products program to other, similar programs in New England. Cadmus reviewed the 16 programs or initiatives shown in Table 17, comparing their offerings to NHSaves. The jurisdictional scan included electric and gas measure offerings.

Notable differences in program offerings are these:

- New Hampshire ENERGY STAR Products program is the only program that offered room air conditioner recycling.
- New Hampshire's is the only program that did not offer rebates for efficient shower fixtures.
- Massachusetts programs offered incentives for the early replacement of central air conditioners, central heat pumps, hot water boilers, and furnaces with electronically commutated motors (ECMs).
- Rhode Island's 2017 National Grid Energy Efficiency Program and Massachusetts' Residential Heating and Cooling (Gas and Electric) Program offer effective retailer and contractor training.
- Many benchmarked programs used marketing and outreach strategies that include affinity marketing, social media, in-store events, and community engagement events.

Following the table are descriptions of each of the benchmarked programs.

Table 17. Comparison of New Hampshire ENERGY STAR Products Program to Benchmarked Programs

Program Name	Utility, Jurisdiction	Evaluated Annual Net Energy Savings (MWh)	Gross Savings (MWh)	Delivery Model	Rebate and Incentive Model	Marketing and Outreach Strategies
New Hampshire ENERGY STAR Products Program	New Hampshire	-	10,102	Administered by PAs with use of delivery contractors	Upstream incentives, mail-in rebates, online catalog	Direct mail, bill inserts, email, website, point-of-purchase promotions, through contractors and retail
Electric Efficient Products	Efficiency Vermont	-	48,420	Administered by Efficiency Vermont	Upstream incentives, mail-in rebates, online catalog	Point of purchase, print, broadcast, web-based, social media, community events
Residential Consumer Products Initiative	National Grid, Massachusetts	5,668 (PY2016)	-	Administered by PAs with use of delivery contractors, circuit rider	Upstream incentives, mail-in and online rebates, online catalog	Social media, affinity marketing, retail partnerships, point of purchase promotions, consumer engagement events, in-store displays, email
	Unitil, Massachusetts	147 (PY2016)				
	Cape Light, Massachusetts	894 (PY2016)				
	Eversource, Massachusetts	5,716 (PY2016)				
Residential Lighting Initiative	National Grid, Massachusetts	200,287 (PY2016)	-	Administered by PAs with use of delivery contractors, circuit rider	Manufacturer incentives, retail incentives, online catalog	Social media, affinity marketing, retail partnerships, point of purchase promotions, educational advertising, in-store displays
	Unitil, Massachusetts	1,703 (PY2016)				
	Cape Light, Massachusetts	28,906 (PY2016)				
	Eversource, Massachusetts	150,403 (PY2016)				
Residential Heating and Cooling (Gas and Electric)	National Grid, Massachusetts	4,442 (PY2016)	-	Administered by PAs with use of delivery contractors, circuit rider	Upstream incentives and rebates	Direct mail, bill inserts, email, website; through contractors and retail
	Unitil, Massachusetts	97 (PY2016)				
	Cape Light, Massachusetts	939 (PY2016)				
	Eversource, Massachusetts	4,056 (PY2016)				
ENERGY STAR Appliances	National Grid, Rhode Island	4,491 (PY2017)	-	Administered by National Grid, use of vendor	Midstream and upstream incentives, online store	Broadcast and cable television, pre-roll video, broadcast radio, streaming radio, local newspaper, native advertising, social

Program Name	Utility, Jurisdiction	Evaluated Annual Net Energy Savings (MWh)	Gross Savings (MWh)	Delivery Model	Rebate and Incentive Model	Marketing and Outreach Strategies
						media
ENERGY STAR Lighting	National Grid, Rhode Island	60,993 (PY2017)	-	Administered by National Grid, use of vendor	Midstream incentives	Broadcast and cable television, pre-roll video, broadcast radio, streaming radio, local newspaper, native advertising, social media, in-store events
ENERGY STAR HVAC	National Grid, Rhode Island	1,642 (PY2017)	-	Administered by National Grid, use of vendor	Midstream and upstream incentives	Broadcast and cable television, pre-roll video, broadcast radio, streaming radio, local newspaper, native advertising, social media, community events

Efficiency Vermont Electric Efficient Products, 2016

The Electric Efficient Products program offers rebates on ENERGY STAR-certified appliances, point-of-purchase discounts on LED light bulbs, and a range of other incentives and services to educate and motivate Vermonters. Efficiency Vermont administers the program, providing consumers with rebates on select products as well as manufacturer- and retail-level discounts.

In 2016, the Efficient Products program focused on advanced power strips, boilers, central wood pellet furnaces and boilers, clothes washers and dryers, dehumidifiers, furnaces, heat pump cooling and heating systems, heat pump water heaters, high-performance circulator pumps, LED ENERGY STAR downlights, LED ENERGY STAR fixtures, LED ENERGY STAR light bulbs, pool pumps, refrigerators, smart thermostats, solar water heaters, do-it-yourself (DIY) insulating, and air sealing.

The program used a wide range of marketing and outreach strategies, including point-of-purchase marketing; print, broadcast, and web-based advertising promotions; social media; and community events, such as home shows, trade shows, and fairs.

Table 18 shows the gross MWh savings (by end use) for the Efficient Products program.

Table 18. PY2016 Electric Efficient Products End Use Breakdown

End Use	Gross MWh Savings
Air Conditioning Efficiency	213
Cooking and Laundry	564
Electronics	1,619
Hot Water Efficiency	2,312
Lighting	37,457
Motors	1,034
Other Efficiency	0
Other Indirect Activity	0
Refrigeration	268
Space Heat Efficiency	4,955
Total	48,420

Note: Values may not total exactly due to rounding

Rhode Island: National Grid Energy Efficiency Programs, 2017

National Grid Rhode Island offered three programs that provided incentives or rebates on appliances, lighting, and heating and cooling systems. Rhode Island’s Energy Efficiency programs benefited from a comprehensive marketing campaign that included broadcast and cable television, pre-roll video, broadcast radio, streaming radio, local newspaper, native advertising, and social media.

ENERGY STAR Appliances Program

In 2017, the ENERGY STAR Appliances program focused on a wide range of efficient products, including dehumidifiers, dryers, room air cleaners, room air conditioners, pool pumps, advanced power strips, and showerheads. The program also promoted refrigerator and freezer recycling. The ENERGY STAR Appliances program collaborates with the ENERGY STAR Lighting program to use the same resources with retailers, retailer training, and social media campaigns. The program also staffs outreach tables at retail locations to demonstrate and promote various products.

ENERGY STAR Lighting Program

In 2017, National Grid’s ENERGY STAR Lighting program offered low-cost, energy-efficient lighting options to consumers. The program relied on a lead vendor to provide retailers with education and outreach, recruit retailers, organize and staff promotional activities, and coordinate midstream and upstream incentives as well as a network of vendors and distributors to educate and promote products to retailers and consumers. To reach the largest number of customers, the program focused on educating retailers through in-person training and using an online training platform. The program also partnered with food banks to offer no-cost light bulbs to hard-to-reach consumers. In addition to the comprehensive marketing campaign, the program was marketed at the retail level through point-of-purchase promotions and in-store events.

High-Efficiency Heating and Cooling Program

The Heating and Cooling program used tiered customer rebates to promote installations of high-efficiency gas and electric space heating and cooling equipment, water heating measures, and controls. The program also provided contractor training and incentives for quality installation, proper equipment sizing, and distribution system improvements. National Grid administered the program, and a vendor was responsible for outreach and support of participating contractors. In addition to the comprehensive marketing campaign, the program was marketed through industry events such as home shows.

Table 19 shows and energy savings by program.

Table 19. PY2017 Energy Efficiency Program Savings

Program	Actual Annual Energy Savings (MWh)
ENERGY STAR Appliances	4,491
ENERGY STAR Lighting	60,993
High-Efficiency Heating and Cooling	1,642

Massachusetts Residential Products Program: National Grid, Unitil, Cape Light Compact, Eversource, 2016

The electric Residential Products program is one of many energy efficiency programs administered as a collaborative effort among program administrators from utilities throughout Massachusetts. The program comprises four core initiatives that offer rebates and incentives to encourage consumers to install energy-efficient products, lighting, and heating and cooling equipment. Program Administrators

work together to provide access to efficient products and equipment for customers across Massachusetts.

Table 20 shows the Residential Products evaluated annual net electric savings and fossil fuel interactive effects by utility across all initiatives.⁵

Table 20. PY2016 Residential Products Energy Savings by Utility

Utility	Evaluated Annual Net Energy Savings (MWh)	Evaluated Annual Net Gas Savings (Therms)	Evaluated Annual Net Oil Savings (MMBtu)	Evaluated Annual Net Propane Savings (MMBtu)
National Grid, Massachusetts	210,397	-2,727,844	-239,539	-12,119
Unital, Massachusetts	1,947	-18,430	-1,115	-6,774
Cape Light Compact	30,739	-382,900	-25,660	-1,970
Eversource	160,175	-1,980,340	-133,064	-9,885

Residential Consumer Products

The Consumer Products initiative focuses on increasing awareness, educating consumers, and driving market penetration of ENERGY STAR appliances and electronics as well as promoting appliance recycling and expanding the use of innovative technology to achieve greater energy savings. Products promoted through the Consumer Products initiative included advanced power strips, clothes washers, dryers, dehumidifiers, refrigerators, room air cleaners, shower fixtures, and room air conditioners. Discount and incentive levels vary for each product, with rebates for clothes washers and refrigerators requiring prequalification through a home energy assessment. The program also offers refrigerator and freezer recycling.

The initiative applies a multi-stream delivery system that involves using a fulfillment contractor, an Internet/mail-order sales channel contractor, and a circuit rider. The circuit rider is an outreach contractor responsible for engaging with retailers, ensuring stores have point-of-purchase materials, and coordinating the efforts of program administrators, retailers, and manufacturers. The initiative offers upstream incentives, mail-in and online rebates, and an online catalog that allows customers to take advantage of program offerings.

The initiative reaches residential electric customers through a variety of marketing and outreach strategies that include retail partnerships, point-of-purchase promotions, in-store displays, affinity marketing, customer engagement events, and email and social media campaigns. The program

⁵ Interactive effects account for increases in ancillary fuel use, shown as negative savings, resulting from the installation of an energy efficiency measure. As an example, CFL and LED lamps produce the same amount of light as incandescent and halogen lamps but require less input energy because more of the input energy is converted into useful light rather than heat. Because CFLs and LEDs produce less heat, the home heating system actually consumes more energy than it would with halogen or incandescent lighting.

administrators also offer prizes to product manufacturers for efficient product sales and to engage in partnerships with local and national retailers that effectively display and sell various products.⁶ The initiative emphasizes consumer education and motivation, and trains retailers to serve as efficiency resources and champions to consumers.

Table 21 presents the Consumer Products evaluated annual net electric savings and fossil fuel interactive effects by utility.

Table 21. PY2016 Residential Consumer Products Energy Savings by Utility

Utility	Evaluated Annual Net Energy Savings (MWh)	Evaluated Annual Net Gas Savings (Therms)	Evaluated Annual Net Oil Savings (MMBtu)	Evaluated Annual Net Propane Savings (MMBtu)
National Grid, Massachusetts	5,668	3,915	436	384
Unutil, Massachusetts	147	599	43	16
Cape Light Compact	894	262	12	9
Eversource	5,716	12,801	487	405

Residential Lighting

The Residential Lighting initiative’s objectives include educating and motivating consumers to use ENERGY STAR lighting products and to expand the availability of and demand for such products in the current market. The initiative offers rebates or incentives for LED bulbs and fixtures.

The initiative delivers lighting products to consumers through a combination of upstream incentives at the manufacturer level, midstream incentives at the retail level, and an online catalog. The Residential Products and Residential Lighting initiatives use many of the same delivery vendors, including the circuit rider (manufacturer/outreach contractor), internet/mail order vendor, and rebate fulfillment contractor.

As with the Consumer Products initiative, the Lighting initiative has robust marketing and education strategies that include retail partnerships, point-of-purchase promotions, social media campaigns and contests, and affinity marketing. The initiative strives to bring awareness and easy access to efficient lighting for all consumers, including hard-to-reach customers.

Table 22 presents the Lighting evaluated annual net electric savings and fossil fuel interactive effects by utility.

⁶ Performance incentives of any kind are not applicable to Cape Light Compact.

Table 22. PY2016 Residential Lighting Energy Savings by Utility

Utility	Evaluated Annual Net Energy Savings (MWh)	Evaluated Annual Net Gas Savings (Therms)	Evaluated Annual Net Oil Savings (MMBtu)	Evaluated Annual Net Propane Savings (MMBtu)
National Grid, Massachusetts	200,287	-2,720,853	-239,632	-12,448
Unitil, Massachusetts	1,703	-18,920	-1,150	-297
Cape Light Compact	28,906	-380,964	-25,617	-1,971
Eversource	150,403	-1,982,192	-133,285	-10,253

Residential Heating and Cooling (Gas and Electric)

The Residential Heating and Cooling initiative is comprised of an electric program and gas program that work together to bring efficient heating and cooling equipment to electric and gas customers. The electric initiative provides rebates for installations of high-efficiency HVAC and heat pump water heating technologies and provides upstream incentives on ECM circulator pumps. The primary measures promoted include high-efficiency central air conditioners, ducted air source heat pumps, ductless mini-split heat pumps, heat pump water heaters, and ECM furnace fans and circulator pumps. The initiative also offers incentives for duct testing, duct sealing, and equipment downsizing. Contractors receive incentives for using installation best practices, that are confirmed through a third-party verification process.⁷

The natural gas initiative (GasNetworks) provides rebates and incentives for high-efficiency furnaces (with ECM fan systems), hot water boilers, water-heating equipment, and heating system controls, such as wireless programmable thermostats and heat recovery ventilators. The initiative also supports an early replacement promotion and provides incentives to contractors for quality installations.

The electric initiative is administered by the electric program administrators, and GasNetworks is administered by the gas program administrators. The initiatives use the same circuit rider, who is responsible for outreach, education, and support for contractors, distributors, and supply houses as well as for a rebate processing vendor. GasNetworks uses a website contractor for website support.

The electric and gas initiatives collaborate on marketing and outreach efforts, targeting consumers as well as the contractors, distributors, and retailers promoting efficient equipment. Marketing efforts include direct mail, bill inserts, digital media, and participation in trade shows and in other events where contractors and distributors can be reached.

Both initiatives include prioritized contractor training and work together and with industry partners to provide education and awareness to contractors, with an emphasis on installation best practices.

Table 23 presents the evaluated annual net energy savings and fossil fuel electric effects by utility for the Residential Heating and Cooling gas and electric initiatives.

⁷ Performance incentives of any kind are not applicable to Cape Light Compact.

Table 23. PY2016 Residential Heating and Cooling Energy Savings by Utility

Utility	Evaluated Annual Net Energy Savings (MWh) ¹	Evaluated Annual Net Gas Savings (Therms) ¹	Evaluated Annual Net Oil Savings (MMBtu)	Evaluated Annual Net Propane Savings (MMBtu)
National Grid, Massachusetts	4,041	1,469,564	-397	-56
Unitil, Massachusetts	101	13,085	-8	-1
Cape Light Compact	939	-2,198	-55	-8
Eversource	4,275	438,545	-267	-37

¹Savings and interactive effects are both included.

2018–2020 Baseline Assumptions Review

Cadmus reviewed the savings input assumptions and backup calculations provided by the program implementers for the 2018-2020 program cycle. Cadmus reviewed the assumptions and calculations provided by the New Hampshire utilities to technical reference manuals (TRMs) from Massachusetts, Maine, Vermont, and Wisconsin and provided the EM&V Working Group with a workbook that compared all measures across the TRMs.

Cadmus found that all 2018–2020 measures appeared reasonable but offered some suggestions for the future and/or further fine tuning of savings:

- **LED lighting.** Because lighting markets continue to quickly evolve, continue to decrement baseline wattage to reflect the presence of high-efficiency lighting already in the home will provide the most accurate savings.

Cadmus does not suggest applying realization rates from the 2016 evaluation report to the 2018–2020 programs but does suggest incorporating other evaluation findings in future program planning. These evaluated values include lighting HOU and annual unit savings for furnaces and condensing boilers, shown in Table 24 and Table 25.

Table 24. Recommended Update to Lighting Savings Inputs

Measure	Variable	Proposed Daily Value	Proposed Annual Value	Precision at 90% Confidence	Source
Lighting	Hours of Use	1.75	638.8	22.0%	Cadmus home inventory and metering study

Table 25. Recommended Update to Boiler and Furnace Savings Assumptions

Measure	Baseline	Proposed Savings	Precision at 90% Confidence	Source
Boiler: ≥ 90% AFUE (up to 300 MBH)	Early Replacement	10.1	14.5%	Cadmus billing analysis
	Federal Standard	7.9	14.9%	
	Market Research	4.8	15.0%	
Boiler: ≥ 95% AFUE (up to 300 MBH)	Early Replacement	13.8	14.5%	
	Federal Standard	11.7	14.9%	
	Market Research	8.7	15.0%	
Furnace ≥ 95% AFUE w/ECM	Early Replacement	14.5	14.5%	
	Federal Standard	12.4	14.9%	
	Market Research	7.8	15.0%	
Furnace ≥ 97% AFUE w/ECM	Early Replacement	15.7	14.5%	
	Federal Standard	13.7	14.9%	
	Market Research	9.1	15.0%	

Conclusions and Recommendations

Conclusion: Cadmus found most of the program’s deemed assumptions reasonable for 2018–2020, with suggested updates for a handful of measures.

- **Recommendation:** For future program planning, continue to assume that baseline wattage will decrease year-over-year due to the increasing likelihood that a program LED could become a substitute for an LED or CFL not marked down through the program.
- **Recommendation:** Update lighting HOU to use the value determined through the metering study, as shown in Table 26. Given that the program will be incentivizing only LED equipment for the 2018-2020 program cycle, Cadmus recommends using the daily HOU value of 1.75 (638.8 hours annually). Assumptions should be reviewed regularly and revised if needed, including prior to the launch of the 2021 program.

Table 26. Recommended Update to Lighting Savings Inputs

Measure	Variable	Proposed Daily Value	Proposed Annual Value	Precision at 90% Confidence	Source
Lighting	Hours of Use	1.75	638.8	22.0%	Cadmus home inventory and metering study

- **Recommendation:** Update per-unit annual MMBtu savings for furnaces and condensing boilers with results from the metering and billing analysis, as shown in Table 27.

Table 27. Recommended Update to Boiler and Furnace Savings Assumptions

Measure	Baseline	Proposed Savings	Precision at 90% Confidence	Source
Boiler: ≥ 90% AFUE (up to 300 MBH)	Early Replacement	10.1	14.5%	Cadmus billing analysis
	Federal Standard	7.9	14.9%	
	Market Research	4.8	15.0%	
Boiler: ≥ 95% AFUE (up to 300 MBH)	Early Replacement	13.8	14.5%	
	Federal Standard	11.7	14.9%	
	Market Research	8.7	15.0%	
Furnace ≥ 95% AFUE w/ECM	Early Replacement	14.5	14.5%	
	Federal Standard	12.4	14.9%	
	Market Research	7.8	15.0%	
Furnace ≥ 97% AFUE w/ECM	Early Replacement	15.7	14.5%	
	Federal Standard	13.7	14.9%	
	Market Research	9.1	15.0%	

Conclusion: Communication and collaboration among utilities was effective and positive, and perceived by the implementers as a key factor in the program’s success.

- **Recommendation:** Continue to work together effectively and consider additional interaction with retailer and contractor partners.

Conclusion: Retailer and contractor partners play an important role in educating customers and driving program participation; they would be better equipped to succeed with more support from program representatives in the form of regular communications and training.

- **Recommendation:** Consider working with implementation staff to establish connections with contractor partners and retail managers to determine the optimal frequency and audience for educational outreach efforts. For retailers, investigate the possibility of incorporating program education into store-wide training to ensure broad awareness among store staff.
- **Recommendation:** Increase communication with contractors regarding program offerings and incentive levels.

Conclusion: Customers and vendors (retail and contractor) would appreciate a simpler and quicker rebate application process. Gaps in program offerings tend to confuse and frustrate customers and program partners.

- **Recommendation:** Work with implementation staff to explore possible online rebate assistance and tracking tools to assist customers and improve the transparency of the rebate eligibility requirements and process.
- **Recommendation:** Consider developing a rebate path for customers that is independent of contractor participation.

Conclusion: The five most common motivations respondents provided for participating were utility bill reductions or saving money (54%), utility rebates or incentives (40%), to stop wasting energy (30%), to reduce environmental impact (17%), and because equipment no longer worked (14%).

- **Recommendation:** Marketing and outreach materials should target these top five motivators for the 2018–2020 cycle.

Conclusion: Notable differences exist between the ENERGY STAR Products program offered in New Hampshire relative to similar programs offered in neighboring jurisdictions. The New Hampshire program is the only one offering room air conditioner recycling other jurisdictions offered early replacement versions of HVAC measure offerings, and the New Hampshire program does not offer efficient shower fixtures as a program offering.

- **Recommendation:** Consider offering early replacement versions of HVAC measure offerings, including central air conditioners, central heat pumps, and furnaces with ECMs.
- **Recommendation:** Consider including efficient shower fixtures as a program offering.

Conclusion: Over half of online survey participants reported that they removed or replaced working equipment to install the new equipment incentivized through the program. This finding was not incorporated into the evaluation of *ex post* savings because customers were not asked about the age or efficiency of the replaced equipment, and measure-level sample sizes were relatively small.

- **Recommendation:** Consider additional research to determine the rate at which program-incented products are replacing working equipment as well as the age and efficiency of the equipment replaced.

ENERGY STAR Lighting

Program Overview and Evaluation Tasks

In 2016, the New Hampshire ENERGY STAR Products program offered in-store, online, and mail-in rebate incentives as well as product markdowns for lighting products. The New Hampshire utilities also sponsored an online catalog, available through NHSaves.com, that allowed customers to make direct online purchases of certain qualified products at discounted prices. Since 2016, the utilities have shifted away from the online catalog and are increasingly focused on ENERGY STAR product markdowns. The following sections focus on Cadmus’ evaluation of the lighting measures offered through the 2016 ENERGY STAR Products program.

PY2016 Measures

Lighting measures offered in 2016 included a variety of CFL and LED products, including single packs of bulbs, large multipacks of bulbs, and ENERGY STAR-qualified fixtures. Table 28 shows the measures offered through the program.

Table 28. Lighting Measure Counts

Measure Name	Quantity of Units Rebated
CFL Interior Fixtures	1,236
CFL Multipacks	45,240
CFL Single-Packs	17,526
LED Exterior Fixtures	20
LED Interior Fixtures	9,278
LED Multipacks	72,059
LED Single-Packs	206,559
Total	351,918

Source: B/C models provided by the utilities

Summary of Savings Results

Overall, Cadmus found that lighting measures achieved 92.1% of *ex ante* savings. The realization rate, shown in Table 29, was mostly affected by the decrease in per-unit savings, largely resulting from differences in delta watts and HOU. For the purpose of the 2016 evaluation, demand savings are reported for the Independent System Operator New England (ISO-NE) summer and winter peak periods. Cadmus used the peak coincidence factors recorded in the utility B/C models to evaluate demand savings.

Table 29. 2016 ENERGY STAR Lighting Savings

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	7,905,902	138,201,987	852.3	2,446.6	0	0
<i>Ex Post</i> ¹	7,284,885	125,709,927	924.6	2,653.5	0	0
Realization Rate	92.1%	91.0%	108.5%	108.5%	--	--

¹ *Ex post* demand savings are based on findings from the in-home lighting study and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Table 30 displays lighting *ex ante* and *ex post* savings. Overall, LEDs contributed 84% of annual *ex post* program savings and 95% of lifetime *ex post* savings.

Table 30. Lighting Products *Ex Ante* and *Ex Post* kWh Savings

Measure	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings	Precision at 90% Confidence
CFL Interior Fixtures	22,326	178,609	102.0%	22,773	182,188	16.1%
CFL Multipacks	816,871	4,084,356	102.0%	833,553	4,167,763	16.1%
CFL Single-Packs	316,435	1,582,174	102.0%	322,919	1,614,594	16.1%
LED Exterior Fixtures	492	2,461	86.2%	424	2,121	14.0%
LED Interior Fixtures	220,096	1,760,772	89.4%	196,754	1,574,035	14.0%
LED Multipacks	1,700,768	34,015,365	89.8%	1,528,056	30,561,122	14.0%
LED Single-Packs	4,828,913	96,578,251	90.7%	4,380,405	87,608,104	14.0%
Total	7,905,902	138,201,987	92.1%	7,284,885	125,709,927	14.1%

Note: Values in table may not match exactly due to rounding.

The lighting products achieved 925 kW savings coincident with the ISO-NE summer peak and 2,654.8 kW coincident with the ISO-NE winter peak. Program-level summaries are provided in Table 31.

Table 31. Lighting Demand Savings

Measure	<i>Ex Ante</i> ISO-NE Summer kW Savings	<i>Ex Ante</i> ISO-NE Winter kW Savings	Realization Rate	<i>Ex Post</i> ISO-NE Summer kW Savings ¹	<i>Ex Post</i> ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
CFL Interior Fixtures	2.3	6.9	119.8%	2.8	8.3	16.1%
CFL Multipacks	91.0	252.7	119.9%	109.0	302.9	16.1%
CFL Single-Packs	32.9	98.4	119.9%	39.5	117.9	16.1%
LED Exterior Fixtures	0.1	0.2	101.2%	0.1	0.2	14.0%
LED Interior Fixtures	22.9	68.4	105.0%	24.1	71.9	14.0%
LED Multipacks	191.2	520.4	106.6%	203.7	554.5	14.0%
LED Single-Packs	511.9	1,499.6	106.6%	545.4	1,597.9	14.0%
Total	852.3	2,446.6	108.5%	924.6	2,653.5	14.3%

¹ *Ex post* demand savings are based on the findings from the in-home lighting study and participant surveys. Cadmus did not evaluate coincidence factors and uses the same values outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Table 32 displays the *ex ante* kWh savings contribution by utility.

Table 32. Lighting *Ex Ante* kWh Savings Contributions by Utility

Utility	<i>Ex Ante</i> kWh Savings	Percentage Contribution
Eversource	4,905,207	62.0%
Liberty	757,585	9.6%
NHEC	681,649	8.6%
Unitil	1,561,460	19.8%
Total	7,905,902	100.0%

Note: Values in table may not match exactly due to rounding.

Evaluation Tasks

Cadmus used a combination of the research activities described below, as well as a participant survey, to evaluate the lighting component of the ENERGY STAR Products program. Detailed research methods and findings are provided in the *Ex Post* Savings Findings and the Process Evaluation Findings sections.

Program Records Review

To inform the *ex ante* impact evaluation, Cadmus conducted a review of the benefit-cost (B/C) models used by the utilities to ensure that *ex ante* savings used the applicable algorithms and inputs stipulated by the EM&V Working Group. The utility B/C models were also cross-checked against the year-end savings reports filed with the PUC.

Engineering Analysis

Cadmus determined *ex post* energy and demand savings through an engineering analysis that incorporated findings from on-site data collection and participant surveys. Findings from the primary data collection activities informed the evaluation’s inputs for hours of use, wattage reduction, and in-service rates.

Lighting Inventory and Metering Study

Cadmus measured residential lighting hours of use for LED and non-LED fixtures (i.e., estimated a whole home average) and conducted comprehensive lighting inventories in 48 New Hampshire households to determine LED lamp saturation levels among energy efficiency program participants. The home inventory data allowed Cadmus to assess current LED saturation level in New Hampshire and investigate whether trends in LED installation by room or socket type. Installation and storage-rate data, in conjunction with data collected during the lighting intercept survey, were used to assess the installation rate assumptions used to estimate *ex post* savings. In addition, Cadmus asked about participants’ motivations for purchasing LEDs, to what extent markdowns or incentives influenced their decisions (if applicable), and what other bulb types they had considered purchasing. The survey instrument is provided in Appendix H.

During the home visits, Cadmus technicians installed up to 10 lighting state meters in each home. These meters were attached to light fixtures to record changes in the on/off state of the metered fixtures; the

team used these data to develop estimates for hours of use.⁸ During the meter installation, Cadmus also conducted in-home audits to collect information on rooms and socket types, along with installed bulb types (e.g., A-line, specialty, reflector) and wattages (where easily accessible). Cadmus technicians also documented bulb types and wattages for each bulb in storage. Finally, they installed an indoor temperature meter in each home to gather indoor air temperature data.

Cadmus offered each study participant a \$50 incentive for the initial visit and another \$50 incentive for a visit to retrieve metering equipment. The 48 study participants were recruited via email from participants in the ENERGY STAR Product program and included 16 gas program participants. Because the sample was selected from program participants, it may not be directly comparable to the general population. Cadmus did not quantify potential bias and did not weight the results to account for differences between the sample sites and the general population.

Table 33 shows the distribution of site visit participants by measure category, and the geographic distribution of these sites is shown in the following **Lighting Intercept Survey** section.

Table 33. Distribution of Sites Visited by Equipment Rebated

Rebated Equipment	Site Count
Recycling	1
Appliances-White Goods ¹	30
Electric HVAC & DHW	1
Gas HVAC & DHW	16
Total	48

¹ Note: Two of these sites also received lighting rebates (coupons).

New Hampshire has a high percentage of vacation homes, so there was some concern that a disproportionate number of homes in the study were secondary homes. Metering occurred largely during non-vacation months (colloquially referred to as “Mud Season”), and Cadmus surveyed homeowners to help determine whether the homes were vacation properties. Approximately 69% of respondents indicated they either worked from the home at least one day per week or had someone in the household who was home during most workdays. Based on the in-home interview responses, the team believes there probably were few, if any, vacation homes in the final sample and did not adjust findings to account for the possibility of vacation homes in the sample.

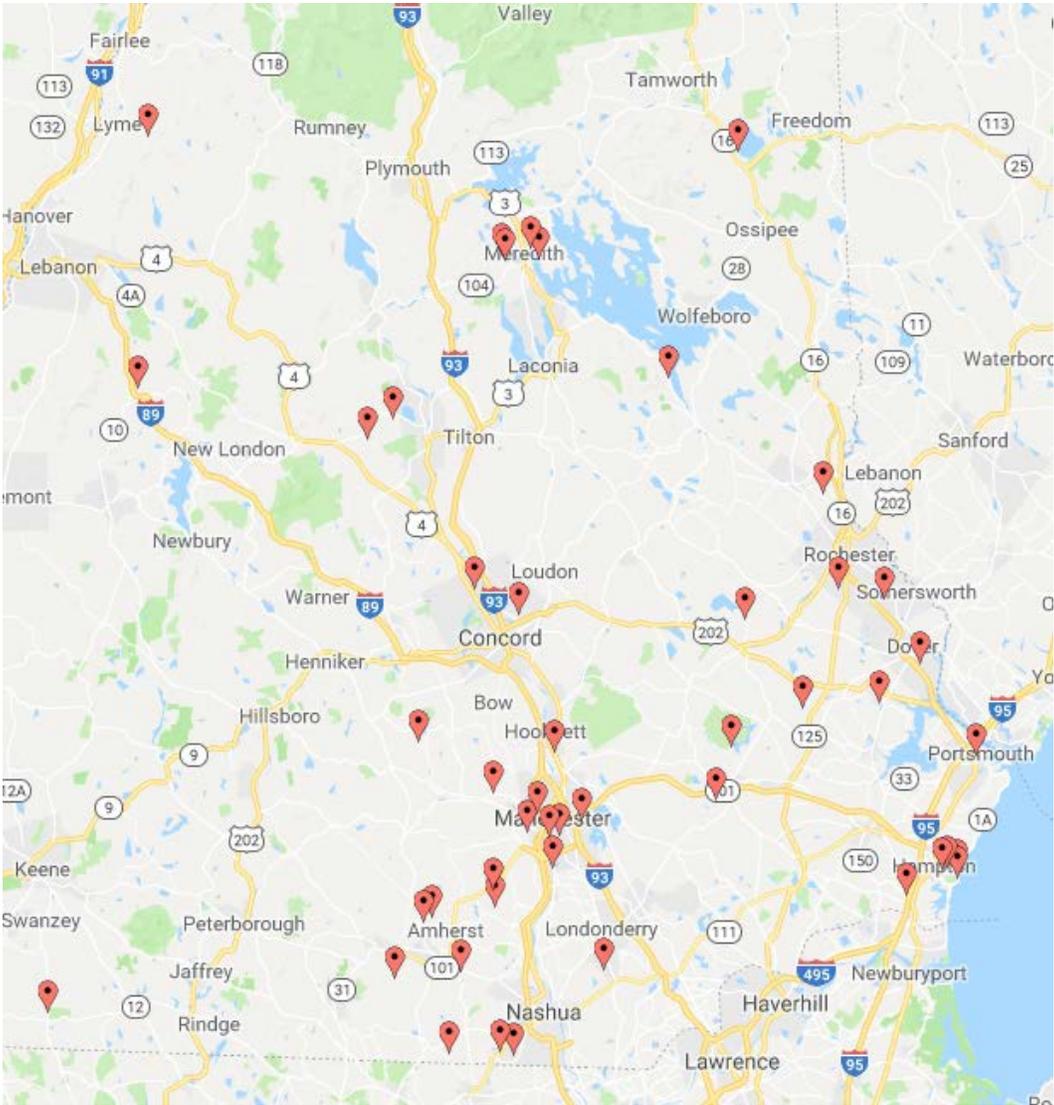
⁸ Cadmus installed meters from the end of January 2018 through May 2018, capturing at least three weeks of data on either side of the spring equinox. However, the metered period did not include sufficient data in the ISO-NE summer and winter peak periods (June – August and December – January) to evaluate peak coincidence factors. Cadmus used the peak coincidence factors recorded in the utility B/C models in conjunction with the in-service rates and delta watts developed through the evaluation to calculate *ex post* demand savings for the lighting measures.

Lighting Intercept Survey

Store intercept surveys provide valuable information on customer behaviors and motivations for purchasing specific lighting products while a respondent’s memory is fresh. Cadmus conducted 33 surveys across 11 big-box stores in New Hampshire, with the goal of estimating out-of-state leakage and sales of markdown lighting products to nonresidential customers. A trained survey enumerator approached shoppers, either in the lighting aisle or immediately after they paid for their purchases, and offered them a small incentive (e.g., a gift card) in exchange for participating in the survey. The surveys addressed all general-service lighting purchases, including non-program products (e.g., halogen or incandescent bulbs).

Figure 11 shows the approximate locations of homes visited.

Figure 11. Home Locations Visited for Lighting Inventory and Metering Study



Because of delays in establishing a new program vendor to service the stores,⁹ the evaluation team did not achieve the desired number of intercept surveys so instead conducted an assessment of lighting pricing. Nevertheless, the information gathered from the completed intercept surveys provided relevant information about the effects of in-store advertising on customer behavior and customer motivations for purchasing specific lighting products. While conducting the intercept surveys, Cadmus also reviewed in-store point-of-purchase advertising, evaluating the presence of advertising types and location of advertising.

Table 34 presents the plan, sample, and results for conducting participant and store intercept surveys. Cadmus ensured that, where applicable, surveys included gas and electric participants. The achieved sample sizes reflect the final number of participant responses included in the evaluation’s analysis. The data collection instrument for the participant survey is provided in 0.

Table 34. Preliminary Participant Survey Plan

Measure	Format	Planned Sample Size	Achieved ¹
Markdown Measures (LEDs and CFLs)	Store Intercept Survey	Up to 20 stores	11 stores; 33 surveys

¹ Low response for heating and cooling and appliance recycling was due to low participation and a low sample for those measures. Due to delays in the lighting program’s launch in certain stores, Cadmus could not achieve an adequate sample for lighting intercept and replaced the remaining surveys with a lighting pricing assessment.

Lighting Pricing Assessment

Cadmus supplemented the in-store intercept surveys with a lighting pricing assessment. For this assessment, Cadmus collected information about lighting products from retailer websites in New Hampshire and Massachusetts to determine the following:

- Availability (number of models stocked and inventory, when available) of program and non-program lamps at participating and nonparticipating retailers, including incandescent bulbs, halogens, CFLs, and LEDs in standard and specialty forms
- Regular and sales prices offered by retailers (not utility incentives) for program and non-program lamps
- Customer satisfaction, determined by tracking customer reviews and product ratings

⁹ The utilities had completed an RFP for a new vendor to service participating stores. Delays in the new vendor’s set-up process limited the number of stores that could participate in the study.

A web-based search tool was used to monitor program and non-program lamp inventories (number of packages on hand) and pricing at participating and nonparticipating big-box stores.¹⁰ The team collected inventory data of program-equivalent lighting products in 25 stores from a big-box retailer (Retailer 1) selling program-discounted products.¹¹ Of these stores, 20 were in New Hampshire and the remaining five were in Massachusetts, near the shared border. The team also collected data from 18 stores of a competing big-box retailer (Retailer 2) that does not sell program-discounted products. The Retailer 2 stores serve as a comparison to characterize the LED market absent program support.

Table 35. Preliminary Participant Survey Plan

Measure	Format	Planned Sample Size	Achieved
Markdown Measures (LEDs and CFLs)	Online	Websites of two major retailers representing 43 brick-and-mortar store locations (25 for Retailer 1; 18 for Retailer 2) in New Hampshire and Massachusetts	2 major retailers; 43 brick-and-mortar locations

Data on the available inventory within each store location was collected once per week for three consecutive weeks. To calculate the share of inventory, package quantity was multiplied by the number of bulbs per package, summed across the three weekly observations, and divided by total inventory within each store and product category (e.g., all 60-watt equivalent general service program LEDs at a location divided by all 60-watt equivalent bulbs at that location).

To assess customer satisfaction with non-program products, Cadmus compared customer satisfaction ratings for program LEDs and non-program LED products at both participating and nonparticipating retailers. Using customer ratings to assess customer satisfaction assumes there is no difference in the frequency or proportions of fake reviews between ENERGY STAR-qualified products, “value” LED products, and other technologies. As such, Cadmus considered only the numerical rating of each review and did not make any adjustments for the possibility of fake reviews. The team did not collect written comments provided in product reviews.

The team reviewed the data for completeness throughout the three-week data collection period, with special attention to the following factors:

- Prices (original and sale price)
- Brand or manufacturer
- Number of packs in stock
- Bulb style (reflector, decorative, general)

¹⁰ Large and established national lighting brands account for the majority of products available in the stores included in the study, regardless of technology or ENERGY STAR qualification. For example, at one retailer, General Electric has multiple product lines for LED bulbs at a variety of price points: GE Basic LEDs are non-dimmable and are not ENERGY STAR-qualified; GE Classic are mid-tier and meet ENERGY STAR 2.0 specifications. The other retailer sells EcoSmart LEDs that are ENERGY STAR-qualified as well as EcoSmart LEDs that are not qualified.

¹¹ In this context, “program-equivalent” means lighting products that are program-qualified or could be installed in place of a program-qualified product.

- Date of data collection
- Pack size
- Product identifier (store SKU, model number)
- purpose)
- Lumen output
- Customer rating

Additionally, the data collection tool pulled data for all light bulb types, including nonresidential, appliance, and decorative/holiday lights. To ensure a meaningful comparison, all bulbs that were not directly comparable to products featured in New Hampshire’s program were removed from the data. Bulbs removed from the data were tube fluorescents, appliance bulbs, heat lamps, black lights, holiday lighting strings, bullet-shaped bulbs, and programmable or connected bulbs.

Impact Evaluation

Cadmus determined energy savings, summer peak demand savings, and winter peak demand savings using engineering analysis and primary data gathered through the home inventory and metering site visits. Participant survey data informed the team’s evaluated in-service rates.

Ex Ante Savings Methodology

Cadmus conducted a review of the utility B/C models to determine the total number of measures rebated and verify *ex ante* reported savings. The team also reviewed savings inputs and compared energy-savings assumptions across the four utilities to identify inconsistencies in savings assumptions.

Ex Ante Savings Findings

Overall, the PY2016 New Hampshire ENERGY STAR Products program claimed 7,905,902 in *ex ante* kWh savings, 852.3 in ISO-NE summer kW savings, and 2,446.6 in ISO-NE winter kW savings attributable to the program’s lighting measures. The program also claimed 138,201,987 in lifetime kWh savings.

Table 36 shows the program’s *ex ante* savings inputs by measure. Table 37 summarizes the *ex ante* savings by measure and includes the utility-estimated in-service rates. Table 38 presents total utility *ex ante* savings for each utility.

Table 36. 2016 Program Ex Ante Per-Unit Savings Inputs

Measure Name	Baseline Wattage	Efficient Wattage	Delta Watts	HOU	ISR ¹	Waste Heat Factor	ISO-NE Summer Coincidence ²	ISO-NE Winter Coincidence ³
LED Exterior Fixtures	44.5	10.8	33.7	2.0	100.0%	1.0	7.6%	22.7%
LED Interior Fixtures	44.5	10.8	33.7	2.0	96.4%	1.0	7.6%	22.7%
LED Multipacks	44.5	10.8	33.7	2.0	95.0%	1.0	7.6%	22.7%
LED Single-Packs	44.5	10.8	33.7	2.0	95.0%	1.0	7.6%	22.7%
CFL Interior Fixtures	59.0	19.3	39.7	2.0	96.4%	1.0	7.6%	22.7%
CFL Multipacks	59.0	19.3	39.7	2.0	62.3%	1.0	7.6%	22.7%
CFL Single-Packs	59.0	19.3	39.7	2.0	62.3%	1.0	7.6%	22.7%

¹ Until assumed an ISR of 96.4% for LED multipack energy (kWh) savings. NHEC assumed an ISR of 62.3% for CFL Interior Fixtures.

² Liberty assumed 10.8% for ISO-NE Summer Coincidence for 93.3% of lighting measures rebated.

³ Liberty assumed 22.0% for ISO-NE Winter Coincidence for 93.3% of lighting measures rebated.

Table 37. 2016 Program *Ex Ante* Savings by Measure

Measure Name	Quantity Units Rebated	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW
CFL Interior Fixtures	1,236	22,326	178,609	2.3	6.9
CFL Multipacks	45,240	816,871	4,084,356	91.0	252.7
CFL Single-Packs	17,526	316,435	1,582,174	32.9	98.4
LED Exterior Fixtures	20	492	2,461	0.1	0.2
LED Interior Fixtures	9,278	220,096	1,760,772	22.9	68.4
LED Multipacks	72,059	1,700,768	34,015,365	191.2	520.4
LED Single-Packs	206,559	4,828,913	96,578,251	511.9	1,499.6
Total	351,918	7,905,902	138,201,987	852.3	2,446.6

Source: B/C models provided by the utilities.

Note: Values in table may not match exactly due to rounding.

Table 38. 2016 Program *Ex Ante* Savings by Utility

Utility	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW
Eversource	4,905,207	85,799,540	510.7	1,525.3
Liberty	757,585	12,859,070	109.8	228.8
NHEC	681,649	11,951,142	71.0	212.0
Unitil	1,561,460	27,592,234	160.9	480.5
Total	7,905,902	138,201,987	852.3	2,446.6

Source: B/C models provided by the utilities.

Note: Values in table may not match exactly due to rounding.

Ex Post Savings Methodology

Lighting savings were determined through engineering analysis with supporting research from the home site visits and participant surveys used to inform the *ex post* savings assumptions. Cadmus evaluated *ex post* savings using the algorithms below. The savings inputs are defined in Table 39.

$$kWh\ Savings = Quantity \times ISR \times \frac{\Delta Watts}{1000} \times HOU \times WHF$$

$$Coincident\ Peak\ Demand\ Reduction = Quantity \times ISR \times \frac{\Delta Watts}{1000} \times CF \times WHF$$

Table 39. Savings Inputs for Lighting Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of bulbs purchased	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Fixtures: 97.7% LEDs: 97.0% CFLs: 100.0%	Cadmus Participant Survey
ΔWatts (Delta Watts)	Difference between baseline and energy-efficient connected wattage	LEDs: 35.2 CFLs: 29.6	Cadmus Home Inventory Site Visits; ENERGY STAR Qualified Products List
1,000	Conversion factor to convert watts to kilowatts	1,000	--
HOU	Average annual hours of use per bulb	620.9	Cadmus Metering Study
WHF	Waste heat factor to account for cooling savings from efficient lighting	1.0	2016 Vermont Technical Reference Manual
CF	ISO-NE peak coincidence factor (summer or winter)	Summer: 7.6% Winter: 22.7%	Utility B/C Models

Ex Post Savings Findings

Table 40 displays lighting *ex ante* and *ex post* savings. Overall, LEDs contributed 84% of total *ex post* program savings.

Table 40. Lighting Products Ex Ante and Ex Post kWh Savings

Measure	Ex Ante kWh Savings	Ex Ante Lifetime kWh Savings	Realization Rate	Ex Post kWh Savings	Ex Post Lifetime kWh Savings	Precision at 90% Confidence
CFL Interior Fixtures	22,326	178,609	102.0%	22,773	182,188	16.1%
CFL Multipacks	816,871	4,084,356	102.0%	833,553	4,167,763	16.1%
CFL Single-Packs	316,435	1,582,174	102.0%	322,919	1,614,594	16.1%
LED Exterior Fixtures	492	2,461	86.2%	424	2,121	14.0%
LED Interior Fixtures	220,096	1,760,772	89.4%	196,754	1,574,035	14.0%
LED Multipacks	1,700,768	34,015,365	89.8%	1,528,056	30,561,122	14.0%
LED Single-Packs	4,828,913	96,578,251	90.7%	4,380,405	87,608,104	14.0%
Total	7,905,902	138,201,987	92.1%	7,284,885	125,709,927	14.1%

Note: Values in table may not match exactly due to rounding.

The lighting products achieved 924.6 kW savings coincident with the ISO-NE summer peak and 2,653.5 kW coincident with the ISO-NE winter peak. Cadmus’ per-unit savings inputs are provided in Table 41, and program-level summaries are provided in Table 42.

Table 41. Ex Post Lighting Demand Per-Unit Savings Inputs

Measure Name	Maximum kW Reduction	ISO-NE Summer Coincidence	ISO-NE Winter Coincidence	ISR	ISO-NE Summer kW Savings	ISO-NE Winter kW Savings
LED Exterior Fixtures	0.0352	7.6%	22.7%	97.7%	0.0026	0.0078
LED Interior Fixtures	0.0352	7.6%	22.7%	97.7%	0.0026	0.0078
LED Multipacks	0.0352	7.6%	22.7%	97.0%	0.0026	0.0077
LED Single-Packs	0.0352	7.6%	22.7%	97.0%	0.0026	0.0077
CFL Interior Fixtures	0.0296	7.6%	22.7%	97.7%	0.0022	0.0066
CFL Multipacks	0.0296	7.6%	22.7%	100.0%	0.0023	0.0067
CFL Single-Packs	0.0296	7.6%	22.7%	100.0%	0.0023	0.0067

Table 42. Lighting Demand Savings

Measure	Ex Ante ISO-NE Summer kW Savings	Ex Ante ISO-NE Winter kW Savings	Realization Rate	Ex Post ISO-NE Summer kW Savings ¹	Ex Post ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
CFL Interior Fixtures	2.3	6.9	119.8%	2.8	8.3	16.1%
CFL Multipacks	91.0	252.7	119.9%	109.0	302.9	16.1%
CFL Single-Packs	32.9	98.4	119.9%	39.5	117.9	16.1%
LED Exterior Fixtures	0.1	0.2	101.2%	0.1	0.2	14.0%
LED Interior Fixtures	22.9	68.4	105.0%	24.1	71.9	14.0%
LED Multipacks	191.2	520.4	106.6%	203.7	554.5	14.0%
LED Single-Packs	511.9	1,499.6	106.6%	545.4	1,597.9	14.0%
Total	852.3	2,446.6	108.5%	924.6	2,653.5	14.3%

¹ Ex post demand savings are based on findings from the in-home lighting study and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models. Note: Values in table may not match exactly due to rounding.

Lighting Inventory and Metering Study Results

Cadmus measured residential lighting hours of use for LED and non-LED fixtures (i.e., estimated a whole home average) and conducted comprehensive lighting inventories in 48 New Hampshire households to determine LED lamp saturation levels among program participants. During the site visits, a Cadmus technician performed a whole-home lighting inventory, moving from room-to-room within the home and recording the characteristics of each fixture and light bulb. Once the whole-home survey was complete, the technician generated a random list of rooms then installed meters on fixtures selected randomly within those rooms.

Data collected during the visit included bulb location (room type), type and style of bulb (e.g., LED standard A lamp, LED reflector), bulb wattage, number of bulbs per fixture, type of fixture, type of socket, and the installation status of the bulb (in service, that is, plugged into a socket, or stored and not in use). Cadmus also tracked the number of empty sockets in each room in the household.

LED Socket Saturation

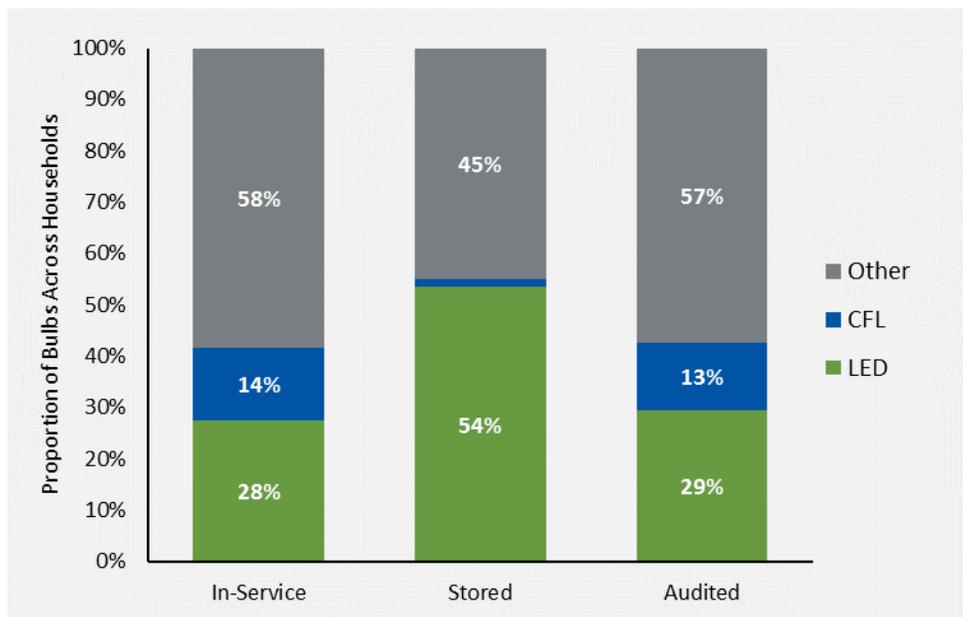
Cadmus used the in-home audit data to calculate the saturation of LED bulbs across households in the study. LED saturation is high in New Hampshire, and LEDs are relatively well distributed across room types—LED bulbs accounted for 28% of all bulbs in-service and CFL bulbs accounted for an additional 14% of bulbs. Other less-efficient lighting filled the remaining 58% of sockets.

LED saturation is high in New Hampshire, and LEDs are relatively well distributed across room types. LED bulbs accounted for 28% of all bulbs in service, and CFL bulbs accounted for an additional 14% of bulbs.

LED saturation in New Hampshire is higher than in nearby states: the 2018 Massachusetts Residential Lighting Market Assessment found an LED saturation of 27% and in New York LED saturation was found to be 14%. The CFL socket saturation found in this study (14%) is lower than the percentages found in Massachusetts (26%) and New York (21%) in 2016–2017.¹²

The majority of stored bulbs were LEDs (54%) and CFLs (2%), with the remainder comprised of other bulb types (45%). Figure 12 shows the proportion of bulbs in service, in storage, and across all audited bulbs by bulb type.

Figure 12. LED Saturation for In-Service, Stored, and Audited Bulbs

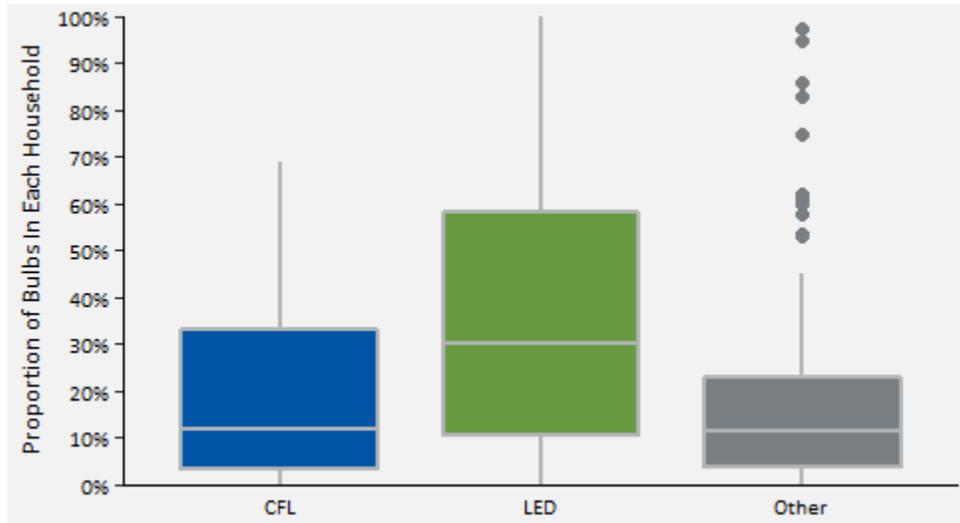


Note: Audited means the sum total of all lamps in-service or in storage at the time of the site visit.

¹² NMR Group, Inc. *RLPNC Study 17-9 2017-18 Residential Lighting Market Assessment Study*. March 28, 2018. Prepared for the Electric and Gas Program Administrators of Massachusetts. Available online: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_179_LtgMarketAssessment_28March2018_FINAL-1.pdf

LED saturation was more than 30% in nearly half of the 48 participating households, with another quarter of households having CFL saturations of at least 30%. The percentage of LEDs in homes ranged from 0% to 100%; two homes in the study were entirely LED and seven homes did not have any LEDs. Four homes did not have any CFLs or LEDs. Figure 13 shows the distribution of socket saturations by bulb type across all households.

Figure 13. Socket Saturation Across Households



Within rooms, Cadmus found that LED saturation typically fell between 20% and 40% of sockets. Of commonly used rooms (such as bathrooms, kitchens, bedrooms, and living areas), LED saturation was highest in living rooms (39%) and bathrooms (38%). LEDs represent approximately 32% of kitchen bulbs and 26% of bulbs in bedrooms. These portions of the home represent a small percentage of the overall lighting observed during the study.

The highest saturation of CFLs was found in offices (30%), followed by bedrooms (25%) and basements (22%). Saturations of CFLs only exceeded LEDs in attics, offices, and closets. Across nearly all room types, non-CFL and non-LED lamps represent at least half of installed lighting. The saturation of CFL, LED, and other bulb technologies is shown by room type in Figure 14.

Figure 14. LED Socket Saturation by Room Type

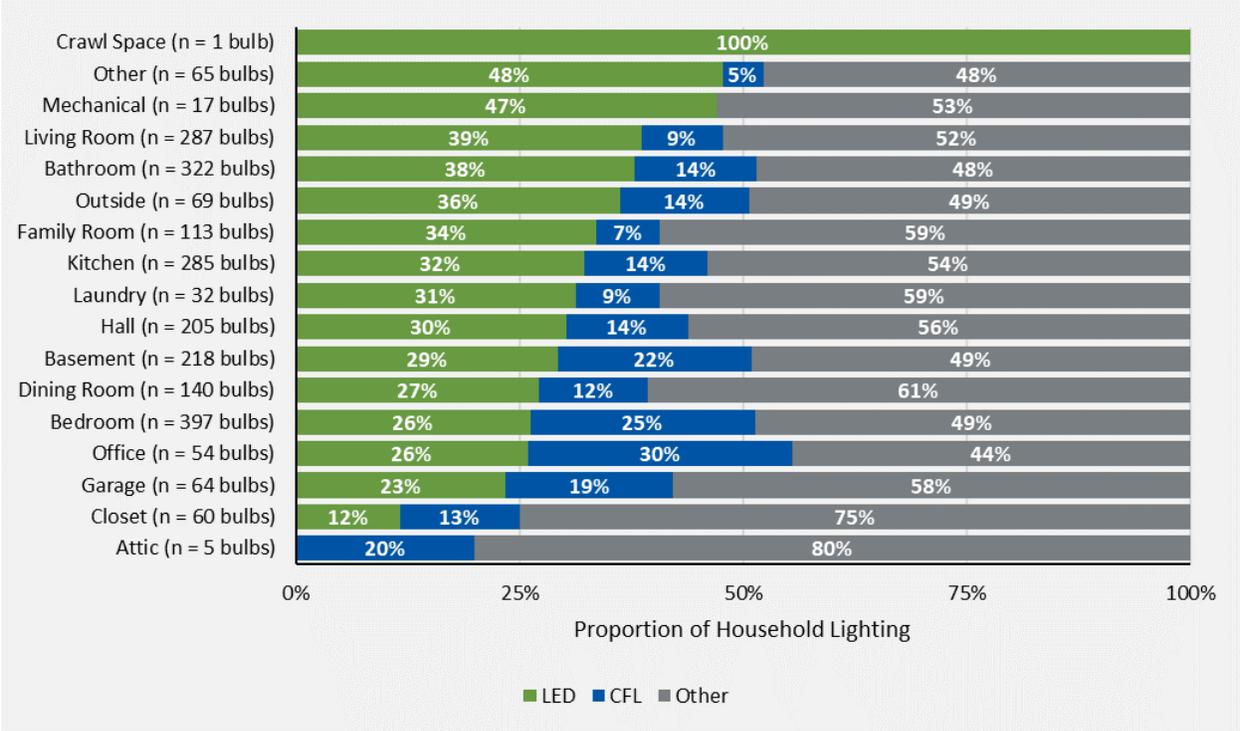
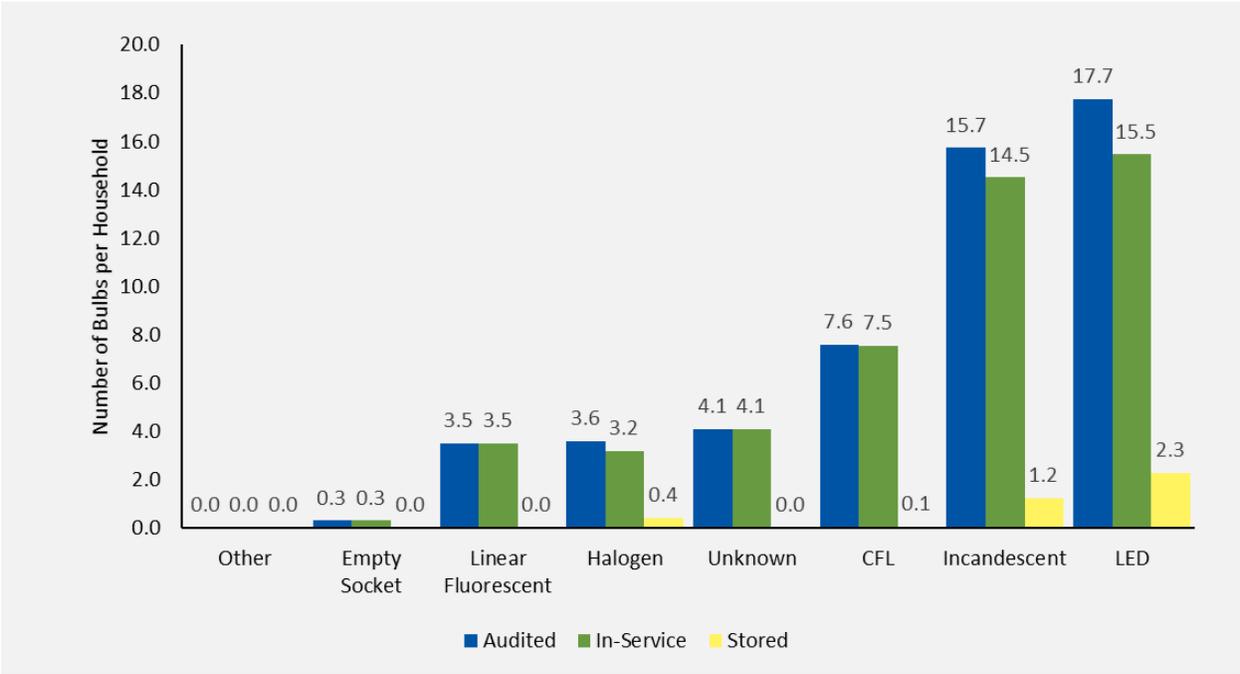


Figure 15 shows the average number of bulbs in service and audited (the sum of lamps in service and in storage) for households participating in the study. Bulbs in storage accounted for the difference between the number of audited bulbs and the number of bulbs in service. Cadmus found LEDs and incandescent bulbs present in higher numbers, on average, across households than other bulb types. The average household had almost twice as many LEDs as CFLs in service.

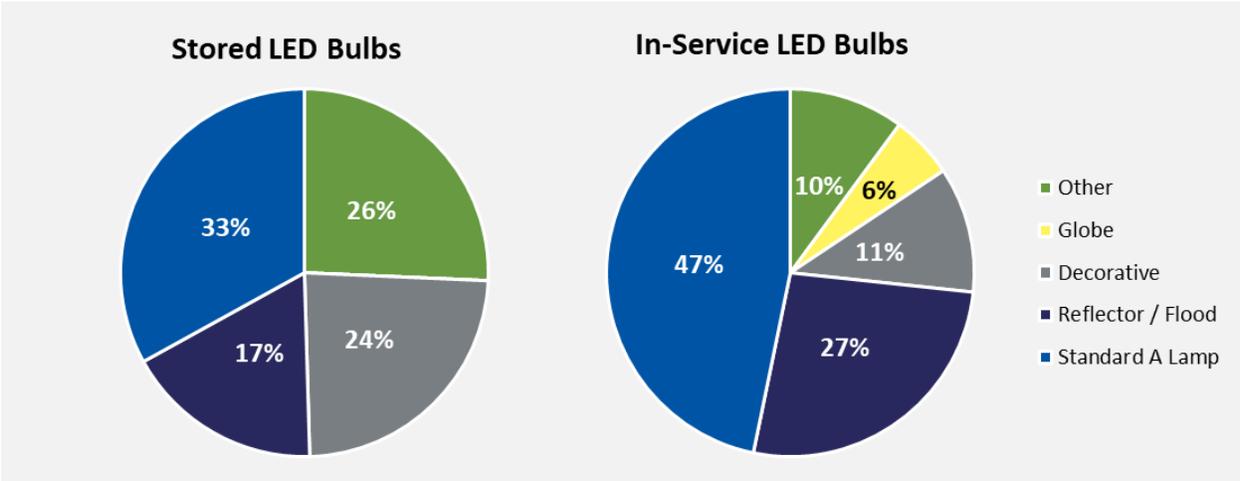
Figure 15. Number of Bulbs in the Average Household



Note: Audited means the sum total of all lamps in-service or in storage at the time of the site visit.

As shown in Figure 16, Cadmus found that almost half of all in-service LED bulbs were standard A-lamps (47%) and an additional 27% were reflector or flood bulbs. The in-home audit found the distribution of bulb styles among storage bulbs more evenly spread between standard A-lamps (33%), decorative (24%), reflector or flood (17%), and other (26%). Globe-style LEDs were found in the lowest proportions, representing approximately 6% of in-service LEDs and 0% of stored LEDs.

Figure 16. Proportion of In-Service LED Bulbs by Bulb Style



In-Service Rates

Cadmus calculated in-service rates for LED and CFL bulbs as the total number of bulbs in service out of the total number of bulbs, including those found in storage. The team compared in-service rates from the home visits to self-reported in-service rates from the participant survey; the results are shown in Table 43. Although self-reported in-service rates for CFLs matched findings from the in-home audit almost exactly, Cadmus found participants reported significantly higher rates of LED installation than observed in the home inventories, suggesting customers may overreport LED installation. Cadmus did not find any LED fixtures in storage.

Table 43. Comparison of In-Service Rates from Participant Survey and In-Home Audit

Measure	Participant Survey	In-Home Audit
LED Bulbs	97.0%	87.2%
CFL Bulbs	100.0% ¹	99.2%
LED Fixtures	97.7%	100.0%

¹ Deemed as 100% because of low sample sizes in the participant survey.

Cadmus used in-service rates derived from the participant survey to evaluate *ex post* savings due to the larger sample size.

Delta Watts (Δ Watts)

Cadmus calculated delta watts, the difference in wattage between an assumed baseline lamp and an installed efficient lamp, using information gathered during the in-home audits. Cadmus used the ENERGY STAR Qualified Products List to calculate efficient wattages and used wattage information collected during the site visit to determine a weighted baseline wattage. The weighted baseline wattage estimates include halogen, incandescent, and CFL bulbs. Cadmus assumed the same baseline for LED and CFL bulbs.

As shown in Table 44, the efficient wattage for CFLs was evaluated at 14.8 watts, and the efficient wattage for LEDs was evaluated as 9.3 watts.

Table 44. Delta Watts from Participant Survey and In-Home Audit

Measure	In-Home Audit		
	Baseline Wattage	Efficient Wattage	Delta Watts
LED Measures	44.5	9.3	35.2
CFL Measures	44.5	14.8	29.6

Cadmus observed only a limited number of integrated fixtures in the study households. Based on the small sample size, Cadmus assumed and recommends applying the delta watts for LED bulbs to LED fixtures until a larger number of fixtures can be analyzed or another source for delta watts is established.

The difference between baseline and efficient lamp wattage was found to be 35.2W for LEDs and 25.6W for CFLs. Cadmus recommends using 35.2W for LED fixtures as well as individual bulbs.

Hours of Use

During the January and February site visits, a Cadmus technician performed a whole-home lighting survey then installed meters on fixtures selected randomly within the home. After completing the home inventory, the technician generated a random list of rooms then installed meters on fixtures selected randomly within those rooms. During the retrieval site visit, the technicians noted whether meters had been moved, exhibited unusually high or low usage, or appeared to be recording light from something other than the desired light fixture.

After retrieving the meters, the team performed a thorough review of the meter data to ensure high-quality inputs were provided to the HOU model. The team removed data for any meters that had recorded daylight rather than the intended light source, had been moved by the customer, or had experienced a technical failure. The team also removed data for any meters that had unusually low usage because the metered fixtures were not likely candidates for LED replacement. This review results in data from 377 of the original 446 meters to inform the HOU model and analysis. Table 45 shows the distribution of meters by their final dispositions.

Table 45. Distribution of Meters by Final Disposition

Disposition	Quantity	Percentage
Meter Damaged or Failed	4	0.9%
Captured Sunlight	8	1.8%
Not viable for LED Install	29	6.5%
Moved or Removed by Resident	28	6.3%
Included in HOU Model	377	84.5%
Total	446	100.0%

In order to evaluate peak coincidence, meter data would need to be captured for the entirety of the summer and winter peak periods, but a few weeks of metered data on both sides of the spring or fall equinox provide enough information to develop an accurate extrapolation for annual HOU.¹³ Cadmus gathered approximately six weeks of metered data on either side of the spring equinox (March 20, 2018). The meter data was annualized by fitting a sine curve to the daily metered usage data and extrapolating the sine curve to a full year. The extrapolated sine curve peaks on the winter solstice and reaches its lowest point during the summer solstice, on the days when natural daylight is at its lowest and highest points, respectively.

¹³ Apex Analytics. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 21: Residential Lighting Evaluation Protocol*. Prepared for the National Renewable Energy Laboratory (NREL). February 2015. Available online: <https://www.energy.gov/sites/prod/files/2015/02/f19/UMChapter21-residential-lighting-evaluation-protocol.pdf>

The analysis considered regular workdays separate from weekends or federal holidays, developing different sine curves for each type of day. Figure 17 shows the annualized sine curves for workdays and non-workdays.

Figure 17. Hours of Use Annualization

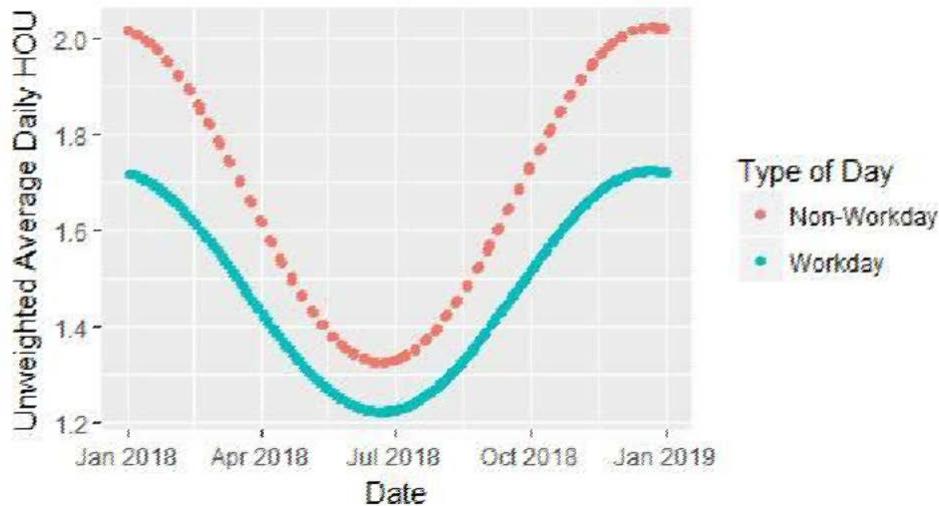


Table 46 shows the distribution of meters, bulbs, and average daily HOU by room type. As expected, high-usage room types such as living rooms, family rooms, and kitchens tend to have higher HOU values.

Table 46. Distribution of Meters, Surveyed Bulbs, and Average Daily HOU by Room Type

Room Type	Number of Meters	Distribution of Meters	In-Service Bulbs	Distribution of Bulbs	Average Daily HOU
Bedroom	84	22%	380	18%	1.54
Bathroom	76	20%	317	15%	1.28
Kitchen	28	7%	277	13%	2.72
Living Room	29	8%	266	12%	3.29
Hall	20	5%	198	9%	0.38
Basement	31	8%	172	8%	1.27
Dining room	9	2%	140	6%	0.93
Family room	10	3%	107	5%	2.65
Outside	2	1%	69	3%	1.41
Other	28	7%	61	3%	1.25
Garage	2	1%	59	3%	0.83
Office	19	5%	51	2%	1.80
Closet	15	4%	30	1%	0.49
Laundry	14	4%	25	1%	0.60
Mechanical	8	2%	12	1%	0.82
Overall Household Daily HOU – Unweighted¹					1.54 ± 0.27
Overall Household Daily HOU – Weighted¹					1.70 ± 0.37

¹Summarized values may not match exactly due to rounding. Confidence intervals provided at 90% confidence.

Because the meter distribution did not reflect the distribution of lamps within the home, the team developed a weighted HOU based on the whole-home lamp distribution. The weighted daily HOU takes into account the distribution of bulbs in service within the home to more appropriately reflect household lighting usage. Cadmus developed weights based on the distribution of meters within each room compared to the distribution of lamps within each room.

After applying weights and annualizing results, Cadmus found an average daily HOU of 1.70 (620.5 annual hours). The weighted HOU is slightly lower than a recent study Cadmus performed in Maryland that found an average HOU of 1.86.

Cadmus found an average daily HOU of 1.70 hours (620.5 annual hours) through the in-home metering study.

Cadmus also investigated an LED-specific HOU based on the distribution of LEDs within the home and found that, although LEDs are placed in higher-usage rooms, the resulting HOU of 1.75 is not dramatically different than the whole-home HOU of 1.70. The distribution of CFLs, LEDs, and the combination of CFLs and LEDs is shown in Table 47 along with overall HOU estimates for each group.

Cadmus also calculated a non-LED HOU to estimate the operating hours for fixtures with the potential to convert to LED. The team found that non-LED fixtures have an average daily HOU of 1.67 ± 0.34 .

Table 47. Distribution of CFLs and LEDs by Room Type

Room Type	Distribution of All Bulbs	Distribution of LEDs	Distribution of CFLs	Distribution of CFLs and LEDs	Average Daily HOU
Bedroom	18%	14%	28%	19%	1.54
Bathroom	15%	16%	12%	15%	1.28
Kitchen	13%	12%	11%	12%	2.72
Living Room	12%	15%	7%	12%	3.29
Hall	9%	8%	8%	8%	0.38
Basement	8%	9%	13%	10%	1.27
Dining room	6%	5%	5%	5%	0.93
Family room	5%	5%	2%	4%	2.65
Outside	3%	3%	3%	3%	1.41
Other	3%	4%	1%	3%	1.25
Garage	3%	2%	3%	2%	0.83
Office	2%	2%	4%	3%	1.80
Closet	1%	1%	2%	1%	0.49
Laundry	1%	1%	1%	1%	0.60
Mechanical	1%	1%	0%	1%	0.82
Overall Household Daily HOU – Unweighted¹					1.54 ± 0.27
Overall Household Daily HOU – Weighted¹					1.70 ± 0.37
Overall Household Daily LED HOU – Weighted¹					1.75 ± 0.39
Overall Household Daily CFL HOU – Weighted¹					1.58 ± 0.29
Overall Household Daily CFL + LED HOU – Weighted¹					1.70 ± 0.37

¹ Summarized values may not match exactly due to rounding. Confidence intervals provided at 90% confidence.

Process Evaluation

As with the cross-cutting evaluation, the primary goals of the ENERGY STAR Lighting process evaluation were to identify opportunities for increasing program effectiveness and evaluate program satisfaction. This section presents the process evaluation’s methodology and findings.

Process Evaluation Methodology

Cadmus assessed the effectiveness and customer satisfaction of the program’s lighting measures using a combination of primary and secondary research activities. These activities included reviewing program materials, interviewing program stakeholders and partners, surveying participants in the home and online, and surveying customers in the store. In addition to these activities, Cadmus conducted a lighting pricing assessment to supplement the intercept survey activity. Each task is described in more detail in the preceding Evaluation Tasks section,¹⁴ and Table 48 summarizes the participation for each.

Table 48. Process Data Collection Efforts

Activity	Planned Sample Size	Achieved Sample	Sample Frame
Interviews with program staff and stakeholders	8–14	7 ¹	Census of program administrators and third-party vendors
Partner interviews	4–10 (email invitations sent to all identified partners)	4	Random sample of contractors and retail partners
Email surveys of program participants	220	214 ²	Random sample of ENERGY STAR Products program participants
In-Home Lighting Inventory Study Survey	40	48	Random sample of ENERGY STAR Products program participants
Intercept surveys	Up to 20 stores (up to 3 surveys per store), targeting top sellers	11 stores; 33 surveys ³	Sample of retail partner stores in NH
Review of program materials	All program guidelines and educational materials	Completed	--
Lighting pricing assessment	Websites of two major retailers representing 43 brick-and-mortar store locations (25 for Retailer 1; 18 for Retailer 2) in New Hampshire and Massachusetts	Completed	Census of all retailer locations in NH plus a sampling of stores in MA near the NH-MA border

¹ Cadmus spoke with all program staff and stakeholders relevant to the 2016 program (less than planned sample size).

² Through data cleaning and validation, six of the 220 survey completions were removed from the final analysis.

³ Due to delays in the program’s launch, Cadmus could not achieve an adequate sample and replaced the remaining surveys with a lighting pricing assessment.

¹⁴ The online participant survey is described in the Cross-Cutting Process Evaluation section.

Process Evaluation Findings

This section details Cadmus’ findings on program awareness, customer purchase patterns, and customer experience, including satisfaction and outreach, as well as lighting pricing results. Findings are based on the program materials review, in-home lighting inventory study, online participant survey, in-store intercept survey, and lighting pricing assessment.

Program Awareness

Cadmus assessed customers’ knowledge of LEDs, awareness of utility-led discounts, and purchasing patterns, including where customers purchase LEDs and what qualities they look for when purchasing bulbs. Findings for these topics are presented in the following sections.

LED Awareness and Purchase Patterns

Overall, respondents showed a high degree of LED acceptance, and NHSaves marketing appears to be successful in influencing customers to purchase utility-discounted ENERGY STAR bulbs. Both the online survey respondents and in-home lighting inventory study participants reported similar levels of LED awareness and purchasing patterns. Ninety-eight percent of online survey respondents (n=213) and 94% of in-home respondents (n=48) have purchased LEDs in the past, and 85% of the customers interviewed in the store purchased LEDs that day. The lower percentage of in-store customers purchasing LEDs indicates that customers who participate in utility energy efficiency programs may be more likely to purchase LEDs than non-participants.

Program participants also indicated increased awareness of utility discounts offered by NHSaves, with 55% of the in-home respondents (n=47) and 49% of the online participants (n=209) indicating they were aware of those discounts, compared with only 22% of the in-store customers. Signage at the store is the primary way that both online respondents (54%, n=116) and in-home participants (45%, n=31) learned about the discounts, followed by the NH Saves website (16% for online respondents and 19% for in-home respondents). Customers interviewed in the store also reported learning about the utility discounts from store staff during their visit.

Both online and in-store respondents reported The Home Depot and Lowe’s as the top two stores, followed by Walmart and Amazon, from which they purchase screw-in light bulbs. Overall, online respondents (n=214), in-home respondents (n=48), and in-store interviewees ranked brightness/color, energy savings, and purchase price as the three qualities they look for when purchasing lighting. Price is a significant factor in the purchase decision: 81% of the in-home respondents and 69% of the online respondents said the utility discounted price was *very influential* or *somewhat influential* in their decision to purchase an LED bulb.

The lighting characteristics with the biggest impact on purchase decision-making are brightness and color temperature, energy savings, and price.

Additional detail on the LED awareness and purchasing patterns for the online respondents, in-home respondents, and those interviewed in the store are discussed below.

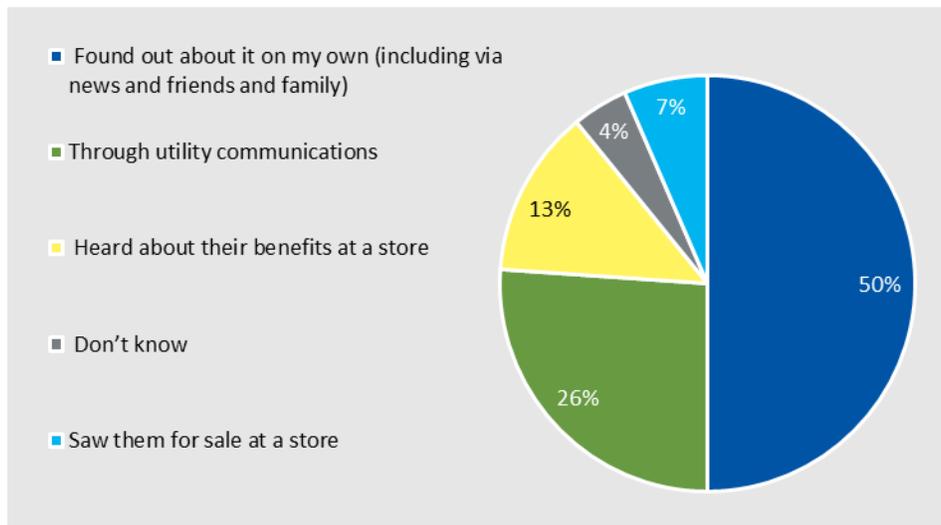
In-Home Inventory Study Awareness Purchase Patterns

In-home survey respondents were familiar with LEDs: 94% of respondents indicated they were *very familiar* (61%) or *somewhat familiar* (33%) with LED light bulbs (n=46) and almost all (94%) in-home respondents reported purchasing LEDs (n=48).

Figure 18 shows how in-home participants first became aware of LEDs, with one-half of participants indicating they “found out about LEDs on their own,” including through news or friends and family. Over one-quarter (26%) became aware of LEDs via utility communications (n=46).

Approximately 26% of in-home survey respondents became aware of LEDs via utility communications

Figure 18. How Participants Became Aware of LEDs



Source: In-Home Lighting Inventory Study. Question 2. "How did you first become aware of LEDs?" (n=46)

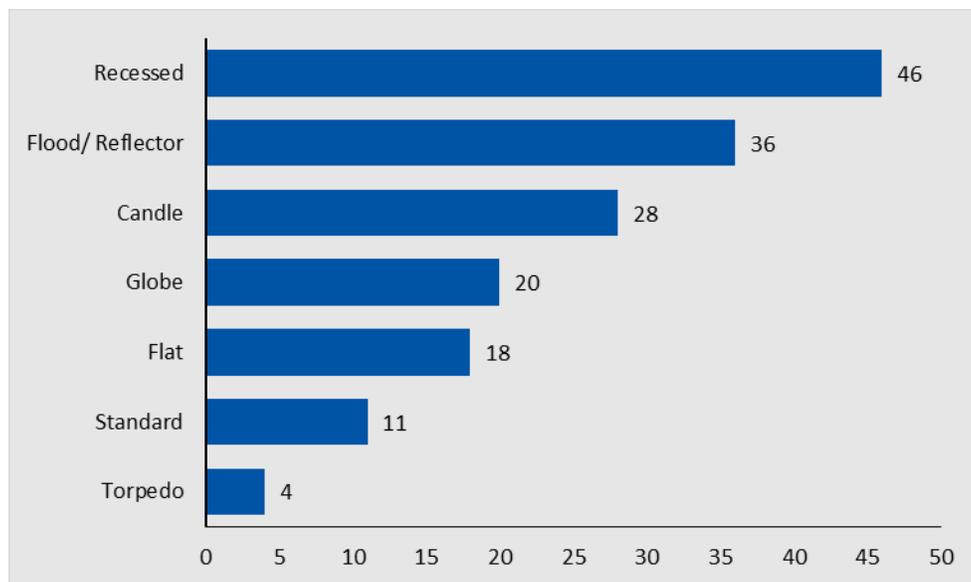
Lighting inventory study participants were also aware that utility programs sponsor discounts for LEDs. More than one-half of the participants were aware that utility-discounted LEDs are available through at least one channel: 28% of participants knew of just the local store discounts, 23% knew of both the local store and online store discounts, and 4% knew only of the online store discounts. Participants most commonly heard about the discounts through signage at a store (45%) or through the website: 19% through the NHSaves website and 13% through their utility’s website. Thirty-six percent of participants did not know of utility-sponsored discounts on LEDs and 9% indicated they knew of discounts but did not know they were offered by their utility.

Cadmus compared the types of LED products available through the markdown offering with the LEDs most commonly found in the home site visits.^{15,16}

Approximately half of the 163 LED bulbs purchased by in-home lighting inventory study participants were recessed (46) or flood lights (36), however these styles account for only 25% of the lamp models marked down through the program. Conversely, standard A-lamp bulbs represent 75% of the models marked down through the program, but account for only 11 of 163 LEDs purchased (7%). The distribution of LED lamps in the home inventory study is shown by style in Figure 19.

Recessed LEDs and flood lights were the most commonly purchased LED lamp types among in-home lighting inventory participants, but represent a small percentage of the lamp models marked down by the program.

Figure 19. Other Types of LEDs Purchased



Source: In-Home Lighting Inventory Study. Question 5. "What other types of LEDs did you purchase?" (n=80, multiple responses)

¹⁵ The 2016 markdown offering discounted nine A-lamp models, two flood lamp models, and one recessed lamp model.

¹⁶ The households were recruited from all facets of the program (appliances, HVAC, etc.) and could be considered non-participant site visits for the purpose of evaluating lighting. Because the program includes an upstream lighting channel—which does not collect participant information—it was not clear whether the recruited households had purchased program-incentivized lighting products. The in-home survey respondents reported approximately 60% - 70% of the LEDs identified were not rebated through the program.

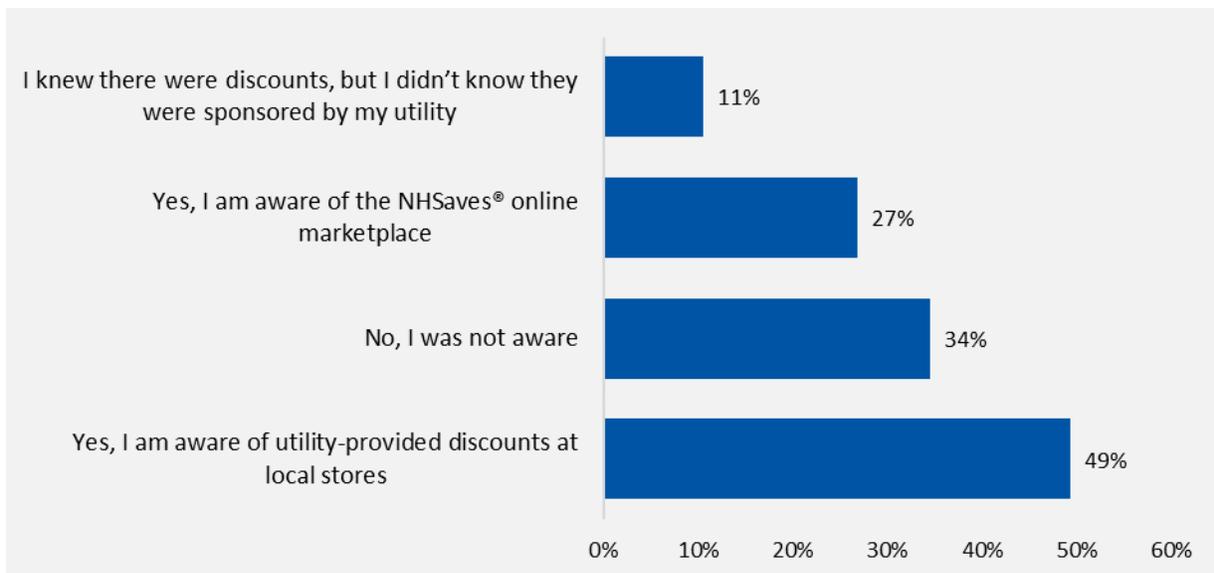
Of lighting inventory study participants who had purchased at least one LED, 29% knew they had purchased a program-discounted LED and 11% were unsure; the remaining 60% did not believe they purchased a program-sponsored LED (n=45).

Online Survey Awareness and Purchase Patterns

Nearly all online survey respondents (98%, n=158) indicated they had purchased at least one LED. Respondents most frequently purchased directional or different-shaped bulbs (55%, n=206) or bulbs fitting a regular lighting socket (44%). Figure 20 shows that most online survey respondents (72%, n=254) knew of the discounts available for LED bulbs. More respondents knew of utility-provided discounts available through local stores (41%) than were aware of the NHSaves Online Marketplace (22%).

More respondents were aware of utility-provided discounts available through local stores than through the NHSaves Online Marketplace. The program has moved away from promoting the NHSaves online store since 2016.

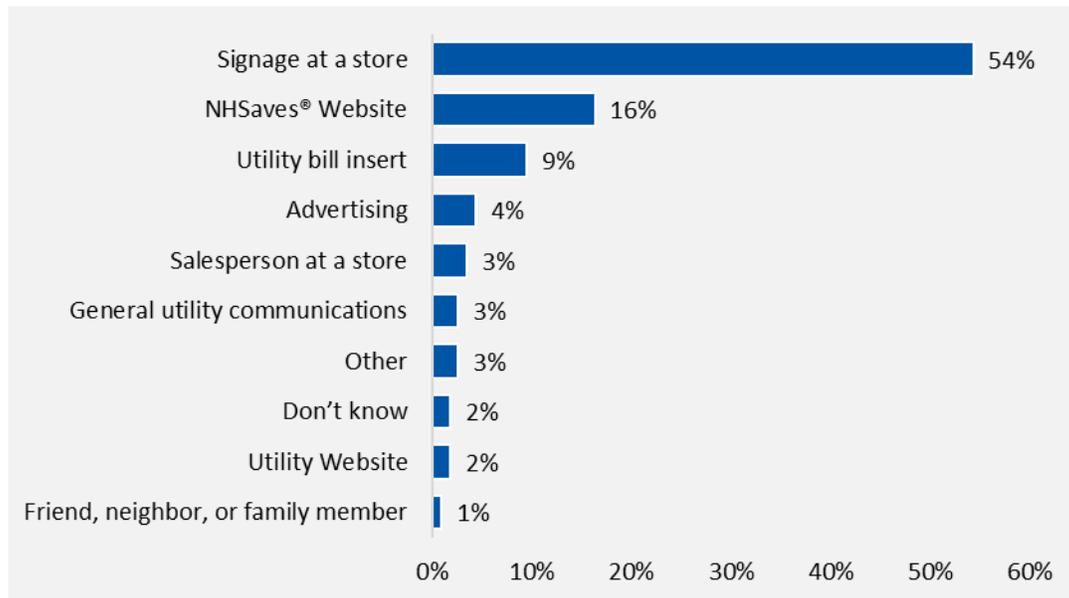
Figure 20. Awareness of Utility LED Discounts



Source: Participant Survey. Question E5. "Are you aware that your NH electric utility provides discounts on energy-saving LED light bulbs sold at local stores and through the NH Saves online marketplace?" (n=209; multiple response)

Participants most frequently learned about utility-provided discounts via signage at the store and the second most common was through the NHSaves Online Marketplace. Figure 21 shows the frequency distribution of how participants learned of the discounts.

Figure 21. How Participants Heard About Discounts



Source: Participant Survey. Question E6. "Where did you hear about the discounts?" (n=116)

Respondents were motivated to purchase these bulbs by low prices, the convenience of buying online, and their trust in buying from NHSaves. Respondents (n=14) most often learned about the NHSaves Online Marketplace through the NHSaves website (36%) and utility bill inserts (29%).

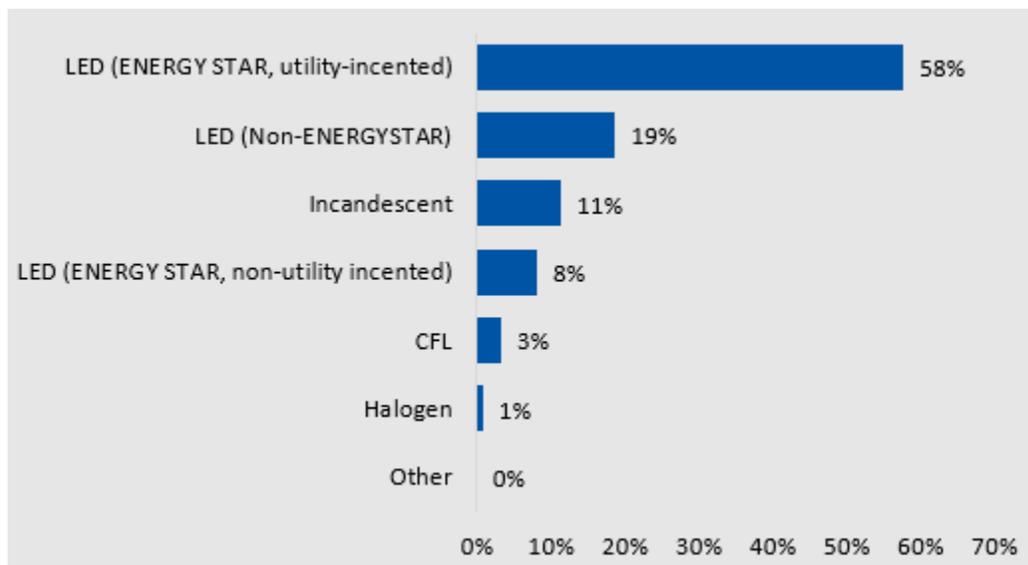
In-Store Intercept Awareness and Purchase Patterns

Cadmus spoke with 33 customers purchasing light bulbs in 11 stores. During the intercepts, customers purchased 123 light bulbs and fixtures, consisting of 85% LEDs and 58% program-discounted bulbs. As shown in Figure 22, more than 10% of bulbs purchased were incandescent bulbs.

Purchase price, prior general awareness of LEDs, and in-store marketing had a greater influence on interviewed customers' purchasing decisions than the ENERGY STAR label or prior knowledge of utility discounts. When asked what qualities are most important when purchasing new light bulbs, customers most commonly mentioned energy use (13), purchase price (13), and lighting quality (12). These characteristics are consistent with those identified by the in-home survey and online survey respondents. No customers mentioned the ENERGY STAR label as an influential factor, which is consistent with their purchase behavior: more customers chose to purchase non-ENERGY STAR LEDs than the ENERGY STAR, non-utility discounted LEDs. Nearly one-third (10) of those interviewed explained that they came to the store specifically to convert part of their home or business to LEDs.

In-home interviews, online participant surveys, and intercept surveys indicate that energy use, cost, and lighting quality (brightness and color temperature) are the primary factors that influence purchase decisions.

Figure 22. Light Bulbs Purchased by Interviewed Consumers



Source: NHSaves Intercept Interviews. Question 3: “May I take a look at the types of light bulbs you are purchasing?” (n=123)

Prior to entering the store, less than one-quarter (22%) of the interviewed customers were aware that New Hampshire electric utilities, particularly their utility, offered discounts for energy-efficient products. Just one customer came to the store that day specifically intending to purchase NHSaves or utility-discounted bulbs. No surveyed customers noticed point-of-purchase advertising, but, because intercept studies are self-reported, customers may not attribute purchases to in-store education, product placement, or advertising because these are unconscious factors (i.e., many consumers do not believe they are influenced by advertising). The fact that utility-discounted LEDs were the most commonly purchased bulbs suggests that the price discounts, in-store displays, or both influenced customer purchasing decisions.

In-Store Advertising

The lighting retail store markdowns were marketed mainly through point-of-purchase advertising, which Cadmus reviewed during the intercept surveys. Every store visited had point-of-purchase advertising materials on display, with an average of 21 NHSaves point-of-purchase advertising pieces per store. Shoppers were targeted through in-store signs, end caps, tear sheets, stickers, floor clings, shelf hangers, banners, and flyers. Shelf talkers proved the most common advertising material; an average of 15 shelf talkers were displayed in each of the visited stores. Figure 23 shows the most common shelf talker used in stores.

Figure 23. NHSaves Shelf Talker



After shelf talkers, end caps were the most common point-of-purchase advertising materials. Program end caps were present in nine of the 11 stores visited, with an average of four end caps per store. Customers also encountered a similar number of non-program lighting end caps. Program and non-program end caps looked very similar, often displaying similar non-discounted bulbs produced by the same manufacturer and in similar price ranges as program bulbs and fixtures. Cadmus observed 34 non-program end caps and 38 program end caps.

Retailers actively promote non-program LEDs, sometimes alongside program LEDs, with price levels comparable to program-discounted bulbs.

Figure 24 shows two end caps in the same store. The end cap on the left advertises non-program EcoSmart A-lamp LEDs in an eight-pack for \$2.22 per bulb. The end cap on the right advertises NH Saves Program EcoSmart A-lamp LEDs in a four-pack for \$1.70 per bulb.

Figure 24. Non-Program and Program End Caps



In-Store Intercept Spillover and Leakage

Though Cadmus was unable to achieve the desired number of in-store intercept surveys, anecdotal findings from the surveys that were completed may provide some insight into spillover and leakage for the lighting measures.

Twenty-seven percent of the interviewed customers purchasing lighting were not Eversource, Liberty, NHEC, or Unitil customers, and approximately 37% of the lamps they purchased were marked down by the New Hampshire utilities' program. Interviewees included customers from National Grid Massachusetts (five), Central Maine Power (two), Ontario Hydro (one), and Green Mountain Power in Vermont (one). Though they were not asked why they were shopping at New Hampshire stores, these customers were asked why they purchased their lamps. All of these customers indicated that they either were not aware of discounts offered by the New Hampshire electric utilities (66%) or they had not specifically intended to purchase lamps discounted by the New Hampshire electric utilities or NHSaves (33%). Approximately half of the customers from outside New Hampshire had considered purchasing non-LED bulbs that day, and the Ontario Hydro customer had specifically intended to purchase a 3-way LED lamp because they weren't able to find any in their local Canadian stores.

Of interviewed customers purchasing lighting in New Hampshire stores, approximately 27% were not customers of Eversource, Liberty, NHEC, or Unitil. These customers accounted for approximately 11% of program-qualified bulb sales recorded during the intercept surveys.

Cadmus also asked respondents whether they intended to install their purchased lamps in a residential or business application. Business installations tend to have higher operating hours than residential installations and may be eligible for higher savings than those assumed for residential programs. None of the customers interviewed as part of the in-store intercepts indicated that they planned to install their bulbs in a business location.

Awareness of Other Program Offerings

Cadmus asked in-home lighting inventory study participants if they were aware of additional utility-sponsored programs designed to help customers save energy, and 64% of lighting inventory study participants knew of the programs. Of these, 59% purchased energy efficiency products without receiving a rebate. Table 49 shows the measures that the customers purchased without receiving rebates.

Approximately 40% of home-inventory participants reported purchasing energy efficient products without receiving a rebate. Customers were not asked why they didn't receive a rebate for the equipment.

Among those lighting inventory study survey respondents who reported they purchased energy-efficient equipment without rebates, refrigerators were the most commonly purchased item.

Table 49. Measures Installed Absent of Program Incentives

Measure	Quantity
Refrigerator	4
Boiler	2
Water Heater	2
Clothes Washer	2
Clothes Dryer	2
Smart Thermostat	2
Stove	2
Freezer	1
Dish Washer	1
Smart Home Energy Monitor	1
Air Source Heat Pumps	1

Source: In-Home Lighting Inventory Study. Question 20. "Since hearing about your utility's programs, have you purchased any energy-efficient products other than light bulbs, for which you did not receive a utility rebate?"

Customer Experience

Cadmus asked in-home lighting inventory study and online survey participants questions about their experience with the program. Findings regarding satisfaction with installed lighting and ways for utilities to inform customers of energy efficiency offerings are included below.

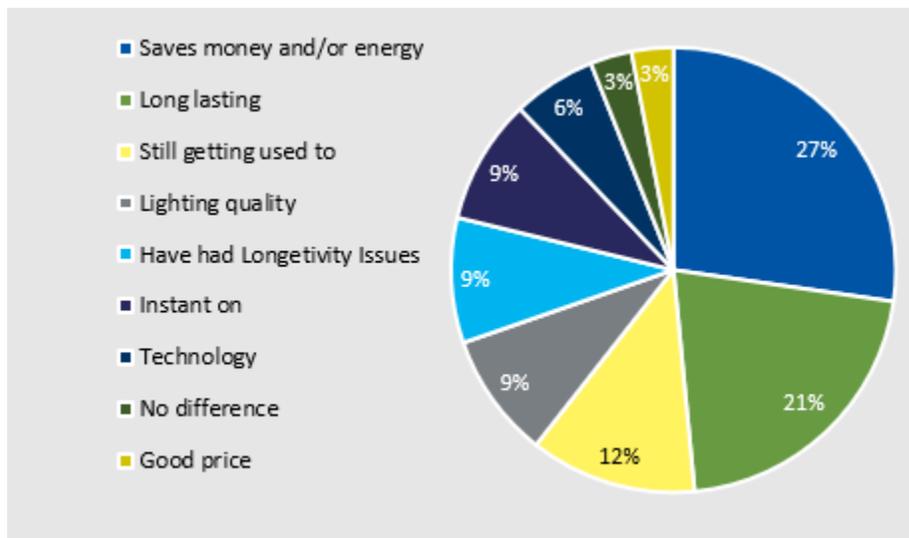
Satisfaction with Installed LEDs

Cadmus found that overall satisfaction with installed LEDs was high among in-home lighting inventory study and online survey participants, as described in the following sections. Common reasons for satisfaction included cost and energy savings and the longevity of the bulbs.

In-home lighting inventory study satisfaction

All in-home lighting inventory study participants (n=44) were *very satisfied* (77%) or *somewhat satisfied* (23%) with the LEDs they installed. As shown in Figure 25, participants most commonly cited saving money or energy (27%) as their main reason for satisfaction, followed by longevity (21%). These reasons for satisfaction with LEDs reflect the two main messages in program advertising: all LED advertising mentions cost and energy savings, and all longer-form LED advertising notes bulb life expectancy as a second quality.

Figure 25. Why Socket Study Customers Indicated Level of Satisfaction with LEDs



Source: In-Home Lighting Inventory Study. Question 8. "How satisfied have you been with the LEDs you have installed in your home? Why do you say that?" (n=33)

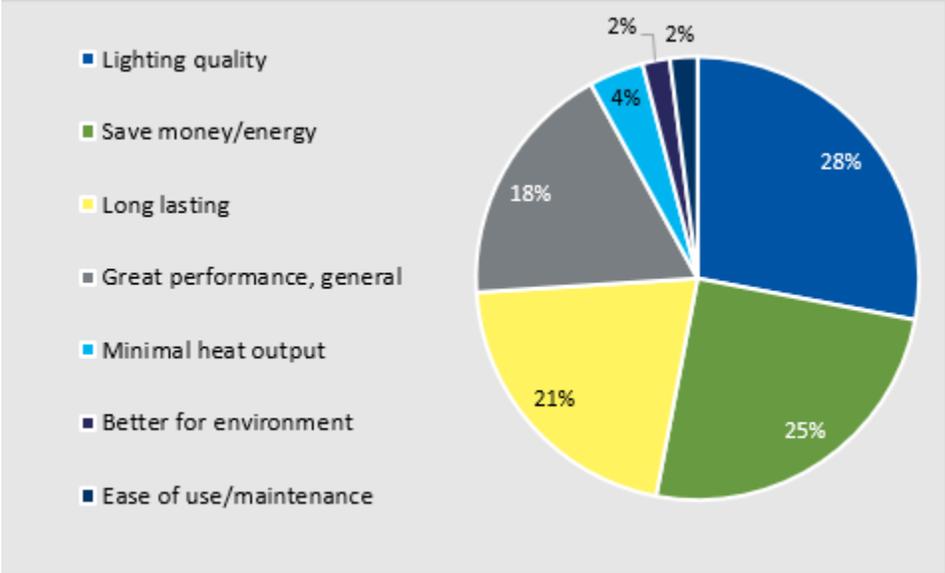
Eleven lighting inventory study respondents indicated they had removed a total of 27 LED lamps in the past two years. Seven respondents said they removed the bulbs because they had burned out, two said they did not like the lighting quality, and two said they did not like the lighting quality and the lamp had burned out. Of the 11 respondents who removed bulbs, seven replaced their LEDs with another LED (19 lamps), two replaced with incandescent lamps (3 lamps), and one replaced with CFLs (1 lamp). The final respondent replaced four LEDs with a mix of LEDs and traditional incandescent lamps. This finding suggests that the customer switch to LEDs may not be permanent, especially if the product has quality issues.

Almost half of removed LEDs are replaced with CFLs or incandescent bulbs, which suggests that the customer switch to LEDs is not permanent. Utility discounts can encourage continued customer adoption of LEDs.

Online survey satisfaction

Like responses received from in-home lighting inventory survey respondents, most online survey respondents (n=205) were *very satisfied* (71%) or *somewhat satisfied* (25%) with the LEDs installed in their homes. No respondents indicated they were *not at all satisfied*. Figure 26 shows the reasons why participants were *very satisfied* with their installed bulbs. Participants most commonly cited lighting quality, including output, color, and brightness (28%); money and/or energy savings (25%); and longevity (21%) as reasons for satisfaction.

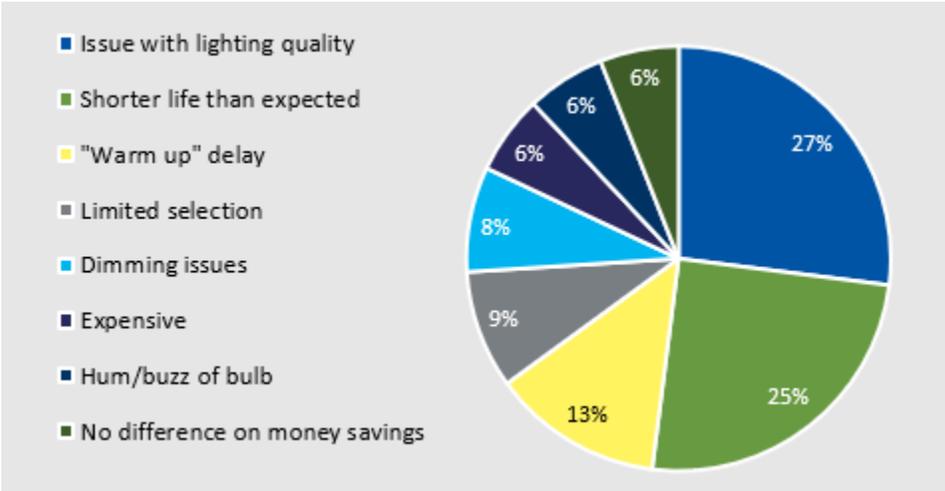
Figure 26. Online Survey Reasons for Higher Satisfaction



Source: Participant Survey. Question E4. “How satisfied have you been with the LEDs you have installed in your home / Why do you say that?” (n=164)

Figure 27 shows respondents’ feedback (n=52) regarding why they were less than *very satisfied* with the LEDs installed in their homes. Participants most commonly identified issues regarding with lighting quality (27%) and shorter lifespans than expected (25%) as reasons for lower satisfaction ratings.

Figure 27. Online Survey Reasons for Lower Satisfaction

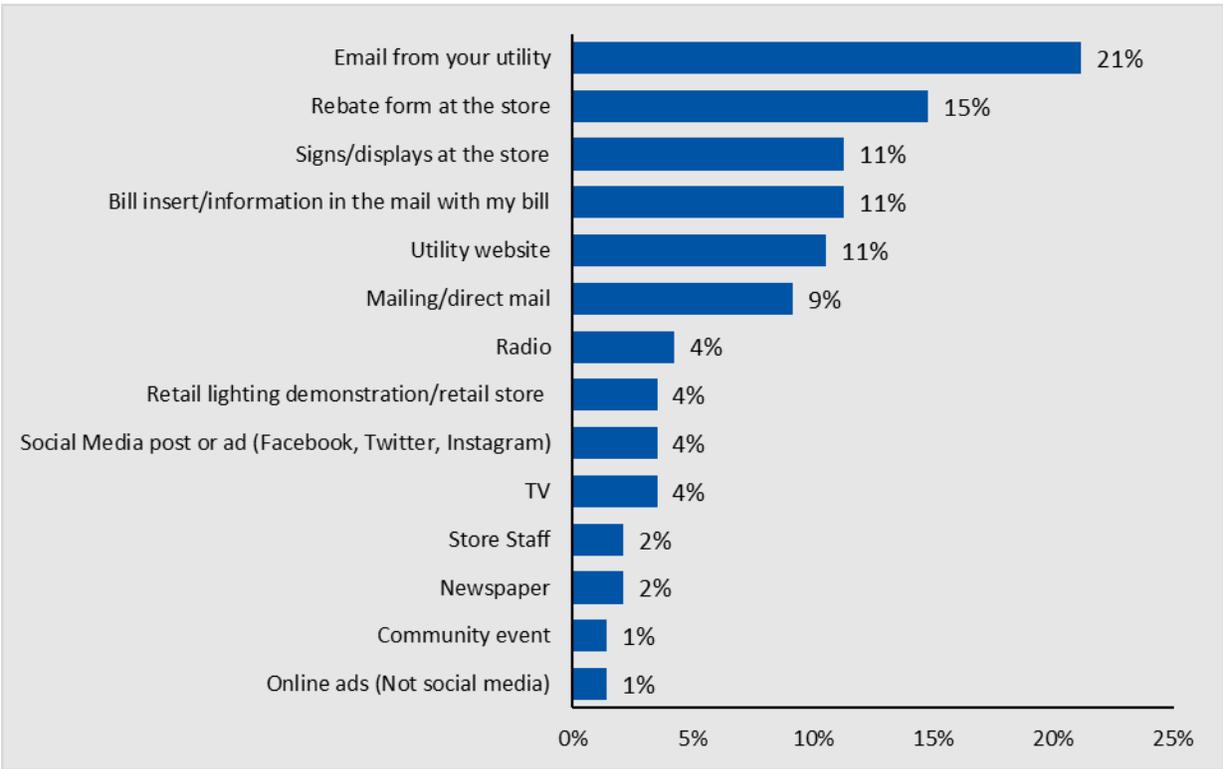


Source: Participant Survey. Question E4. "How satisfied have you been with the LEDs you have installed in your home / Why do you say that?" (n=51)

Program Outreach

In-home lighting inventory study participants were asked to select the best ways for their utility to inform them about energy efficiency offerings. Figure 28 shows that participants most commonly said receiving an email from their utility is the best way to inform them of offerings, which is different than the way most in-store purchasers are informed (56% of purchasers are informed by in-store signage).

Figure 28. Best Ways to Inform Customers About Energy Efficiency Offerings



Source: In-Home Lighting Inventory Study. Question 21. “What are the best ways for your utility to inform you about energy efficiency offerings like their lighting program?” (n=142; multiple response)

Lighting Pricing Assessment

Cadmus assessed the market share of program LEDs and conducted a pricing comparison for various bulb types. This analysis does not cover all of the program’s retail partners since not all of the retailer websites provide the same level of store-specific detail. However, this analysis represents national chains that typically account for a large share of residential lighting program sales.

The team collected inventory data of program-equivalent lighting products in 25 stores from a big-box retailer (Retailer 1) selling program-discounted products.¹⁷ Of these stores, 20 were in New Hampshire and the remaining five were in Massachusetts, near the shared border. The team also collected data from 18 stores of a competing big-box retailer (Retailer 2) that does not sell program-discounted products. Thirteen of these stores were in New Hampshire and the other five were in Massachusetts near the shared border. Retailer 2 serves as a comparison to characterize the LED market absent program support.

While the pricing assessment showed that even without program support LEDs represent a significant proportion of lighting options available, there could still be a role for utility programs in increasing the market share of reflector LEDs and the 75-watt and 100-watt general-purpose bulb market.

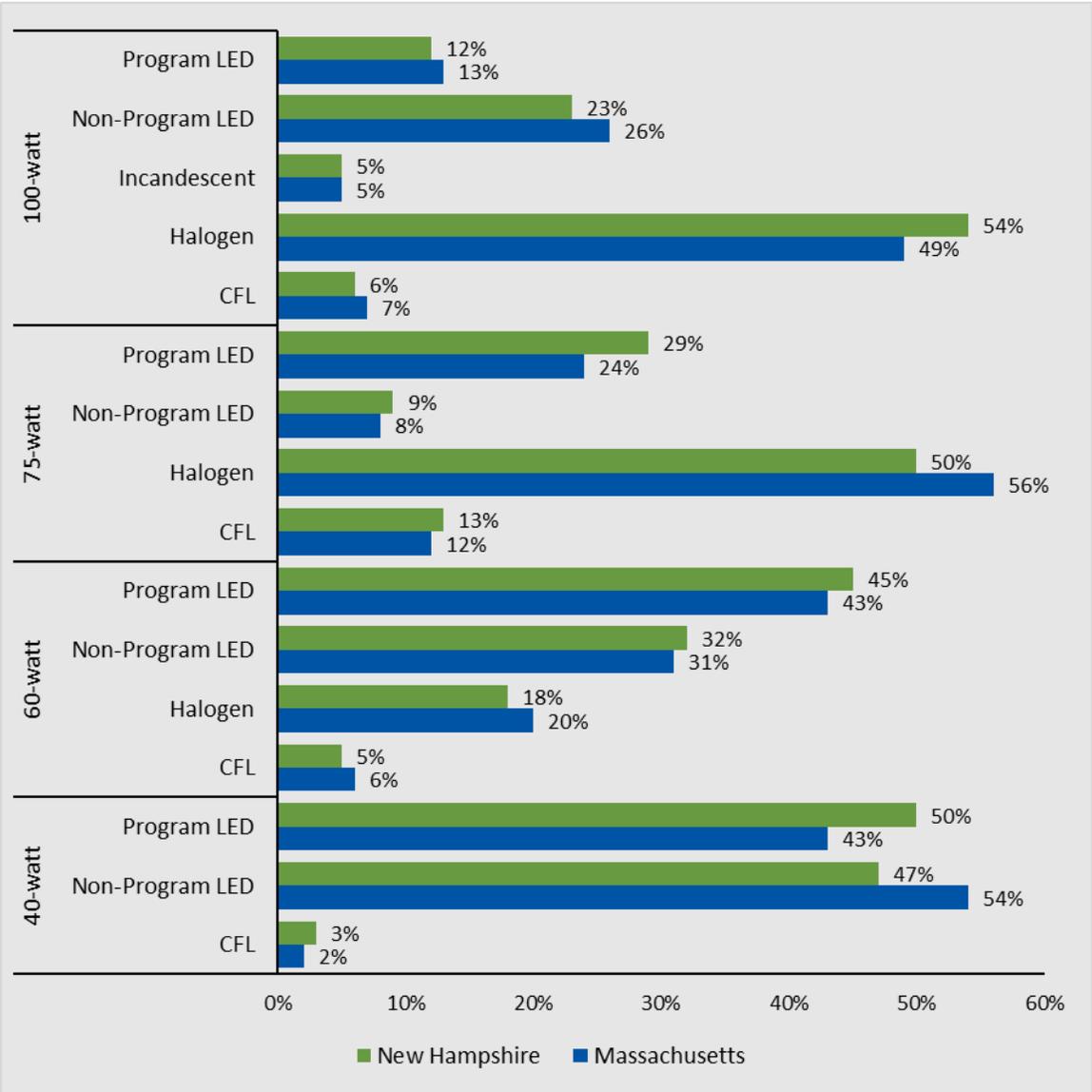
Program LED Market Characterization

Cadmus determined market share using the on-hand quantity for each store and product item number collected from the website. Cadmus’ analysis focused on LED product categories for which the program provided discounted pricing. Decorative bulbs (e.g., candelabra, globe) were not included because the observed retailer did not carry program-supported products in these categories.

Figure 29 compares the share of available inventory of general-purpose bulbs within the participating retailer’s 20 New Hampshire stores and five Massachusetts stores by bulb shape and technology category—CFL, halogen, incandescent, program LED, and other LED (i.e., LEDs that were not discounted by the program). The inventory was collected once per week for three consecutive weeks in June 2018. The inventory levels provide a general estimate of market share during the program period.

¹⁷ In this context, “program-equivalent” means lighting products that are program-qualified or could be installed in place of a program-qualified product.

Figure 29. General-Purpose Bulb Inventory by Technology and Incandescent Equivalence – Retailer 1



Source: Lighting Pricing Assessment

The inventory data show that the market share of program LEDs varies widely across different bulb ratings (40-watt, 60-watt, 75-watt, 100-watt, etc.) and bulb types (general-purpose and reflector). Program LED bulbs represent only 29% of the New Hampshire 75-watt general-purpose bulb inventory and 12% of the 100-watt general-purpose bulb inventory, whereas halogen bulbs make up 50% and 54%, respectively.

Program LEDs represent only 29% of the New Hampshire 75-watt general-purpose bulb inventory and 13% of the 100-watt general-purpose bulb inventory, whereas halogen bulbs make up 50% and 54%, respectively.

For 75-watt equivalent bulbs, program LEDs make up the majority of available LED bulbs. For 100-watt equivalent bulbs, the non-program share of LED inventory is roughly twice the share of program LEDs.

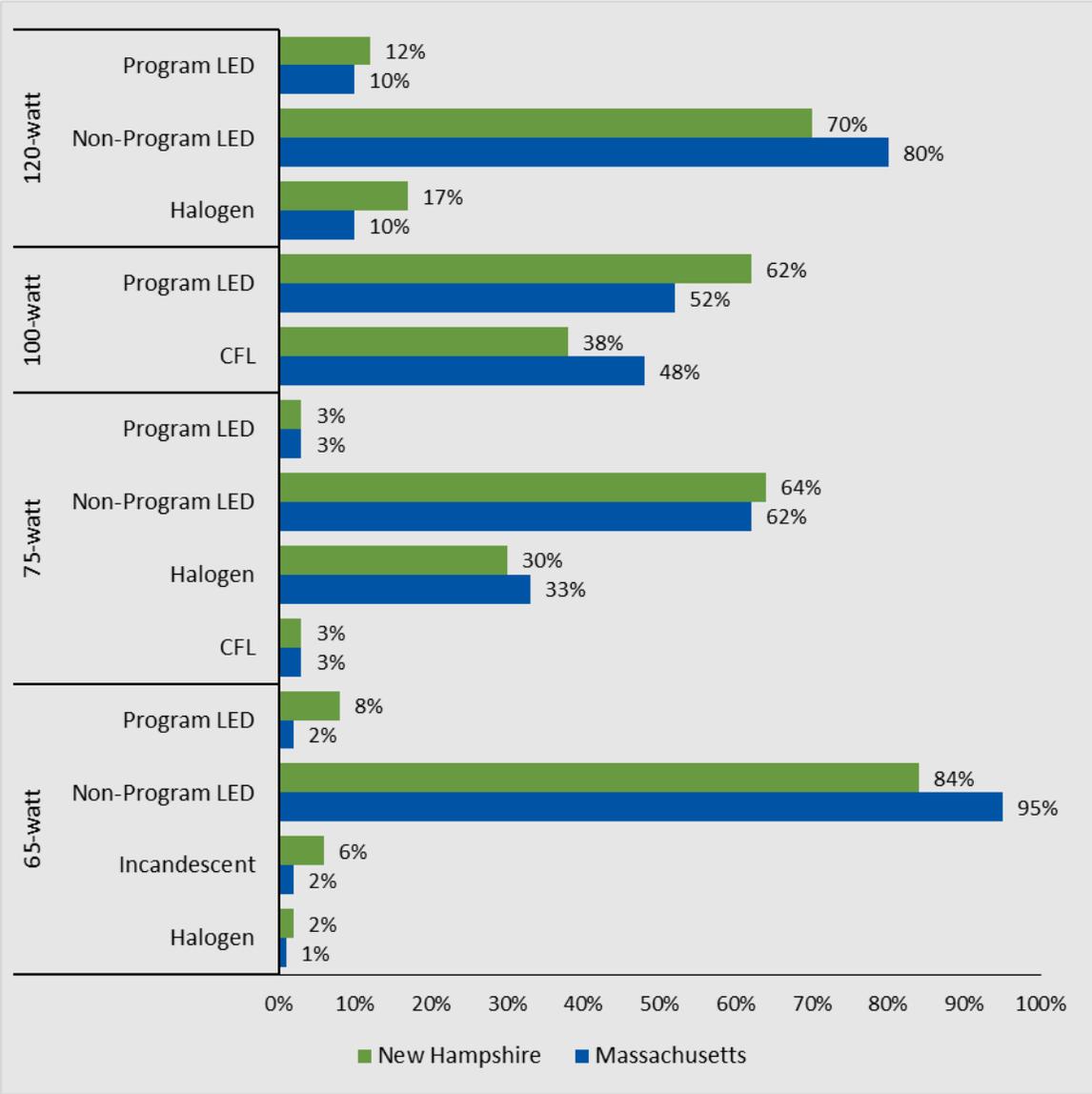
These numbers suggest that the program can focus its efforts on the 75-watt and 100-watt categories for the expansion of program LEDs.

LEDs make up the largest share of available technologies for 40-watt and 60-watt equivalent general-purpose bulbs. Program LEDs account for 50% of LED inventory of 40-watt equivalent bulbs and 45% of 60-watt equivalent bulbs. However, in both categories, the share of non-program LEDs is nearly as large as program LEDs. There was little difference between inventory shares of LED bulbs in Massachusetts and New Hampshire.

The inventory of reflector bulbs, in Figure 30, shows LED technology represents the largest share across all bulb categories observed. However, the share of program LEDs within the categories (except for 100-watt equivalent reflector bulbs) is much smaller than non-program LEDs, and halogen bulbs account for a large share of 75-watt equivalent reflectors while CFLs account for a large share of 100-watt equivalent bulbs. This suggests that the program has an opportunity to increase the market share of program LEDs in the reflector 65-watt, 75-watt, and 120-watt categories.

The share of program LEDs in the reflector bulb market ranged from 8% to 12% for all incandescent equivalencies except 100-watt; non-program LEDs make up most of the market share.

Figure 30. Share of Available Reflector Bulb Inventory by Technology Category and Incandescent Equivalence – Retailer 1



Source: Lighting Pricing Assessment

LED Pricing Assessment

In addition to inventory analysis, Cadmus collected data to compare the average per-bulb price by technology, style, and incandescent equivalent wattage. Cadmus found very little difference in pricing between stores in Massachusetts and New Hampshire other than the program incentives. Therefore, the comparison presents prices from New Hampshire stores only. Note, the price listed on the retailer’s website often includes utility discounts in the list price, so prices in the tables below include program discounts.

Table 50. General Purpose Price per Bulb Ranges by Technology Category and Incandescent Equivalence – Retailer 1

Bulb Style	Incandescent Equivalent	Technology Category	Minimum Price per Bulb	Median Price per Bulb	Mean Price per Bulb	Maximum Price per Bulb
General Purpose	40-watt	CFL	\$1.29	\$1.29	\$1.29	\$1.29
		Non-Program LED	\$1.18	\$2.97	\$3.68	\$9.96
		Program LED	\$0.98	\$0.98	\$1.36	\$1.97
	60-watt	CFL	\$1.49	\$2.49	\$2.12	\$2.74
		Halogen	\$0.97	\$1.49	\$1.43	\$1.74
		Non-Program LED	\$1.24	\$4.76	\$5.17	\$9.94
		Program LED	\$1.37	\$1.69	\$1.76	\$2.43
	75-watt	CFL	\$2.49	\$2.49	\$3.23	\$3.99
		Halogen	\$1.25	\$1.74	\$1.75	\$1.99
		Non-Program LED	\$5.73	\$5.73	\$5.73	\$5.73
		Program LED	\$2.43	\$3.67	\$4.14	\$5.75
	100-watt	CFL	\$2.34	\$2.42	\$2.42	\$2.49
		Halogen	\$1.06	\$1.74	\$1.54	\$1.99
		Incandescent	\$0.95	\$0.95	\$0.97	\$1.00
		Non-Program LED	\$3.37	\$3.37	\$4.46	\$6.46
		Program LED	\$2.72	\$8.10	\$5.94	\$8.84

Table 51. Reflector Price per Bulb Ranges by Technology Category and Incandescent Equivalence – Retailer 1

Bulb Style	Incandescent Equivalent	Technology Category	Minimum Price per Bulb	Median Price per Bulb	Mean Price per Bulb	Maximum Price per Bulb
Reflector	65-watt	Halogen	\$1.55	\$4.97	\$4.79	\$4.97
		Incandescent	\$1.85	\$3.41	\$3.06	\$4.16
		Non-Program LED	\$2.75	\$4.48	\$5.56	\$10.97
		Program LED	\$2.99	\$2.99	\$2.99	\$2.99
	75-watt	CFL	\$6.75	\$6.75	\$6.75	\$6.75
		Halogen	\$3.12	\$8.97	\$8.06	\$9.97
		Non-Program LED	\$3.90	\$4.61	\$4.54	\$5.15
		Program LED	\$5.84	\$5.84	\$5.84	\$5.84
	100-watt	CFL	\$7.77	\$7.77	\$7.77	\$7.77
		Program LED	\$8.45	\$8.45	\$8.45	\$8.45
	120-watt	Halogen	\$9.97	\$9.97	\$9.97	\$9.97
		Non-Program LED	\$7.96	\$7.96	\$8.56	\$9.20
Program LED		\$7.97	\$12.40	\$10.86	\$12.40	

Prices of non-program LEDs are generally higher than other technologies but, even without program incentives, products are available that are competitively priced with CFL, halogen, or incandescent bulbs. The lamps marked down through the program are Energy Star-qualified and typically have longer lifespans and better light distribution than non-qualified lamps. Program LEDs tend to be higher quality and therefore more expensive than non-program LEDs before program markdowns. The pricing assessment results show that the program incentive has a noticeable impact on prices for program LEDs, especially for general purpose lamps:

Non-program LEDs are available in some bulb categories for the same price, or at a lower price, as program-qualified bulbs.

- For 40-watt and 60-watt equivalent LED bulbs, minimum prices for program LEDs are comparable to prices for non-program LEDs but the mean and median prices of program-LEDs are nearly three times the minimum discounted prices for the same lamps. The discounted program LED prices are comparable to prices of halogen bulbs.
- For 75-watt and 100-watt bulbs, the difference in price between program LEDs and non-program LEDs was smaller and both were more expensive than halogen products, although program discounts made program LEDs more cost-competitive than non-program LEDs.

- Reflector bulbs showed much smaller differences in price between program and non-program LED bulbs. Additionally, LEDs were more competitively priced with halogen and CFL products regardless of program discounts.¹⁸

Customer Ratings

Cadmus compared customer ratings collected from the retailer websites for program LEDs, non-program LEDs, and CFLs. The resulting figures compare ratings by quartile for each technology and incandescent-equivalent category. Quartiles show the distribution of ratings rather than just the mean rating; if a technology had a large number of very low ratings and a small number of very high ratings, the mean would not capture this. If non-program LEDs were unique in having a significant number of low-quality, low-price products, we would expect to see this reflected in the distribution of ratings.

Only 65-watt reflector and 40-watt A-line LEDs show low ratings in the first quartile.¹⁹ LEDs are otherwise rated higher than CFL and halogen alternatives. Notably, 60-watt equivalent A-line halogen bulbs are rated lower than other technology options across all quartiles. Ratings for 75-watt and 100-watt halogen A-line bulbs are also lower than other categories in the first two quartiles.

Of LED products, only 65 watt reflector and 40-watt A-line LEDs show low ratings in the first quartile. Otherwise both program and non-program LEDs are rated higher than CFL and halogen alternatives.

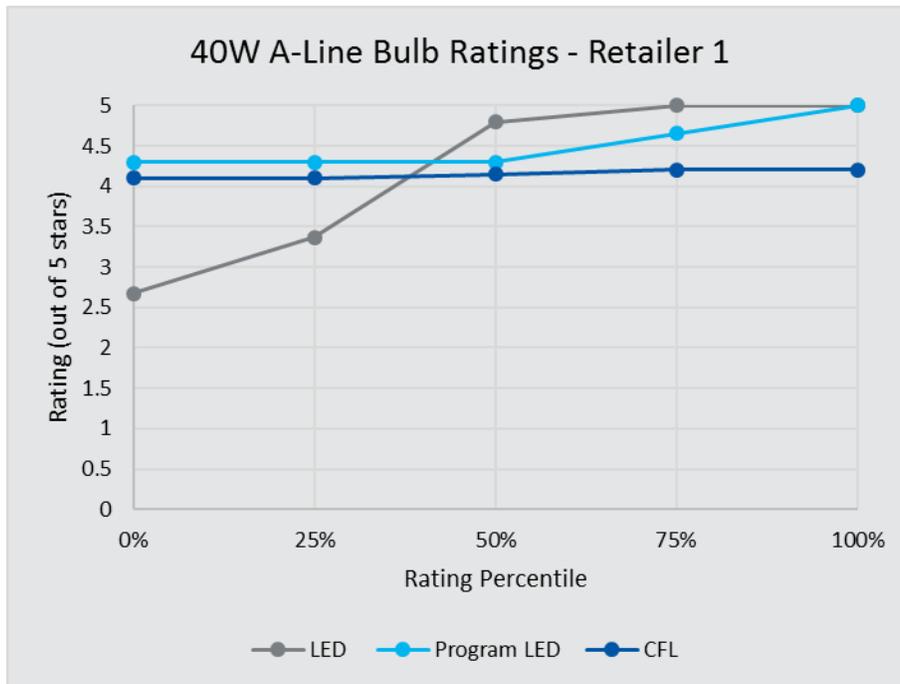
Cadmus found that both program and non-program LEDs are rated highly across all categories. Customer reviews suggest that the quality of even non-program LEDs is sufficient to be competitive with other technologies, and given that price is a large contributing factor in customer purchase decision-making, non-program LEDs may be purchased in lieu of program-qualified bulbs if they are a lower price.

Figure 31 shows customer ratings for 40-watt equivalent bulbs by rating percentile. Figures for additional incandescent lamp-equivalencies are provided in Appendix E.

¹⁸ The price listed on the retailer's website often included utility discounts; prices included in the summary tables in this report reflect program discounts.

¹⁹ These lamp styles represent 8% (65-watt reflector) and 12% (40-watt A-Line) of lamps available at Retailer 1. Additional detail on the lamp availability by wattage-equivalence and style are provided in

Figure 31. Customer Ratings Quartiles 40W Equivalent A-Line – Retailer 1



Reviews were collected from eight unique non-program LED models with an average of 24 reviews per model, five program LED models with an average of 182 reviews per model, and one CFL with 161 reviews.

Program vs. Non-Program Participation

In addition to collecting data from the retailer selling program LEDs (Retailer 1), Cadmus also collected data from a competing retailer who was not selling any program-discounted products during the data collection period (Retailer 2). Retailer 2 is a reasonable representation of what we might expect the market to look like absent program support in New Hampshire.

Product Availability

As with Retailer 1, Cadmus collected data from 13 unique store locations in New Hampshire and five locations in Massachusetts. Store-level inventory data for Retailer 2 were not available when Cadmus collected the data from the website. However, Cadmus counted the number of unique products within each category assuming that the number of unique products in a given category correlates with inventory and sales. Table 52 and Table 53 show counts of unique general service bulbs and reflector bulbs, respectively, for Retailer 2.

Table 52. Count of Unique General Service Bulb Model Numbers by Technology and Incandescent Equivalence – Retailer 2

Bulb Style	Incandescent Equivalent	Technology Category	State	
			Massachusetts	New Hampshire
General Purpose	40-watt	Incandescent	2	4
		Non-Program LED	18	18
	60-watt	CFL	4	3
		Halogen	13	12
		Incandescent	4	4
		Non-Program LED	32	36
	75-watt	Halogen	4	3
		Incandescent	1	1
		Non-Program LED	6	6
	100-watt	CFL	3	4
		Halogen	4	4
		Incandescent	4	4
		Non-Program LED	12	13

Source: Lighting Pricing Assessment

Table 53. Count of Unique Reflector Bulb Model Numbers by Technology and Incandescent Equivalence – Retailer 2

Bulb Style	Incandescent Equivalent	Technology Category	State	
			Massachusetts	New Hampshire
Reflector	40-watt	Halogen	5	6
		Incandescent	4	4
		LED	22	26
	60-watt	CFL	0	1
		Halogen	2	5
		Incandescent	3	5
		LED	50	59
	75-watt	CFL	0	1
		Halogen	3	4
		LED	8	12
	100-watt	Halogen	4	6
		LED	14	17

Source: Lighting Pricing Assessment

In the same way that LEDs accounted for the majority of available daily inventory in Retailer 1 stores for many product categories, LEDs account for the majority of lighting models available in both Massachusetts stores and New Hampshire stores for Retailer 2. Note, the incandescent general service bulbs are medium screw base A-style bulbs that are technically

Despite not participating in the ENERGY STAR Products program, the majority of lighting models available at Retailer 2 stores are LEDs, especially in the 40-watt and 60-watt equivalent categories.

marketed as decorative but could also be used in general service applications.

Similar to the daily inventory findings for Retailer 1, products offered by Retailer 2 in both the 40-watt and 60-watt categories are predominantly LEDs. LEDs are less dominant in the 75-watt and 100-watt-equivalent categories, although LEDs still have more models available than any other technology. Reflector bulbs for Retailer 2 showed a similar pattern to general service bulbs with LEDs accounting for the majority of available products across all categories.

Overall, the product availability shows little difference between Retailer 2 stores in New Hampshire compared to Massachusetts. LEDs in the 60-watt reflector category have more available models in New Hampshire stores than in Massachusetts stores, though there are more halogen and incandescent models in New Hampshire as well.

LED Pricing

Cadmus also compared the per-bulb LED prices between Retailer 1 and Retailer 2 in New Hampshire stores.

Discounted program LED at Retailer 1 are priced lower than comparable bulbs at Retailer 2 stores except for the lowest priced bulbs, where prices are lower at Retailer 2.

The median and mean prices are comparable between

LED bulbs at Retailer 2 and the non-program LEDs at Retailer 1. The maximum price for program LEDs is much lower than both the non-program LEDs at Retailer 1 and bulbs at Retailer 2.

Without program incentives, the prices of LED lamps at Retailer 2 are similar to the prices of non-program LEDs sold through Retailer 1.

The market characterization data suggests that there is a robust market for LEDs. Cadmus has observed a high prevalence of LEDs in stores absent or with little program support, suggesting LEDs have a strong presence in the market independent of program support. Given the number of features available among LED bulbs (dimmbable, non-dimmbable, color temperatures, rated for enclosed fixtures, etc.), this is to be expected.

Conclusions and Recommendations

Conclusion: LED saturation is high in New Hampshire and LEDs are relatively well distributed across room types. LED bulbs accounted for 28% of all bulbs in service. Recessed and reflector were the most commonly purchased LED lamp styles

- **Recommendation:** Continue to discount recessed and reflector-style LED bulbs.

Conclusion: The difference between baseline and efficient lamp wattage was found to be 35.2W for LEDs and 25.6W for CFLs.

- **Recommendation:** Continue to discount LED products. Although CFL bulbs are considered part of the baseline for both bulb types, LEDs are typically lower wattage and will still achieve some level of savings even when replacing CFLs.

Conclusion: Cadmus found an average daily HOU of 1.70 hours (620.5 annual hours) through the in-home metering study. The team also found that LEDs tend to have slightly higher HOU (1.75 daily hours, 638.8 annual hours) than other bulbs in the home.

- **Recommendation:** Adopt the HOU evaluated by Cadmus for future program planning, including incorporating the findings into savings assumptions for the 2018–2020 program offerings. If the program incentivizes only LED equipment, the appropriate input is 1.75 daily HOU (638.8 hours annually).

Conclusion: Although Cadmus was not able to quantify increased LED sales or market share resulting from program support, the large inventory shares of non-program LEDs observed and the large number of available products raises the possibility that sales of program-discounted LEDs could be displacing non-program LEDs rather than halogen, incandescent, or CFL bulbs.

- **Recommendation:** Given minimal differences in efficiency between program LEDs and non-program LEDs, displaced sales of non-program LEDs generate essentially no savings for the program. The program should therefore focus on retail channels that will minimize competition from non-program LEDs, and work with retailer partners to ensure that program-qualified products are featured more prominently than non-program alternatives.

Conclusion: Retailers actively promote non-program LEDs, sometimes alongside program LEDs, with price levels comparable to program-discounted bulbs.

- **Recommendation:** Collaborate with retailers when developing incentive levels on qualifying products to ensure that program and store promotions align and maximize the impact of the incentives. Work with retailers to highlight program-discounted bulbs and attempt to create some separation between program bulbs and non-program bulbs.

Conclusion: The limited number of in-store intercept surveys indicate that a percentage of program lamp sales are likely attributable to customers from neighboring jurisdictions. Though statistical significance was not determined due to the small sample size, approximately 27% of the interviewed customers purchasing lighting products were not customers of Eversource, Liberty, NHEC, or Unitil. None of the intercept survey respondents indicated they planned to install the lamps in a business location.

- **Recommendation:** Consider future research to quantify the volume of program-qualified lamps sold to residents of neighboring states (cross-service area sales), as well as research to quantify the volume of lamps installed in business locations (cross-customer class sales).

Conclusion: Eleven of the in-home lighting inventory interview respondents indicated they had removed LED lamps in the past two years, citing light quality and burn outs as the reason for removal. Most of the removed lamps were replaced with another LED, though some respondents replaced their LEDs with incandescent lamps or CFLs, suggesting the switch to LEDs may not be permanent. The team was not able to identify whether the burned out lamps were program-qualified, but customer feedback on

lighting quality and the early failure of the lamps indicates these may be lower quality non-program LEDs. Price is a key factor in the customer purchase decision, so utility markdowns that make program-LEDs cost-competitive with competing technologies and non-program LED products may improve the customer's experience, resulting in continued customer adoption of LEDs.

- **Recommendation:** Continue to mark down lighting products that provide high-quality light, color temperature, and energy savings. This is especially important for recessed and reflector-style lamps: these lamps account for over 25% of the installed LEDs observed during the home visits, but only one recessed- and two floor-style lamps are incentivized by the program.

Conclusion: Program LEDs represent only 29% of the New Hampshire 75-watt equivalent general-purpose bulb inventory and 13% of the 100-watt equivalent general-purpose bulb inventory, whereas halogen bulbs make up 50% and 54%, respectively.

- **Recommendation:** Target lighting markdowns toward equipment categories with low saturations of LED products, such as 75-watt and 100-watt equivalent lamps.

Conclusion: Non-program LEDs are available in some bulb categories for the same price, or at a lower price, as program-qualified bulbs.

- **Recommendation:** Continue to mark down high-quality LED products so that they are among the cheapest options available on store shelves, especially in product categories where customer satisfaction was found to be lower among non-program bulbs, such as 40-watt A-Line and 65-watt reflectors.

ENERGY STAR Appliances, Water Heating, and Space Heating and Cooling Products

Program Overview and Evaluation Tasks

In 2016, the New Hampshire ENERGY STAR Products program offered in-store, online, and mail-in rebate incentives as well as product markdowns for qualified products. The New Hampshire utilities also sponsored an online catalog, available through NHSaves.com, that allowed customers to make direct online purchases of certain qualified products at discounted prices.

The natural gas initiative (GasNetworks) provides rebates and incentives for high-efficiency furnaces (with ECM fan systems), hot water boilers, water-heating equipment, and heating system controls, such as wireless programmable thermostats and heat recovery ventilators. The initiative also supports an early replacement promotion and provides incentives to contractors for quality installations.

The electric initiative is administered by the electric program administrators, and GasNetworks is administered by the gas program administrators. The initiatives use the same circuit rider, who is responsible for outreach, education, and support for contractors, distributors, and supply houses as well as for a rebate processing vendor. GasNetworks uses a website contractor for website support.

Summary of Savings Results

Cadmus developed verified savings (*ex post* savings) for the products incentivized through the program using a combination of on-site metering and data collection, utility bill analysis, engineering desk reviews, and surveys of program participants. Most of the measures were evaluated using a combination of engineering desk reviews, with in-service rates determined through the participant survey, though savings for the natural gas furnace and boiler measures were determined through billing analysis with in-service rates from the participant survey. Where appropriate, Cadmus recommends the utilities update savings inputs, such as in-service rates and billing analysis results, rather than applying measure-level realization rates for future program planning.

Overall, Cadmus found the non-lighting measures achieved 99.2% of *ex ante* kwh savings. The realization rate, shown in Table 54, was driven primarily by differences in *ex ante* and *ex post* in-service rates from the participant surveys as well as billing analysis results for the natural gas furnace and boiler measures. Some of the measures incentivized through the program contribute both electric and fossil-fuel savings.

For the purpose of the 2016 evaluation, demand savings are reported for the Independent System Operator New England (ISO-NE) summer and winter peak periods. Cadmus used the peak coincidence factors recorded in the utility B/C models to evaluate demand savings. Table 54 includes ancillary electric savings attributable to the gas measures and gas savings attributable to the electric measures. Appendix A provides each utility's savings by fuel type and measure.

Table 54. 2016 ENERGY STAR Appliances, Water Heating, and Space Heating and Cooling Products Savings

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW ¹	ISO-NE Winter Peak kW ¹	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	2,274,685	24,238,893	398.4	510.0	23,182	399,538
<i>Ex Post</i>	2,256,451	24,045,661	393.7	507.7	20,311	348,162
Realization Rate	99.2%	99.2%	98.8%	99.5%	87.6%	87.1%

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Electric Measures

Table 55 displays *ex ante* and *ex post* savings for the electric appliances, water heating, and space heating and cooling measures offered through the program. Overall, white goods constitute the largest portion of the program’s electric savings, representing approximately 45% of appliance *ex post* kWh savings.

Table 55. Electric Appliances *Ex Ante* and *Ex Post* kWh Savings

Measure Name	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings	Precision at 90% Confidence
White Goods						
ENERGY STAR Clothes Washers	800,954	8,810,492	98.2%	786,391	8,650,301	2.9%
ENERGY STAR Freezers	228	2,736	100.0%	228	2,736	--
ENERGY STAR Refrigerators	91,783	1,101,397	100.0%	91,783	1,101,397	--
ENERGY STAR Room Air Conditioners	23,863	214,768	84.6%	20,192	181,727	16.5%
ENERGY STAR Room Air Purifier	81,238	731,142	100.0%	81,238	731,142	--
White Goods Subtotal	998,066	10,860,535	98.2%	979,832	10,667,303	--
Appliance Recycling						
Secondary Freezer Recycling	113,839	910,712	100.0%	113,839	910,712	--
Secondary Refrigerator Recycling	311,060	2,488,480	100.0%	311,060	2,488,480	--
Appliance Recycling Subtotal	424,899	3,399,192	100.0%	424,899	3,399,192	--
Advanced Power Strip						
Advanced Power Strip	791	3,953	100.0%	791	3,953	--
Advanced Power Strip Subtotal	791	3,953	100.0%	791	3,953	--

Measure Name	Ex Ante kWh Savings	Ex Ante Lifetime kWh Savings	Realization Rate	Ex Post kWh Savings	Ex Post Lifetime kWh Savings	Precision at 90% Confidence
Heating and Cooling						
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	575	6,898	100.0%	575	6,898	--
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	4,156	49,867	100.0%	4,156	49,867	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	39,422	473,069	100.0%	39,422	473,069	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	3,564	42,772	100.0%	3,564	42,772	--
ENERGY STAR Central AC (3 Ton)	3,112	43,570	100.0%	3,112	43,570	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	67,341	808,091	100.0%	67,341	808,091	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	3,370	40,440	100.0%	3,370	40,440	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	320,728	3,848,739	100.0%	320,728	3,848,739	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	11,840	142,085	100.0%	11,840	142,085	--
ENERGY STAR Ductless AC (Cooling only)	326	3,918	100.0%	326	3,918	--
Wi-Fi Enabled Thermostats for Air Conditioners	3,028	36,331	100.0%	3,028	36,331	--
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	155	1,863	100.0%	155	1,863	--
Heating and Cooling Subtotal	457,618	5,497,643	100.0%	457,618	5,497,643	--
Domestic Hot Water						
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	209,450.0	2,094,500.0	100.0%	209,450.0	2,094,500.0	--
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	98,864.0	988,640.0	100.0%	98,864.0	988,640.0	--
Domestic Hot Water Subtotal	308,314	3,083,140	100.0%	308,314	3,083,140	--
Electric Measures Total	2,189,688	22,844,463	99.2%	2,171,454	22,651,231	--

Note: Values in table may not match exactly due to rounding.

In addition to electric savings, the ENERGY STAR clothes washer measure also contributes MMBtu and water savings. The measure achieved 2,099 MMBtu annually and approximately 7,578,320 gallons of water saved annually.

Table 56. Electric Appliances *Ex Ante* and *Ex Post* MMBtu Savings

Measure Name	<i>Ex Ante</i> MMBtu Savings	<i>Ex Ante</i> Lifetime MMBtu Savings	Realization Rate	<i>Ex Post</i> MMBtu Savings	<i>Ex Post</i> Lifetime MMBtu Savings	Precision at 90% Confidence
White Goods						
ENERGY STAR Clothes Washers	1,869	20,559	112.3%	2,099	23,084	--
Total	1,869	20,559	112.3%	2,099	23,084	--

Unitil used a different value for fuel oil MMBtu savings (0.02546 MMBtu) vs. the other three utilities (0.2546 MMBtu). Values in the table reflect the higher rate of savings.

The electric measures achieved 376.7 kW savings coincident with the ISO-NE summer peak and 505.4 kW coincident with the ISO-NE winter peak. A comparison of Cadmus’ *ex post* savings and the utility-reported *ex ante* savings are provided at the program level in Table 57.

Table 57. Electric Appliances Achieved Demand Savings

Measure Name	<i>Ex Ante</i> ISO-NE Summer kW Savings	<i>Ex Ante</i> ISO-NE Winter kW Savings	Realization Rate	<i>Ex Post</i> ISO-NE Summer kW Savings ¹	<i>Ex Post</i> ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
White Goods						
ENERGY STAR Clothes Washers	90.9	127.9	98.2%	89.2	125.6	2.9%
ENERGY STAR Freezers	0.0	0.0	100.0%	0.0	0.0	--
ENERGY STAR Refrigerators	10.5	9.4	100.0%	10.5	9.4	--
ENERGY STAR Room Air Conditioners	20.0	0.0	84.6%	16.9	0.0	16.5%
ENERGY STAR Room Air Purifier	9.7	9.6	100.0%	9.7	9.6	--
White Goods Subtotal	131.0	146.9	96.4%	126.3	144.5	--
Appliance Recycling						
Secondary Freezer Recycling	13.0	11.7	100.0%	13.0	11.7	--
Secondary Refrigerator Recycling	36.1	32.5	100.0%	36.1	32.5	--
Appliance Recycling Subtotal	49.1	44.2	100.0%	49.1	44.2	--
Advanced Power Strip						
Advanced Power Strip	0.1	0.3	100.0%	0.1	0.3	--
Advanced Power Strip Subtotal	0.1	0.3	100.0%	0.1	0.3	--

Measure Name	Ex Ante ISO-NE Summer kW Savings	Ex Ante ISO-NE Winter kW Savings	Realization Rate	Ex Post ISO-NE Summer kW Savings ¹	Ex Post ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
Heating and Cooling						
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	1.3	0.0	100.0%	1.3	0.0	--
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	1.3	0.0	100.0%	1.3	0.0	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	14.9	100.0%	0.0	14.9	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	1.3	100.0%	0.0	1.3	--
ENERGY STAR Central AC (3 Ton)	6.9	0.0	100.0%	6.9	0.0	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	148.7	0.0	100.0%	148.7	0.0	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	7.4	0.0	100.0%	7.4	0.0	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	242.9	100.0%	0.0	242.9	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	9.0	100.0%	0.0	9.0	--
ENERGY STAR Ductless AC (Cooling only)	0.7	0.0	100.0%	0.7	0.0	--
Wi-Fi Enabled Thermostats for Air Conditioners	2.6	0.7	100.0%	2.6	0.7	--
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.1	0.1	100.0%	0.1	0.1	--
Heating and Cooling Subtotal	168.9	268.9	100.0%	168.9	268.9	--
Domestic Hot Water						
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	22.1	32.6	100.0%	22.1	32.6	--
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	10.1	14.9	100.0%	10.1	14.9	--
Domestic Hot Water Subtotal	32.2	47.5	100.0%	32.2	47.5	--
Electric Measures Total	381.4	507.7	98.8%	376.7	505.4	--

¹ Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Gas Measures

Table 58 displays *ex ante* and *ex post* savings for the gas measures offered through the program. Wi-Fi thermostats (heating and cooling) were the largest single measure in PY2016, accounting for approximately 30% of *ex post* savings.

Table 58. Gas Appliances *Ex Ante* and *Ex Post* MMBtu Savings

Measure Name	<i>Ex Ante</i> MMBtu Savings	<i>Ex Ante</i> Lifetime MMBtu Savings	Realization Rate	<i>Ex Post</i> MMBtu Savings	<i>Ex Post</i> Lifetime MMBtu Savings	Precision at 90% Confidence
Heating and Domestic Hot Water						
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	1,010	20,200	67.4%	681	13,624	14.9%
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	2,457	49,140	84.7%	2,081	41,623	14.9%
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	566	5,664	43.0%	244	2,436	14.5%
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	250	4,992	133.0%	332	6,637	14.5%
Furnace ≥ 95% AFUE w/ECM	2,003	36,061	49.1%	983	17,696	15.0%
Furnace ≥ 97% AFUE w/ECM	1,990	35,811	52.6%	1,046	18,827	15.0%
Heat Recovery Ventilator	23	462	100.0%	23	462	--
Thermostat: Standard 7-day Programmable	547	8,208	100.0%	547	8,208	--
Thermostat: Wi-Fi (Cooling & Heating)	4,957	74,354	96.1%	4,765	71,478	--
Thermostat: Wi-Fi (Heating Only)	726	10,890	100.0%	726	10,890	--
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	968	19,360	100.0%	968	19,360	--
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	1,952	39,032	100.0%	1,952	39,032	--
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	1,452	29,036	100.0%	1,452	29,036	--
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	13	164	100.0%	13	164	--
Water Heater: Tankless, On Demand, EF ≥ 0.82	143	2,713	100.0%	143	2,713	--
Water Heater: Tankless, On Demand, EF ≥ 0.94	2,258	42,893	100.0%	2,258	42,893	--
Gas Measures Total	21,313	378,979	85.5%	18,213	325,078	--

Note: Values in table may not match exactly due to rounding.

In addition to gas savings, the furnace measures, heat recovery ventilator, and Wi-Fi thermostat (heating and cooling) measure also contribute kWh and kW savings. Overall, the measures achieved 84,997 kWh annually. Table 59 shows the cumulative savings for these measures.

Table 59. Gas Appliances *Ex Ante* and *Ex Post* kWh Savings

Measure Name	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings
Furnace ≥ 95% AFUE w/ECM	21,168	381,024	100.0%	21,168	381,024
Furnace ≥ 97% AFUE w/ECM	19,320	347,760	100.0%	19,320	347,760
Heat Recovery Ventilator	-399	-7,980	100.0%	-399	-7,980
Thermostat: Wi-Fi (Cooling & Heating)	44,908	673,626	100.0%	44,908	673,626
Gas Measures Total	84,997	1,394,430	100.0%	84,997	1,394,430

Note: Values in table may not match exactly due to rounding.

The same products achieved 17.0 kW savings coincident with the ISO-NE summer peak and 2.3 kW coincident with the ISO-NE winter peak. A comparison of Cadmus' *ex post* savings and the utility-reported *ex ante* savings are provided at the program level in Table 60.

Table 60. Gas Appliances Achieved Demand Savings

Measure Name	<i>Ex Ante</i> ISO-NE Summer kW Savings	<i>Ex Ante</i> ISO-NE Winter kW Savings	Realization Rate	<i>Ex Post</i> ISO-NE Summer kW Savings ¹	<i>Ex Post</i> ISO-NE Winter kW Savings ¹
Furnace ≥ 95% AFUE w/ECM	0.0	1.3	100.0%	0.0	1.3
Furnace ≥ 97% AFUE w/ECM	0.0	1.2	100.0%	0.0	1.2
Heat Recovery Ventilator	0.0	-0.2	100.0%	0.0	-0.2
Thermostat: Wi-Fi (Cooling & Heating)	17.0	0.0	100.0%	17.0	0.0
White Goods Subtotal	17.0	2.3	100.0%	17.0	2.3

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Evaluation Tasks

Cadmus used a combination of the research activities described below, as well as a participant survey, to evaluate the non-lighting components of the ENERGY STAR Products program. Detailed research methods and findings are provided in the section on *Ex Post* Savings Findings.

Program Records Review

To inform the *ex ante* impact evaluation, Cadmus conducted a review of the B/C models used by the utilities to ensure that the *ex ante* savings used the applicable algorithms and inputs stipulated by the EM&V Working Group. The utility B/C models were also cross-checked against the year-end savings reports filed with the PUC.

Engineering Desk Review

Cadmus reviewed the savings estimates used by the utilities and relied on primary or secondary research to update savings as appropriate. Primary data collection included participant surveys to assess in-service rates.

Billing Analysis

Cadmus conducted a billing analysis (80 homes) to evaluate savings for natural gas furnaces and boilers rebated through the program. The team conducted a post-only billing analysis to develop energy consumption estimates for the rebated equipment then applied engineering algorithms to estimate baseline energy consumption. Energy savings were evaluated as the difference between the baseline and rebated consumption estimates.

Metering Study

As a supplement to the billing analysis, Cadmus installed temperature and HVAC meters during the lighting home inventory site visits. Temperature meters were installed in all of the visited homes, and HVAC metering equipment were installed in 16 homes that received rebates for new natural gas furnaces. State loggers track the on/off operation of mechanical equipment—in this instance, the team tracked the furnace fan motor to determine when the unit was in operation.

Impact Evaluation

Cadmus determined energy savings, summer peak demand savings, and winter peak demand savings through engineering desk reviews, participant billing analysis, and on-site data collection. Participant survey data informed the team's evaluated in-service rates.

Ex Ante Savings Methodology

Cadmus verified reported energy and demand savings during the 2016 program year for all fuel types, as applicable (e.g., electricity, natural gas, liquid propane, fuel oil), and for water savings. Cadmus conducted a program documentation review to ensure *ex ante* savings in the utility B/C models matched the final report each utility submitted to the NHPUC.

Ex Ante Savings Findings

Overall, the PY2016 New Hampshire ENERGY STAR Products program claimed 2,189,688 in *ex ante* kWh savings, 381.4 in ISO-NE Summer kW savings, and 507.7 in ISO-NE Winter kW savings for the program's appliance, water heating, and space heating and cooling measures. In addition, the program claimed 22,844,463 kWh in *ex ante* lifetime savings. The program's *ex ante* quantities and savings are shown by primary fuel type and measure in Table 61 (electric) and Table 62 (gas). The *ex ante* savings include utility-reported in-service rates.

Table 61. 2016 Program Electric Measures—Ex Ante kWh and kW Savings by Measure

Measure Name	Quantity Units Rebated	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW
White Goods					
ENERGY STAR Clothes Washers	4,406	800,954	8,810,492	90.9	127.9
ENERGY STAR Freezers	2	228	2,736	0.0	0.0
ENERGY STAR Refrigerators	2,316	91,783	1,101,397	10.5	9.4
ENERGY STAR Room Air Conditioners	1,477	23,863	214,768	20.0	0.0
ENERGY STAR Room Air Purifier	208	81,238	731,142	9.7	9.6
White Goods Subtotal	8,409	998,066	10,860,535	131.0	146.9
Appliance Recycling					
Secondary Freezer Recycling	173	113,839	910,712	13.0	11.7
Secondary Refrigerator Recycling	412	311,060	2,488,480	36.1	32.5
Appliance Recycling Subtotal	585	424,899	3,399,192	49.1	44.2
Advanced Power Strip					
Advanced Power Strip	10	791	3,953	0.1	0.3
Advanced Power Strip Subtotal	10	791	3,953	0.1	0.3
Heating and Cooling					
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5) ¹	7.5	575	6,898	1.3	0.0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5) ¹	16.2	4,156	49,867	1.3	0.0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10) ¹	16.2	39,422	473,069	0.0	14.9
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5) ¹	7.5	3,564	42,772	0.0	1.3
ENERGY STAR Central AC (3 Ton) ¹	21.9	3,112	43,570	6.9	0.0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5) ¹	873.9	67,341	808,091	148.7	0.0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5) ¹	153.2	3,370	40,440	7.4	0.0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5) ¹	827.9	320,728	3,848,739	0.0	242.9
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5) ¹	153.2	11,840	142,085	0.0	9.0
ENERGY STAR Ductless AC (Cooling only) ¹	6.9	326	3,918	0.7	0.0
Wi-Fi Enabled Thermostats for Air Conditioners	118	3,028	36,331	2.6	0.7
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	4	155	1,863	0.1	0.1
Heating and Cooling Subtotal	2,206.2	457,618	5,497,643	168.9	268.9
Domestic Hot Water					
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	118	209,450	2,094,500	22.1	32.6
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	37	98,864	988,640	10.1	14.9
Domestic Hot Water Subtotal	155	308,314	3,083,140	32.2	47.5
Electric Measures Total	11,365.2	2,189,688	22,844,463	381.4	507.7

¹ Quantities for these measures represent the total tonnage of equipment rebated. Per-unit savings for these measures are given in savings per ton.

Note: Values in table may not match exactly due to rounding.

Table 62. 2016 Program Gas Measures—*Ex Ante* MMBtu Savings by Measure

Measure Name	Quantity Units Rebated	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating and Domestic Hot Water			
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	86	1,010	20,200
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	178	2,457	49,140
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	24	566	5,664
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	24	250	4,992
Furnace ≥ 95% AFUE w/ECM	126	2,003	36,061
Furnace ≥ 97% AFUE w/ECM	115	1,990	35,811
Heat Recovery Ventilator	3	23	462
Thermostat: Standard 7-day Programmable	171	547	8,208
Thermostat: Wi-Fi (Cooling & Heating)	722	4,957	74,354
Thermostat: Wi-Fi (Heating Only)	110	726	10,890
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	121	968	19,360
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	82	1,952	39,032
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	61	1,452	29,036
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	3	13	164
Water Heater: Tankless, On Demand, EF ≥ 0.82	14	143	2,713
Water Heater: Tankless, On Demand, EF ≥ 0.94	215	2,258	42,893
Gas Measures Total	2,055	21,313	378,979

Note: Values in table may not match exactly due to rounding.

Table 63 presents total utility *ex ante* savings by fuel type and measure for each utility, and Table 64 shows ancillary savings achieved by each utility for secondary fuel types.

Table 63. 2016 *Ex Ante* Program Savings by Fuel and Utility—Electric Measures

Utility	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Eversource	1,665,982	17,539,119	279.8	406.2	1,479	11,035,100
Liberty	139,181	1,349,839	27.9	17.8	93	693,925
NHEC	181,880	1,747,468	21.6	22.4	201	1,502,940
Unitil	202,644	2,208,037	52.1	61.3	96	1,682,345
Total	2,189,688	22,844,463	381.4	507.7	1,869	14,914,310

Source: B/C models provided by the utilities

Note: Values in table may not match exactly due to rounding.

Table 64. 2016 Program Savings by Fuel and Utility—Gas Measures

Utility	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Eversource	0	0	0.0	0.0	0	0
Liberty	72,842	1,191,915	15.0	2.0	16,658	294,860
NHEC	0	0	0.0	0.0	0	0
Unitil	12,156	202,515	2.0	0.3	4,656	84,119
Total	84,997	1,394,430	17.0	2.3	21,313	378,979

Source: B/C models provided by the utilities

Note: Values in table may not match exactly due to rounding.

Ex Post Methodology

Cadmus evaluated energy savings for the appliances, water heating, and space heating and cooling products through a combination of engineering reviews and billing analysis. To support the analysis, Cadmus conducted metering and participant surveys to inform and validate the evaluated savings assumptions. Where appropriate, the team calculated secondary fuel savings (i.e., MMBtu savings for clothes washers or kWh savings for furnaces). The team did not identify any measures that contributed to kerosene or wood fuel savings.

White Goods

In 2016, the program offered ENERGY STAR refrigerators, freezers, clothes washers, room air conditioners, and room air purifiers. Cadmus conducted a desk review for these five measures, as shown in Table 65.

Table 65. Electric White Goods Measures

White Goods	Evaluation Method
ENERGY STAR Clothes Washers	Desk Review
ENERGY STAR Freezers	Desk Review
ENERGY STAR Refrigerators	Desk Review
ENERGY STAR Room Air Conditioners	Desk Review
ENERGY STAR Room Air Purifier	Desk Review

Cadmus used the following algorithm to evaluate *ex post* program savings. The savings inputs are defined in Table 66.

$$kWh\ Savings = Quantity \times Deemed\ kWh\ Savings\ per\ Unit \times ISR$$

Table 66. Savings Inputs for White Goods Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Cadmus Participant Survey

The team verified in-service rates for white goods through the participant survey.

In addition to the electric energy savings, the utilities also claimed MMBtu savings for the clothes washer measure. The fossil fuel savings are a result of decreased hot water usage—ENERGY STAR reports that clothes washers that meet its standards use 33% less water on average than regular clothes washers. Cadmus used the following algorithm to evaluate *ex post* program savings. The savings inputs are defined in Table 67.

$$MMBtu\ Savings = Quantity \times Deemed\ MMBtu\ Savings\ per\ Unit \times ISR$$

Table 67. Savings Inputs for White Goods Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Cadmus Participant Survey

Appliance Recycling

The 2016 New Hampshire ENERGY STAR Products program offered secondary refrigerator and freezer recycling, resulting in 585 units recycled. Cadmus evaluated these two measures through an engineering desk review, using the following algorithm to evaluate *ex post* program savings. The savings inputs are defined in Table 68.

$$kWh\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

Table 68. Savings Inputs for Appliance Recycling Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Deemed

Cadmus reviewed program savings assumptions for recycled refrigerators and freezers measures and compared these to other jurisdictions.

Electric Heating and Cooling

The 2016 New Hampshire ENERGY STAR Products program offered many electric heating and cooling measures, although one utility, NHEC, offered electric heating and cooling measures in 2016 through a member-services program rather than the statewide offering. The full list of measures is shown in Table 69.

Table 69. Electric Heating and Cooling Measures

Heating and Cooling	Evaluation Method
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	Desk Review
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	Desk Review
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	Desk Review
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	Desk Review
ENERGY STAR Central A/C (3 Ton)	Desk Review
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	Desk Review
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	Desk Review
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	Desk Review
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	Desk Review
ENERGY STAR Ductless AC (Cooling only)	Desk Review
Wi-Fi Enabled Thermostats for Air Conditioners	Desk Review
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	Desk Review

Cadmus reviewed program savings assumptions for all measures and compared these to other jurisdictions. *Ex post* program savings were evaluated using the following algorithm. The savings inputs are defined in Table 70.

$$kWh\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

Table 70. Savings Inputs for Heating and Cooling Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Cadmus Participant Survey

The team verified in-service rates for electric heating and cooling through the participant survey. For measures with less than 10 responses in the participant survey, Cadmus applied a deemed in-service rate of 100%.

Electric Domestic Hot Water

The 2016 New Hampshire ENERGY STAR Products program offered the two electric domestic hot water measures shown in Table 71. NHEC did not rebate any electric domestic hot water measures through the ENERGY STAR Products program though the measure were available through a member-services program.

Table 71. Electric Domestic Hot Water Measures

Domestic Hot Water	Evaluation Method
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	Desk Review
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	Desk Review

Cadmus reviewed program savings assumptions for all measures and compared these to other jurisdictions. The team used the following algorithm to evaluate *ex post* program savings. The savings inputs are defined in Table 72.

$$kWh\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

Table 72. Savings Inputs for Domestic Hot Water Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Cadmus Participant Survey

The team verified in-service rates for electric domestic hot water through the participant survey. For measures with less than 10 responses in the participant survey, Cadmus applied a deemed in-service rate of 100%.

Smartstrip Power Strips

The program rebated ten Smartstrip power strips in 2016 and Cadmus evaluated savings through an engineering desk review. The measure was only offered online in 2016, which may have contributed to the low measure participation. *Ex post* program savings were evaluated using the following algorithm. The savings inputs are defined in Table 73.

$$kWh\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

Table 73. Savings Inputs for Smartstrip Engineering Analysis

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	100%	Cadmus Participant Survey

Through the participant survey, Cadmus attempted to verify in-service rates for smart power strips, but because of the low incidence of these measures in the participant survey, the in-service rate was deemed at 100%.

Gas Heating and Domestic Hot Water

Cadmus evaluated savings for the gas program measures using a combination of engineering desk reviews, billing analysis, and meter data analysis from the home inventory site visits. Billing analysis and meter data were used to evaluate savings for the natural gas furnace and boiler measures, and engineering reviews were used to evaluate savings for the other measures offered through the program.

The 2016 New Hampshire ENERGY STAR Program offered many natural gas energy efficiency products, shown in Table 74.

Table 74. Domestic Hot Water and Space Heating Gas Program Offerings

Space Heating	Evaluation Method
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	Billing Analysis, Metering
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	Billing Analysis, Metering
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	Billing Analysis, Metering
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	Billing Analysis, Metering
Furnace ≥ 95% AFUE w/ECM	Billing Analysis, Metering
Furnace ≥ 97% AFUE w/ECM	Billing Analysis, Metering
Heat Recovery Ventilator	Desk Review
Thermostat: Standard 7-day Programmable	Desk Review
Thermostat: Wi-Fi (Cooling & Heating)	Desk Review
Thermostat: Wi-Fi (Heating Only)	Desk Review
Domestic Hot Water	
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	Desk Review
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	Desk Review
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	Desk Review
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	Desk Review
Water Heater: Tankless, On Demand, EF ≥ 0.82	Desk Review
Water Heater: Tankless, On Demand, EF ≥ 0.94	Desk Review

Engineering Desk Review

Cadmus used the following algorithm to determine *ex post* savings, and the savings inputs are defined in Table 75.

$$MMBtu\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

Through the participant survey, Cadmus attempted to verify in-service rates for natural gas domestic hot water and space heating measures.

Table 75. Savings Inputs for Gas Domestic Hot Water and Space Heating Measures

Input	Description	Value	Source
Quantity	Total number of units rebated	Varies	Utility B/C Models
Deemed Savings per Unit	A standardized, pre-determined savings estimate attributable to the equipment rebated	Varies	Utility B/C Models
In-Service Rate	In-service rate; percentage of rebated units installed and operating	Varies	Cadmus Participant Survey

In addition to the expected MMBtu savings, three of the gas measures also resulted in ancillary kWh savings: heat recovery ventilators, high-efficiency furnaces equipped with ECMs, and Wi-Fi thermostats installed in homes with central cooling. Heat recovery ventilators supply fresh outdoor air to a house, simultaneously exhausting an equal volume of stale air. Heat recovery ventilators incur an electric penalty, as they rely on fans that use electricity to introduce outdoor air into the home. On the other

hand, high-efficiency gas furnaces equipped with ECMs result in electric savings because the fan operates more efficiently than a standard furnace fan. Similarly, Wi-Fi thermostats result in electric savings because of lower cooling energy consumption.

Cadmus used the following algorithms to determine *ex post* savings for all measures except furnaces and condensing boilers:

$$kWh\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

$$kW\ Savings = Quantity \times Deemed\ Savings\ per\ Unit \times ISR$$

The team verified in-service rates for gas program measures via the participant survey, applying a deemed in-service rate of 100% for all measures with fewer than 10 survey responses.

Utility Billing Analysis

For natural gas furnaces and condensing boilers, Cadmus evaluated results using a combination of billing analysis and engineering algorithms, with additional verification provided through analysis of the meter data collected on the site. The two natural gas utilities, Liberty and Unitil, offered rebates for installing furnaces and condensing boilers during 2016.

Cadmus conducted a post-only billing analysis of high-efficiency boilers and furnaces to estimate annual natural gas consumption of the program-rebated equipment then used an engineering algorithm to estimate consumption for the baseline equipment, based on the efficiency of the equipment. This approach assumes that the baseline and installed unit are capable of providing the same level of heat to the home. The difference in energy consumed is a result of the different operating efficiencies of the baseline and installed equipment. Baseline consumption was estimated using the following algorithms, with the inputs provided in Table 76, and savings were evaluated as the difference between baseline and installed MMBtu.

$$Baseline\ MMBtu\ Consumption = Installed\ MMBtu \times \left(\frac{Installed\ AFUE}{Baseline\ AFUE} \right)$$

$$MMBtu\ Savings = Baseline\ MMBtu\ Consumption - Installed\ MMBtu\ Consumption$$

Table 76. Engineering Inputs for Boiler and Furnace Savings

Input	Description	Value	Source
Installed MMBtu	Annual, normalized consumption of the program-incentivized equipment	Varies	Utility B/C Models
Installed AFUE	Annual fuel utilization efficiency (AFUE) of the program-incentivized equipment	Varies	Utility B/C Models
Baseline AFUE	Annual fuel utilization efficiency (AFUE) of the baseline equipment	Varies	Assumed

For the 2016 evaluation, Cadmus estimated savings from three different baselines: an early replacement baseline, a federal standard baseline, and a market baseline (Table 77). All three savings are provided in the report to inform future program planning.

Table 77. Baseline AFUE by Baseline and Measure Type

Baseline Type	Furnaces	Boilers	Source
Early Replacement	78%	80%	MA HEHE 2015 Evaluation ¹
Federal Standard	80%	82%	Federal standard
Market	85%	85%	MA 2015-2018 Planning TRM for Furnaces; assumed for boilers

¹ Cadmus. *Massachusetts High Efficiency Heating Equipment Impact Evaluation*. 2015. Prepared for the Electric and Gas Program Administrators of Massachusetts. Available online: <http://www.neep.org/sites/default/files/resources/High-Efficiency-Heating-Equipment-Impact-Evaluation-Final-Report.pdf>

Cadmus used four datasets in the billing analysis, described in Table 78.

Table 78. Billing Analysis Data Sources

Dataset	Description	Source	Attributes Used in Analysis
Billing Data	Time series data of natural gas consumption maintained for purposes of billing customers	Liberty and Unutil	Monthly gas consumption measured in therms
Utility B/C Models	Dataset describing multiple attributes of rebated high-efficiency boilers and furnaces	Liberty and Unutil	<ul style="list-style-type: none"> • Site address • Measure type (boiler/furnace) • Efficiency (AFUE) • Baseline (early replacement/replace on failure) • Installation date
Local Temperature Data	Hourly records of meteorological measurements collected at weather stations nearest the homes with installed meters	National Oceanic and Atmospheric Administration	Hourly outdoor temperature (used to calculate heating and cooling degree days)
Typical Meteorological Year (TMY3) Data	Standard dataset within the energy efficiency industry, used to estimate energy consumption during a "typical" year	National Renewable Energy Laboratory	Hourly outdoor temperature (used to calculate typical year heating and cooling degree days)

Cadmus compiled data from these sources for a sample of sites that installed high-efficiency boilers and furnaces. The initial sample target was 50 sites in Liberty’s territory and 50 sites in Unutil’s territory. Billing analyses require extensive cleaning and organizing of data. During the data screening and review process, Cadmus removed sites from the analysis that had issues such as missing or insufficient data. The team did not identify any sites with irregular gas consumption patterns. Table 79 details how Cadmus arrived at a final sample sizes of 39 Liberty sites and 41 Unutil sites to include in the analysis.

Table 79. Determination of Analysis Sample

Stage of Evaluation	Count of Sites		
	Liberty	Unitil	Combined
Targeted Sample Size	50	50	100
Requested Billing Data ¹	49	48	97
Received Billing Data ²	46	47	93
Received Measure Installation Date ³	39	47	86
Review of Billing Data ⁴	39	41	80
Final Analysis Sample	39	41	80

¹The provided tracking data used to pull samples contained duplicate project IDs for customers who installed more than one piece of equipment; one Liberty account was sampled twice and one Unitil account was sampled three times.

²Three Liberty and one Unitil participant could not be matched to any of the provided billing data.

³Seven Liberty participants did not have measure installation dates; these measures were early replacement boilers.

⁴For replace-on-failure measures, a minimum of 11 months of post-installation consumption records were required for a site to be analyzed. This requirement resulted in the exclusion of six Unitil sites because of issues with accessing old billing data from Unitil’s new CIS.

Cadmus determined energy savings for each site by first estimating annual consumption of the rebated equipment during a typical meteorological year. The team developed statistical models for each site using 12 months of billing data and outdoor air temperatures recorded at climatological weather stations. The statistical models correlate gas billing data, such as in Figure 33, with heating degree-days (HDDs) during the 12-month period after the high-efficiency equipment was installed.

HDDs are determined by mapping each site to the nearest weather station, and the difference between the measured outdoor air temperature and a reference base temperature (typically 65°F). The latitude and longitude of each site was used to map out the closest weather station, and Figure 32 shows the location of each site relative to the weather stations used in the evaluation.²⁰ Monthly billing data for an example site are shown in Figure 33.

²⁰ In total, six weather stations were used for the evaluation. Cadmus gathered weather data for the post-installation period from the following weather stations:
 [1] Pease International Tradeport Airport, NH; [2] Lawrence Municipal Airport, MA; [3] Laconia Municipal Airport, NH; [4] Manchester Airport, NH; [5] Concord Municipal Airport, NH; [6] Sanford Regional Airport, ME

Figure 32. Location of Sampled Sites and Weather Stations Included in the Billing Analysis

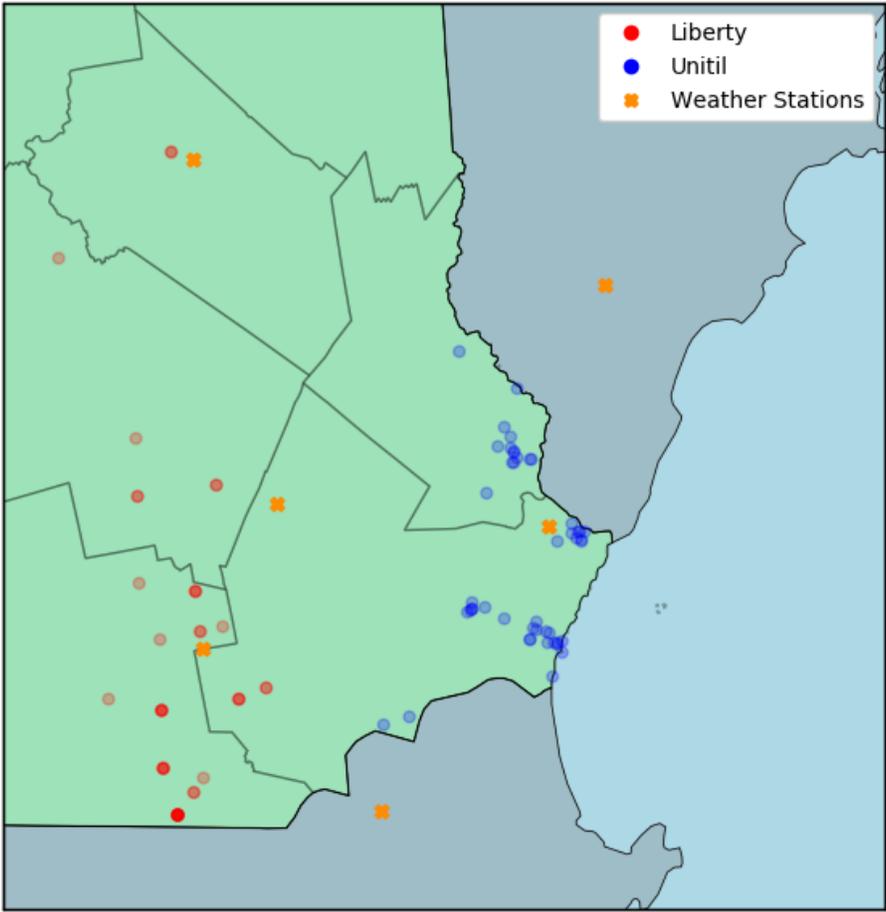
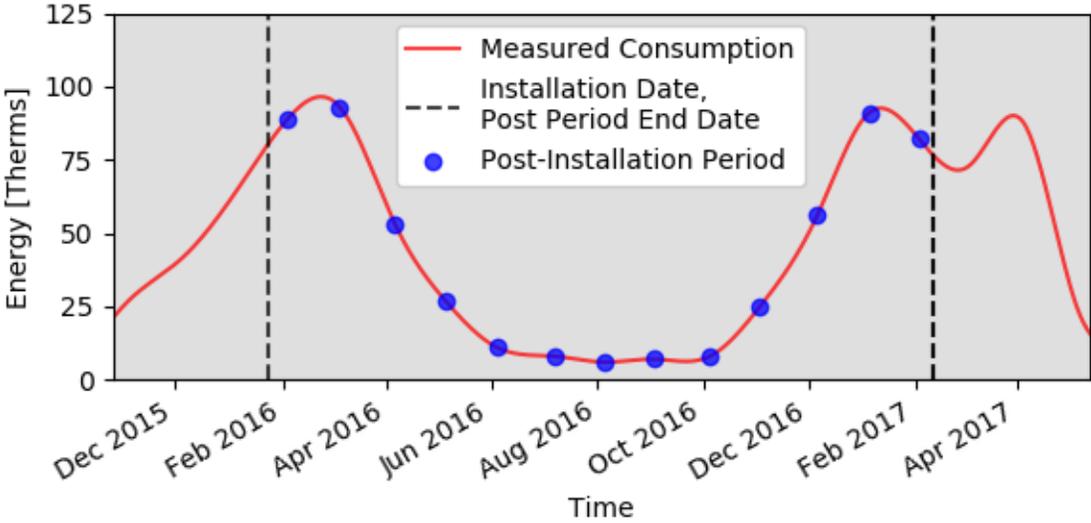


Figure 33. Metered Consumption Data for an Example Site



For this example site, gas usage is not zero during the summer months, implying that some portion of household gas consumption is not heating related and would not be impacted by the installation of a high-efficiency heating system. To tailor the model to reflect only heating-related consumption, Cadmus subtracted the average gas consumption during June, July, and August from each of the site’s monthly readings and bounded the results at zero. This correction was made to each site included in the billing analysis. Figure 34 illustrates the data from Figure 33 after making this correction for one site.

Figure 34. Post-Installation Energy Consumption Data for an Example Site

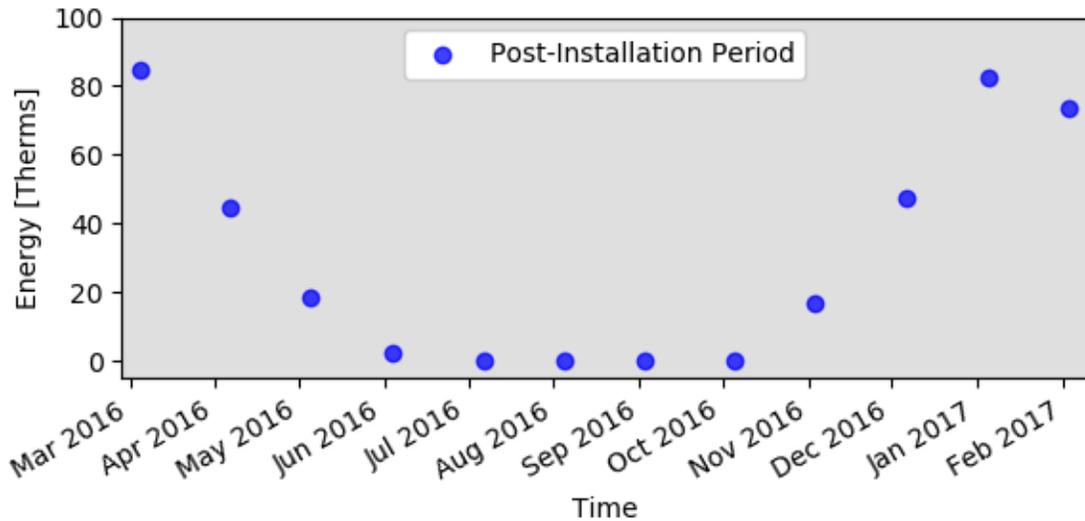
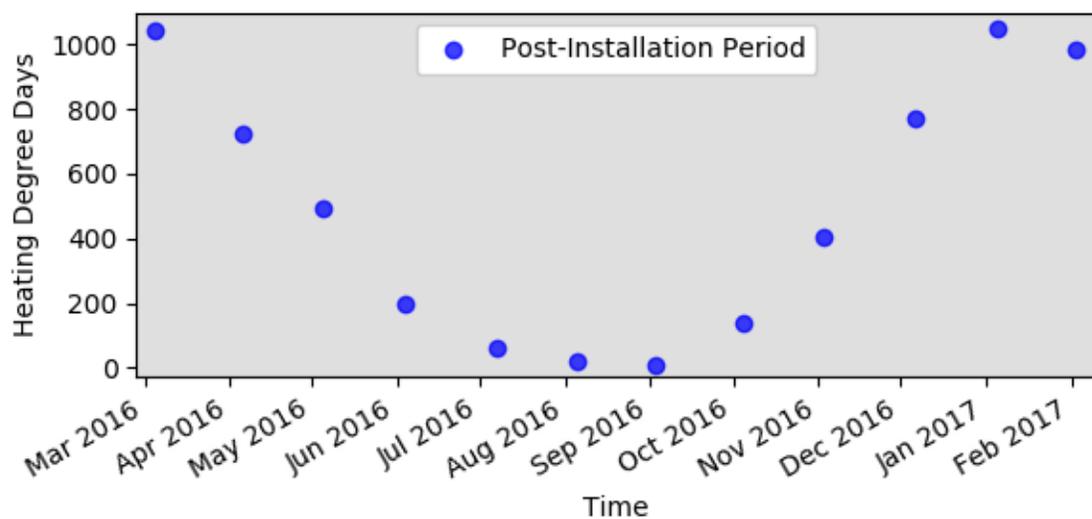


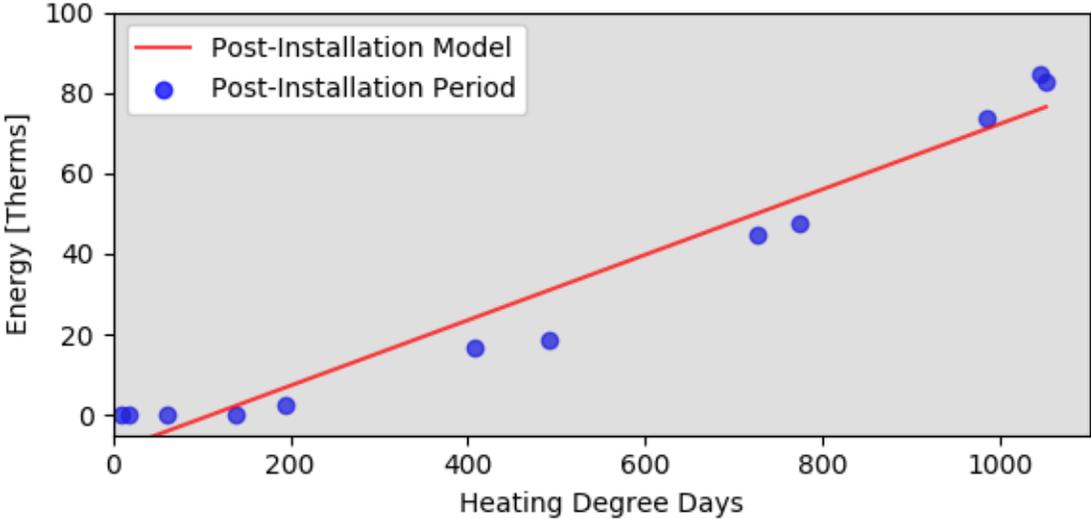
Figure 35 shows the HDDs corresponding to the previous two figures. As expected, these figures exhibit similar shapes, indicating that consumption is correlated with monthly HDDs.

Figure 35. Post-Installation Heating Degree Day Data for an Example Site



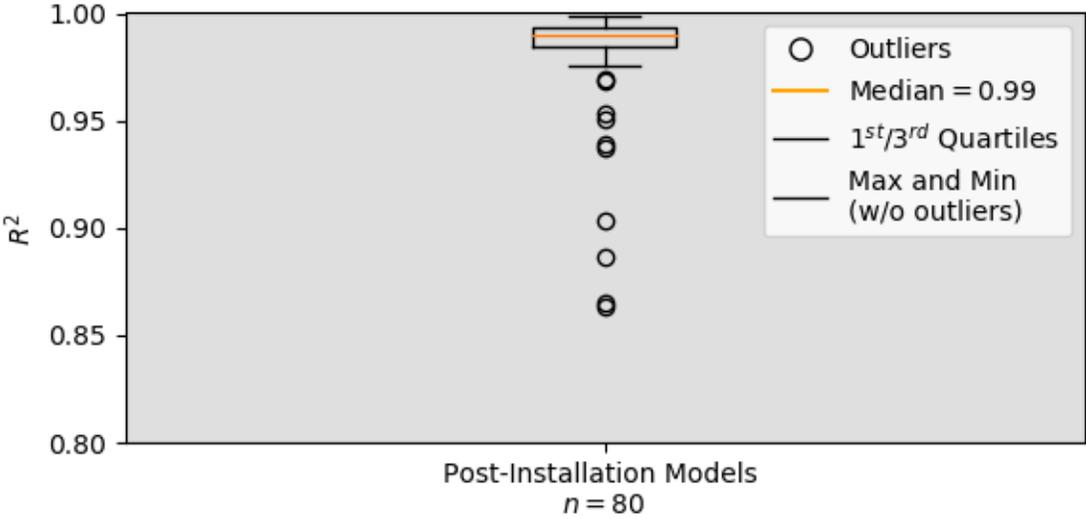
Cadmus used the relationship between HDDs and gas consumption to develop linear models for each site. An example linear model is shown in Figure 36. The model estimates heating gas consumption based on observed HDDs during the 12-month post-installation period.

Figure 36. Post-Installation Model Fitting for an Example Site



The team also calculated R-squared values for each model to assess how well the model fits the billing data and calculated HDDs. The median R-squared value across all the models was 0.99, indicating most of the variability in gas consumption is explained by HDDs. Figure 37 shows the distribution of R-Squared values for the 80 models Cadmus fit.

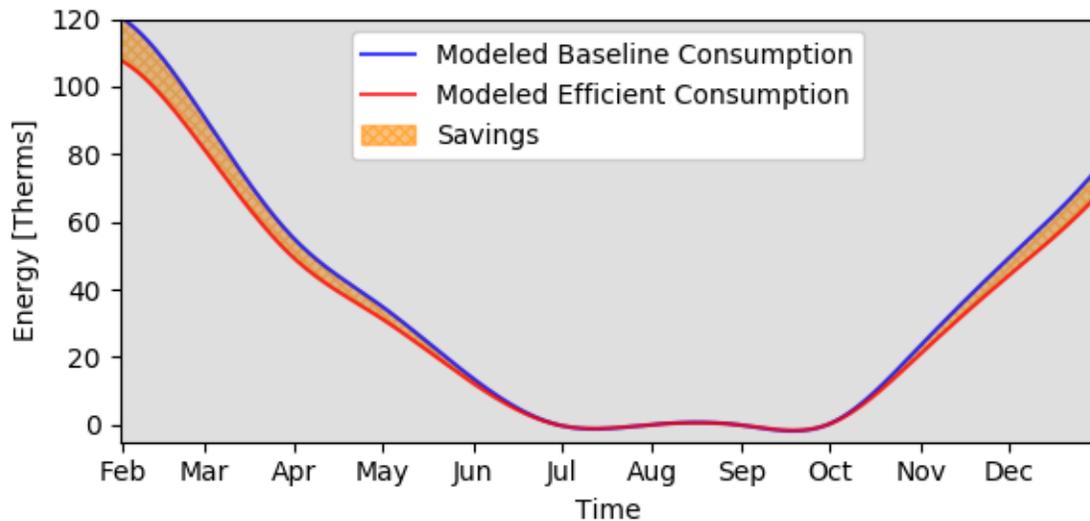
Figure 37. Distribution of Post-Installation Model R-Squared Values for All Sites



After developing a model for each site, Cadmus calculated monthly HDD values for a typical year based on typical meteorological year 3 (TMY3) weather. Using the TMY3 HDDs and the site’s linear model,

Cadmus estimated consumption during a typical year at each site’s geographic location. Finally, Cadmus used these predictions of consumption to estimate baseline consumption using the annual fuel utilization efficiency (AFUE) of the installed system and a set of baseline efficiencies. Savings were calculated as the difference between these predictions and are illustrated in Figure 38.

Figure 38. Typical Meteorological Year Energy Savings for an Example Site



HVAC Metering Study

To supplement the billing analysis and check calculated consumption, Cadmus installed state loggers in 16 homes that replaced their gas furnaces. State loggers track the on/off operation of mechanical equipment—in this instance, the team tracked the furnace fan motor to determine when the unit was in operation. Of the 16 sites where HVAC meters were installed, 11 sites had sufficient meter data to use in the analysis.

Cadmus calculated TMY3 full load hours then combined the TMY3 hours with system capacities to determine consumption. The process involved first modeling runtime as a function of heating degree days then applying each model to the TMY3 HDDs. For two stage furnaces, Cadmus estimated the portion of time in low fire mode, so the metered values are approximate.²¹

For the PY2016 evaluation, Cadmus estimated savings from three different baselines: an early replacement baseline, a federal standard baseline, and a market baseline (Table 80).

²¹ State meters track only whether a piece of equipment’s state has changed. Because the meter does not capture the magnitude of the operation, it is not possible to tell what stage the furnace is operating in.

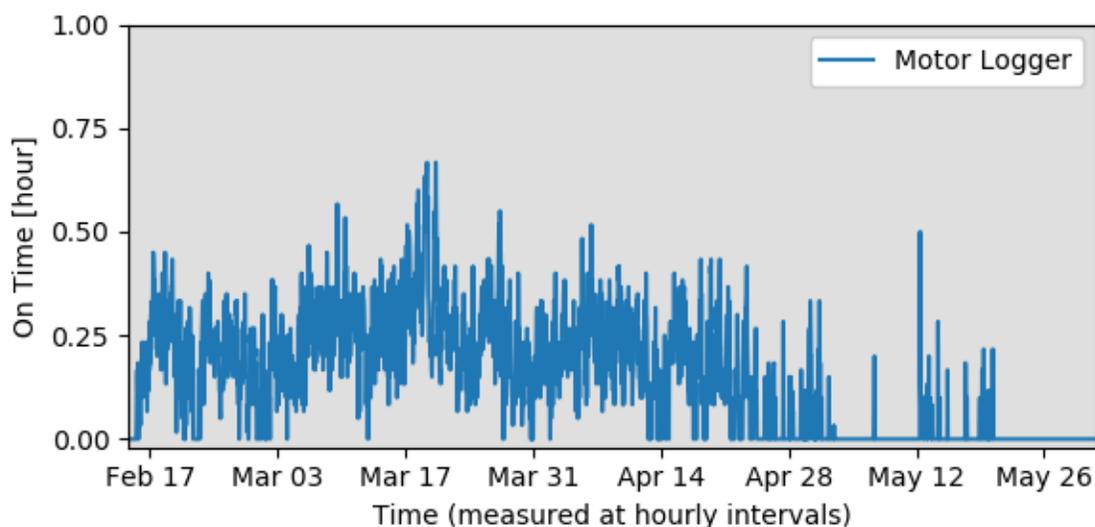
Table 80. Baseline AFUE by Baseline and Measure Type

Baseline Type	Furnaces	Boilers	Source
Early Replacement	78%	80%	MA HEHE 2015 Evaluation ¹
Federal Standard	80%	82%	Federal Standard
Market	85%	85%	MA 2015-2018 Planning TRM for Furnaces; Assumed for Boilers

¹ Cadmus. *Massachusetts High Efficiency Heating Equipment Impact Evaluation*. 2015. Prepared for the Electric and Gas Program Administrators of Massachusetts. Available online: <http://www.neep.org/sites/default/files/resources/High-Efficiency-Heating-Equipment-Impact-Evaluation-Final-Report.pdf>

Cadmus collected the efficiencies and capacities of metered systems while on site. The average capacity was 103 kBtu/h and the average AFUE was 0.95. Typical year full load hours were modeled using runtime data collected at 16 participants homes. Figure 39 illustrates what these data look like after grouping the total runtime for each hour during the metering period. This graph can be understood as the value 0.5 corresponding to a furnace operating a total of 30 minutes during a single hour and a value of zero corresponding to no recorded operation during a single hour.

Figure 39. Motor Logger Data



Temperature data were collected from nearby weather stations during the period concurrent with the metering. The motor data in Figure 39 were recorded during the same period as the outdoor temperature data in Figure 40. As shown in Figure 41, there is an inverse relationship between these two variables: as temperature drops hourly runtime increases.

Cadmus developed actual full load hours by modeling the metered furnace consumption as a function of observed outdoor temperature. The full load hour estimates were then normalized to a typical year using outdoor air temperature information from TMY3 datasets.

Figure 40. Outdoor Temperature Data

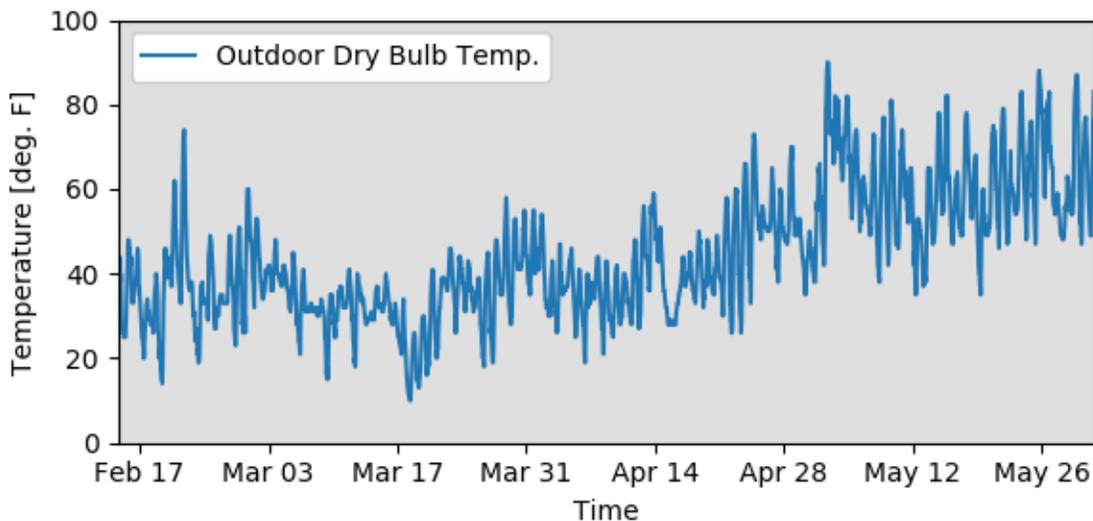
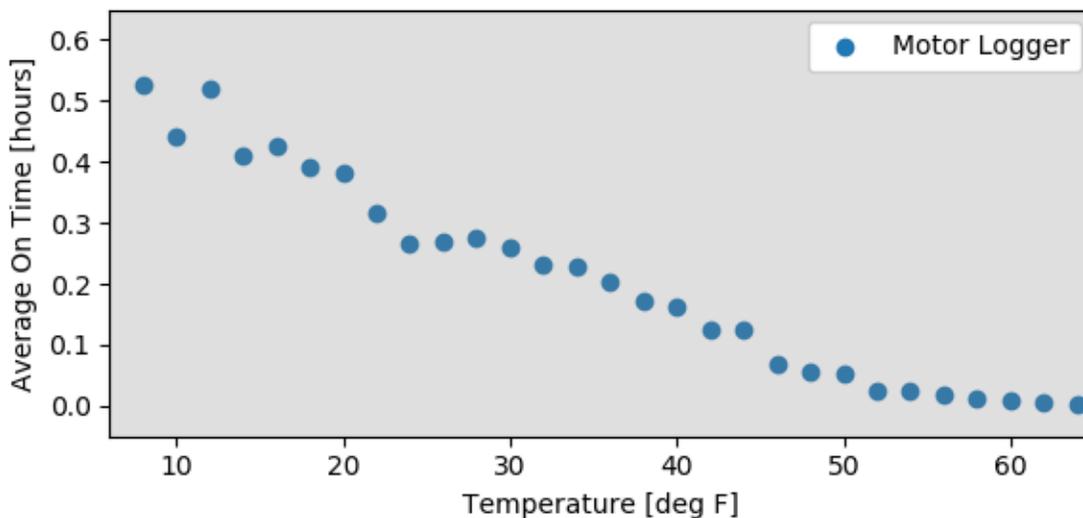


Figure 41. Motor Logger On-Time Binned by Temperature



Ex Post Savings Findings

Overall, the electric appliances, water heating, and space heating and cooling measures rebated through the 2016 New Hampshire ENERGY STAR Products program achieved 2,171,454 kWh in *ex post* kWh savings, 376.7 kW coincident with the ISO-NE summer peak, and 505.4 kW coincident with the ISO-NE winter peak. The program achieved 2,099 *ex post* MMBtu and 23,084 lifetime MMBtu. The gas measures rebated through the program achieved 84,997 kWh, 17.0 kW coincident with the ISO-NE summer peak, and 2.3 kW coincident with the ISO-NE winter peak. *Ex post* savings for the gas measures is 18,124 MMBtu annually and 323,397 MMBtu lifetime. Table 81 provides the program’s *ex post* savings and realization rates by measure.

Table 81. Savings for Electric Appliances, Water Heating, and Space Heating and Cooling Products

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW ¹	ISO-NE Winter Peak kW ¹	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	2,189,688	22,844,463	381.4	507.7	1,869	20,559
<i>Ex Post</i>	2,171,454	22,651,231	376.7	505.4	2,099	23,084
Total	99.2%	99.2%	98.8%	99.5%	112.3%	112.3%

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Table 82. Savings for Gas Appliances, Water Heating, and Space Heating and Cooling Products

Savings Description	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW ¹	ISO-NE Winter Peak kW ¹	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i>	84,997	1,394,430	17.0	2.3	21,313	378,979
<i>Ex Post</i>	84,997	1,394,430	17.0	2.3	18,124	323,313
Total	100.0%	100.0%	100.0%	100.0%	85.0%	85.3%

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

The program achieved an overall realization rate of 99.2% for kWh energy savings and 85.0% for MMBtu energy savings. Lower realization rates for electric measures are primarily a result of lower in-service rates for room air conditioners and clothes washers; lower realization rates for gas measures are the result of lower evaluated savings for the furnace and boiler measures.²² Appendix A provides each utility’s savings by fuel type and measure.

White Goods

Customers purchased just under 8,500 rebated white goods appliances through the 2016 New Hampshire ENERGY STAR Products program. Table 83 displays purchased quantities for 2016, as well as the deemed savings used for the evaluation.

²² Where appropriate, Cadmus recommends the utilities update savings inputs and in-service rates rather than applying measure-level realization rates for future program planning. Savings inputs developed through the evaluation include billing analysis results for the furnace and boiler measures and updates to the in-service rates for the clothes washer and room air conditioner measures are based on the participant surveys. These are highlighted throughout the report.

Table 83. White Good Quantities and Ex Post Per-Unit Savings

Measure Name	Quantity Units Rebated	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coincidence	ISO-NE Winter Coincidence
Advanced Power Strip	10	79.1	0.027	100.0%	35.0%	100.0%
ENERGY STAR Clothes Washers	4,406	181.8	0.028	98.2%	67.8%	100.0%
ENERGY STAR Freezers	2	114.0	0.013	100.0%	100.0%	89.9%
ENERGY STAR Refrigerators	2,316	39.6	0.005	100.0%	100.0%	89.9%
ENERGY STAR Room Air Conditioners	1,477	16.2	0.094	84.6%	14.3%	0.0%
ENERGY STAR Room Air Purifier	208	390.6	0.045	100.0%	100.0%	92.0%

Cadmus found PY2016 deemed savings for all white goods measures offered by the program reasonable and accepted the *ex ante* deemed savings except for water savings and secondary fuel savings for clothes washers.

Cadmus surveyed 94 program participants who purchased white goods rebated by the program. Table 84 shows in-service rates found through the survey for white goods products.

Table 84. White Goods In-Service Rates

Measure	ISR	Number of Responses	Notes
ENERGY STAR Clothes Washer	98%	56	Determined through participant survey
ENERGY STAR Room Air Conditioner	85%	13	Determined through participant survey. Some respondents purchased a program incented air conditioner but indicated the equipment were no longer installed in their homes.
ENERGY STAR Room Air Purifier	100%	3	Deemed at 100% due to the low number of survey respondents. All of the responding participants indicated the equipment was still installed.
ENERGY STAR Refrigerator	100%	21	Determined through participant survey. All respondents who purchased a program-incented refrigerator installed the measure in their home.
ENERGY STAR Freezer	100%	N/A	Deemed at 100% due to non-incidence in survey sample

Overall, Cadmus found white goods achieved 98.2% of *ex ante* kWh savings. Table 85 displays their *ex ante* and *ex post* kWh savings. White goods measures contributed approximately 45% of the program’s total 2016 *ex post* kWh savings. The room air conditioner measure had a realization rate of 84.6% because participant survey respondents indicated the product they had received a rebate for were no longer installed. When asked, the customers who indicated the equipment was no longer installed did not provide any further detail about their decision to remove the equipment. One clothes washer respondent also indicated that the equipment was not installed, but planned to install a new clothes washer within the next 12 months. The clothes washer measure is a significant portion of white goods savings and is the primary reason for the category’s realization rate of 98.2%.

Table 85. White Goods Products *Ex Ante* and *Ex Post* Savings

Measure Name	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings	Precision at 90% Confidence
White Goods						
Energy Star Clothes Washers	800,954	8,810,492	98.2%	786,391	8,650,301	2.9%
Energy Star Freezers	228	2,736	100.0%	228	2,736	--
Energy Star Refrigerators	91,783	1,101,397	100.0%	91,783	1,101,397	--
Energy Star Room Air Conditioners	23,863	214,768	84.6%	20,192	181,727	16.5%
Energy Star Room Air Purifier	81,238	731,142	100.0%	81,238	731,142	--
White Goods Subtotal	998,066	10,860,535	98.2%	979,832	10,667,303	--

Note: Values in table may not match exactly due to rounding.

Demand savings for the white goods offerings had a realization rate of approximately 96.4% for similar reasons: the lower in-service rate evaluated through the participant survey resulted in lower savings. Demand savings for the white goods measures are shown in Table 86.

Table 86. White Goods Achieved Demand Savings

Measure Name	<i>Ex Ante</i> ISO-NE Summer kW Savings	<i>Ex Ante</i> ISO-NE Winter kW Savings	Realization Rate	<i>Ex Post</i> ISO-NE Summer kW Savings ¹	<i>Ex Post</i> ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
ENERGY STAR Clothes Washers	90.9	127.9	98.2%	89.2	125.6	2.9%
ENERGY STAR Freezers	0.0	0.0	100.0%	0.0	0.0	--
ENERGY STAR Refrigerators	10.5	9.4	100.0%	10.5	9.4	--
ENERGY STAR Room Air Conditioners	20.0	0.0	84.6%	16.9	0.0	16.5%
ENERGY STAR Room Air Purifier	9.7	9.6	100.0%	9.7	9.6	--
White Goods Subtotal	131.0	146.9	96.4%	126.3	144.5	--

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

In addition to electric energy and demand savings, the clothes washer measure also contributes MMBtu savings and water savings. Cadmus determined the *ex ante* deemed per-unit water savings was high when compared to other jurisdictions and applied revised values to determine *ex post* water savings.

Cadmus applied a per-unit water savings to each clothes washer of 1,720 gallons saved annually.²³ Using the revised per-unit water savings, Cadmus calculated that the 4,406 program-purchased clothes washers saved 7,578,320 gallons of water annually.

Cadmus reviewed the program assumptions for natural gas, propane, and fuel oil savings and determined that the per-unit assumptions were low compared with other jurisdictions and did not match the fuel distribution found through the evaluation. Cadmus asked home inventory and online survey respondents to provide their primary domestic water heating fuel types. After combining the responses, Cadmus found that 25% of participants heated water with propane, 27% with fuel oil, and 15% with natural gas, as shown in Table 87.

Table 87. Comparison of *Ex Ante* and *Ex Post* Clothes Washer MMBtu Inputs

Savings Source	Fuel Type	<i>Ex Ante</i>		<i>Ex Post</i>	
		Fuel Share	MMBtu	Fuel Share	MMBtu
Water Heater Savings	Natural Gas	23%	0.154	15%	0.100
	Fuel Oil	38% ¹	0.255	27%	0.179
	Propane	2%	0.013	25%	0.165
Dryer Savings	Natural Gas	9%	0.032	9%	0.032
Total		--	0.4536	0.454	0.4763

¹ The Unitol B/C workbook uses a fuel oil saturation of 3.8%, compared to 38% used by the rest of the utilities.

Note: Values in table may not match exactly due to rounding.

Applying this distribution to the *ex ante* savings inputs, Cadmus developed the *ex post* clothes washer inputs shown in Table 88.

Table 88. Clothes Washer Ancillary Water and Fossil Fuel Savings

Measure Name	<i>Ex Post</i> Input Values			
	Quantity Units Rebated	MMBtu Savings	Water Savings	ISR
ENERGY STAR Clothes Washers	4,406	0.476	1,720	98.2%

Based on the new inputs, the final MMBtu realization rate for the clothes washer measure is 112.3%. This rate is partially driven by the updated MMBtu savings distribution but is also partly because of a clerical error in one of the utility B/C workbooks. The Unitol B/C workbook uses a fuel oil saturation of approximately 3.8%, compared to 38% used by the rest of the utilities. Table 89 shows the fossil fuel savings for the clothes washer measure.

²³ Shelter Analytics. Mid-Atlantic Technical Reference Manual, Version 8. May 2018. Prepared for Northeast Energy Efficiency Partnerships (NEEP). Available online: <https://neep.org/sites/default/files/resources/Mid Atlantic TRM V8 0.pdf>

Table 89. Secondary Fuel Savings for ENERGY STAR Clothes Washers

Measure Name	Ex Ante MMBtu Savings	Ex Ante Lifetime MMBtu Savings	Realization Rate	Ex Post MMBtu Savings	Ex Post Lifetime MMBtu Savings	Precision at 90% Confidence
ENERGY STAR Clothes Washers	1,869	20,559	112.3%	2,099	23,084	--
White Goods Subtotal	1,869	20,559	112.3%	2,099	23,084	--

Note: Values in table may not match exactly due to rounding.

Appliance Recycling

The New Hampshire ENERGY STAR Products program recycled 585 appliances. Table 90 displays recycled quantities for 2016, as well as the deemed savings used to calculate *ex post* savings.

Table 90. Appliance Recycling Quantities and Ex Post Per-Unit Savings Inputs

Measure Name	Ex Post Input Values					
	Quantity Units Rebated	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coincidence	ISO-NE Winter Coincidence
Secondary Refrigerator Recycling	412	755.0	0.086	100.0%	100.0%	89.9%
Secondary Freezer Recycling	173	658.0	0.075	100.0%	100.0%	89.9%

Cadmus found deemed savings for freezer and refrigerator recycling measures offered by the program reasonable and accepted all deemed values to reach *ex post* savings. The team surveyed only four program participants with refrigerators or freezers recycled by the program. Because of the low number of survey respondents, and the nature of recycling programs, Cadmus deemed the in-service rate for freezer and refrigerator recycling at 100%.

Overall, Cadmus found the appliance recycling measures achieved 100% of *ex ante* savings. Table 91 displays the appliance recycling measures' *ex ante* and *ex post* savings. Appliance recycling measures contributed 20% of the programs' total 2016 kWh savings.

Table 91. Appliance Recycling Ex Ante and Ex Post Savings

Measure	Ex Ante kWh Savings	Ex Ante Lifetime kWh Savings	Realization Rate	Ex Post kWh Savings	Ex Post Lifetime kWh Savings	Precision at 90% Confidence
Secondary Freezer Recycling	113,839	910,712	100.0%	113,839	910,712	--
Secondary Refrigerator Recycling	311,060	2,488,480	100.0%	311,060	2,488,480	--
Total	424,899	3,399,192	100.0%	424,899	3,399,192	--

Note: Values in table may not match exactly due to rounding.

Overall, appliance recycling achieved 49.1 kW savings coincident with the ISO-NE summer peak and 44.2 kW savings coincident with the ISO-NE winter peak, as shown in Table 92.

Table 92. Appliance Recycling Achieved Demand Savings

Measure Name	Ex Ante ISO-NE Summer	Ex Ante ISO-NE Winter	Realization Rate	Ex Post ISO-NE Summer	Ex Post ISO-NE Winter	Precision at 90%
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	kW Savings	kW Savings		kW Savings ¹	kW Savings ¹	Confidence
Secondary Freezer Recycling	13.0	11.7	100%	13.0	11.7	--
Secondary Refrigerator Recycling	36.1	32.5	100%	36.1	32.5	--
Appliance Recycling Subtotal	49.1	44.2	100%	49.1	44.2	--

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Electric Heating and Cooling

Ductless heat pump mini-splits were the most-installed electric heating and cooling measures, followed by Wi-Fi thermostats for air conditioners. Table 93 displays purchased quantities for 2016 electric heating and cooling measures.

Table 93. Electric Heating and Cooling Measure Quantities and *Ex Post* Per-Unit Savings Inputs

Measure Name	Quantity Units Rebated ¹	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coinc.	ISO-NE Winter Coinc.
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	7.5	77.0	0.200	100.0%	85.0%	0.0%
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	16.2	256.5	0.097	100.0%	85.0%	0.0%
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	16.2	2,433.5	0.921	100.0%	0.0%	100.0%
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	7.5	477.2	0.181	100.0%	0.0%	100.0%
ENERGY STAR Central AC (3 Ton)	21.9	142.2	0.369	100.0%	85.0%	0.0%
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	873.9	73.3	0.190	100.0%	85.0%	0.0%
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	153.2	22.0	0.057	100.0%	85.0%	0.0%
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	827.9	394.2	0.299	100.0%	0.0%	100.0%
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	153.2	77.3	0.059	100.0%	0.0%	100.0%
ENERGY STAR Ductless AC (Cooling only)	6.9	47.4	0.123	100.0%	85.0%	0.0%
Wi-Fi Enabled Thermostats for Air Conditioners	118.0	19.8	0.007	100.0%	100.0%	100.0%
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	4.0	38.8	0.000	100.0%	100.0%	100.0%

¹Quantities for central A/Cs, air source heat pumps, and ductless heat pumps given in tons. Per-unit savings for central A/Cs, air source heat pumps, and ductless heat pumps are given as savings per ton.

Note: Values in table may not match exactly due to rounding.

Cadmus found the deemed savings that the program offered for all electric heating and cooling measures reasonable and accepted all deemed values to reach *ex post* savings.

Overall, Cadmus found electric heating and cooling measures achieved 100% of *ex ante* kWh savings.²⁴ Table 94 displays electric heating and cooling products *ex ante* and *ex post* savings. Overall, electric heating and cooling measures contributed 21% of the program’s total 2016 *ex post* kWh savings.

Table 94. Electric Heating and Cooling Products *Ex Ante* and *Ex Post* Savings

Measure	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings	Precision at 90% Confidence
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	575	6,898	100.0%	575	6,898	--
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	4,156	49,867	100.0%	4,156	49,867	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	39,422	473,069	100.0%	39,422	473,069	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	3,564	42,772	100.0%	3,564	42,772	--
ENERGY STAR Central A/C (3 Ton)	3,112	43,570	100.0%	3,112	43,570	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	67,341	808,091	100.0%	67,341	808,091	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	3,370	40,440	100.0%	3,370	40,440	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	320,728	3,848,739	100.0%	320,728	3,848,739	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	11,840	142,085	100.0%	11,840	142,085	--
ENERGY STAR Ductless A/C (Cooling only)	326	3,918	100.0%	326	3,918	--
Wi-Fi Enabled Thermostats for Air Conditioners	3,028	36,331	100.0%	3,028	36,331	--
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	155	1,863	100.0%	155	1,863	--
Total	457,618	5,497,643	100.0%	457,618	5,497,643	--

Note: Values in table may not match exactly due to rounding.

Overall, the electric heating and cooling measures achieved approximately half of the program’s ISO-NE peak demand reduction in both the summer (44%) and winter (53%) seasons (shown in Table 95).

²⁴ This section does not include room or window air conditioners, which are classified by the program as a white good.

Table 95. Electric Heating and Cooling Products Achieved Demand Savings

Measure Name	Ex Ante ISO-NE Summer kW Savings	Ex Ante ISO-NE Winter kW Savings	Realization Rate	Ex Post ISO-NE Summer kW Savings ¹	Ex Post ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	1.3	0.0	100%	1.3	0.0	--
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	1.3	0.0	100%	1.3	0.0	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	14.9	100%	0.0	14.9	--
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	1.3	100%	0.0	1.3	--
ENERGY STAR Central A/C (3 Ton)	6.9	0.0	100%	6.9	0.0	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	148.7	0.0	100%	148.7	0.0	--
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	7.4	0.0	100%	7.4	0.0	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	242.9	100%	0.0	242.9	--
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	9.0	100%	0.0	9.0	--
ENERGY STAR Ductless A/C (Cooling only)	0.7	0.0	100%	0.7	0.0	--
Wi-Fi Enabled Thermostats for Air Conditioners	2.6	0.7	100%	2.6	0.7	--
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.1	0.1	100%	0.1	0.1	--
Heating and Cooling Subtotal	168.9	268.9	100%	168.9	268.9	--

¹ Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Electric Domestic Hot Water

The 2016 New Hampshire ENERGY STAR Products program installed 155 electric heat pump water heaters. Table 96 displays purchased quantities and deemed savings for 2016.

Table 96. Electric Domestic Hot Water Quantities and Ex Post Per-Unit Savings Inputs

Measure Name	Quantity Units Rebated	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coinc.	ISO-NE Winter Coinc.
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	118	1,775.0	0.270	100.0%	67.8%	100.0%
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	37	2,672.0	0.406	100.0%	67.8%	100.0%

Cadmus found the deemed savings reasonable for electric heat pump hot water heaters offered by the program and accepted all deemed values as inputs for the *ex post* savings. In conducting the evaluation, Cadmus spoke with eight program participants who purchased electric heat pump hot water heaters incented by the program: all eight still had their electric heat pump hot water heaters installed, so Cadmus determined an in-service rate of 100%.

Overall, Cadmus found that electric domestic hot water measures achieved 100% of *ex ante* savings. Table 97 displays the electric domestic hot water products *ex ante* and *ex post* savings. The electric heat pump hot water heaters contributed 5% of the program’s total 2016 *ex post* kWh savings.

Table 97. Electric Domestic Hot Water Ex Ante and Ex Post Savings

Measure Name	Ex Ante kWh Savings	Ex Ante Lifetime kWh Savings	Realization Rate	Ex Post kWh Savings	Ex Post Lifetime kWh Savings	Precision at 90% Confidence
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	209,450	2,094,500	100.0%	209,450	2,094,500	--
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	98,864	988,640	100.0%	98,864	988,640	--
Domestic Hot Water Subtotal	308,314	3,083,140	100.0%	308,314	3,083,140	--

Note: Values in table may not match exactly due to rounding.

Overall, the electric heating and cooling measures achieved approximately 3% of the program’s demand reduction during both the summer and winter ISO-NE peak periods. Table 98 shows electric domestic hot water demand savings.

Table 98. Electric Domestic Hot Water Demand Savings

Measure Name	Ex Ante ISO-NE Summer kW Savings	Ex Ante ISO-NE Winter kW Savings	Realization Rate	Ex Post ISO-NE Summer kW Savings ¹	Ex Post ISO-NE Winter kW Savings ¹
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	22.1	32.6	100.0%	22.1	32.6
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	10.1	14.9	100.0%	10.1	14.9
Total	32.2	47.5	100.0%	32.2	47.5

¹ *Ex post* demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Smartstrip Power Strips

In 2016, customers purchased 10 smart power strips through the program. Cadmus found the deemed savings for smart power strips reasonable and accepted all *ex ante* values as *ex post* savings. Cadmus deemed the in-service rate for smart power strips at 100% as the sample was not large enough to be verified through the participant survey. Still, Cadmus spoke with four program participants who purchased smart power strips rebated by the program and all four indicated their smart power strips were still installed.

Cadmus reviewed program savings assumptions for the Smartstrip power strip measures and compared them to other jurisdictions. Table 99 displays deemed per-unit *ex post* savings for these other measures installed in 2016.

Table 99. Deemed Smartstrip Power Strip *Ex Post* Per-Unit Savings

Measure Name	Quantity Units Rebated	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coincidence	ISO-NE Winter Coincidence
Advanced Power Strip	10	79.1	0.027	100.0%	35.0%	100.0%

Table 100 displays *ex ante* and *ex post* savings for smart power strips, and Table 101 shows *ex ante* and *ex post* demand savings for the measure. Overall, the measure contributed less than 1% of the program's total 2016 *ex post* kWh savings.

Table 100. Smartstrip Power Strip *Ex Ante* and *Ex Post* kWh Savings

Measure Name	<i>Ex Ante</i> kWh Savings	<i>Ex Ante</i> Lifetime kWh Savings	Realization Rate	<i>Ex Post</i> kWh Savings	<i>Ex Post</i> Lifetime kWh Savings	Precision at 90% Confidence
Advanced Power Strip	791	3,953	100.0%	791	3,953	--
Advanced Power Strip Subtotal	791	3,953	100.0%	791	3,953	--

Note: Values in table may not match exactly due to rounding.

Smartstrips accounted for less than 1% of *ex post* demand reduction during the ISO-NE peak periods. Eversource contributed six power strips, Liberty contributed three, and Unitil contributed one.

Table 101. Smartstrip Demand Savings

Measure Name	Ex Ante ISO-NE Summer kW Savings	Ex Ante ISO-NE Winter kW Savings	Realization Rate	Ex Post ISO-NE Summer kW Savings ¹	Ex Post ISO-NE Winter kW Savings ¹	Precision at 90% Confidence
Advanced Power Strip	0.1	0.3	100.0%	0.1	0.3	--
Advanced Power Strip Subtotal	0.1	0.3	100.0%	0.1	0.3	--

¹ Ex post demand savings are based on engineering desk reviews and in-service rates from participant surveys. Cadmus did not evaluate coincidence factors and uses the same coincidence factors outlined in the utility B/C models.

Note: Values in table may not match exactly due to rounding.

Gas Heating and Domestic Hot Water

Customers purchased over 2,000 gas products under the 2016 New Hampshire ENERGY STAR Products program, with thermostats the most popular measure purchased and contributing the largest percentage of the program’s ex ante MMBtu natural gas savings (29%). Table 102 shows the purchased quantities and per-unit savings for 2016.

Table 102. Gas Program Quantities and Per-Unit Savings Inputs

Measure Name	Quantity Units Rebated	Ex Ante MMBtu Savings	Ex Ante ISR	Ex Post MMBtu Savings	Ex Post ISR
HVAC					
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	86	11.0	100.0%	7.9	100.0%
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	178	13.7	100.0%	11.7	100.0%
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	24	23.6	100.0%	10.1	100.0%
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	24	10.4	100.0%	10.1	100.0%
Furnace ≥ 95% AFUE w/ECM	126	15.9	100.0%	7.8	100.0%
Furnace ≥ 97% AFUE w/ECM	115	17.3	100.0%	9.1	100.0%
Heat Recovery Ventilator	3	7.7	100.0%	7.7	100.0%
Thermostat: Standard 7-day Programmable	171	3.2	100.0%	3.2	100.0%
Thermostat: Wi-Fi (Cooling & Heating) ¹	722	6.6	100.0%	6.6	100.0%
Thermostat: Wi-Fi (Heating Only)	110	6.6	100.0%	6.6	100.0%
Domestic Hot Water					
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	121	8.0	100.0%	8.0	100.0%
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	82	23.8	100.0%	23.8	100.0%
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	61	23.8	100.0%	23.8	100.0%
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	3	4.2	100.0%	4.2	100.0%
Water Heater: Tankless, On Demand, EF ≥ 0.82	14	10.2	100.0%	10.2	100.0%

Measure Name	Quantity Units Rebated	Ex Ante MMBtu Savings	Ex Ante ISR	Ex Post MMBtu Savings	Ex Post ISR
Water Heater: Tankless, On Demand, EF ≥ 0.94	215	10.5	100.0%	10.5	100.0%

¹ Unifit assumes an ex ante savings of 6.6 MMBtu; Liberty assumes an ex ante savings of 6.9 MMBtu. The value of 6.9 MMBtu is sourced to a memo Cadmus issued to Liberty in 2013 and represents the average savings per home. Because savings are claimed on a per-thermostat basis, Cadmus evaluated ex post savings using a value of 6.6 MMBtu, which is included in the same memo.

Note: Values in table may not match exactly due to rounding.

In addition to the expected MMBtu savings, some of the gas measures also provide electric savings benefits. Cadmus reviewed program savings assumptions for these measures and compared them to other jurisdictions. Table 103 displays deemed ex post per-unit savings for these other measures installed in 2016.

Table 103. Gas Measures—Ex Post Per-Unit Ancillary Electric Savings for Gas Measures

Measure Name	Quantity Units Rebated	Deemed kWh	Deemed kW	ISR	ISO-NE Summer Coincidence	ISO-NE Winter Coincidence
Furnace ≥ 95% AFUE w/ECM	126	168.0	0.064	100.0%	0.0%	16.0%
Furnace ≥ 97% AFUE w/ECM	115	168.0	0.064	100.0%	0.0%	16.0%
Heat Recovery Ventilator	3	-133.0	-0.050	100.0%	0.3%	100.0%
Thermostat: Wi-Fi (Cooling & Heating)	722	62.2	0.024	100.0%	100.0%	0.0%

Cadmus surveyed 32 gas program participants. Table 104 shows in-service rates estimates from the participant survey. Where fewer than 10 respondents indicated they had installed a measure, Cadmus applied an in-service rate of 100%.

Table 104. Gas Program In-Service Rate

Measure	ISR	Number of Responses	Notes
Tankless Water Heaters	100%	2	Deemed at 100% due to the low number of survey respondents.
Furnaces	100%	4	Deemed at 100% due to the low number of survey respondents.
Boilers (including Condensing Boilers)	100%	7	Deemed at 100% due to the low number of survey respondents.
Wi-fi Thermostats	100%	10	Determined through participant survey. All thermostats were installed at participant homes.
Programmable Thermostats	100%	3	Deemed at 100% due to the low number of survey respondents.
Heat Recovery Ventilators	100%	N/A	Deemed at 100% due to the lack of incidence in the participant survey.
Other Water Heater Measures	100%	N/A	Deemed at 100% due to the lack of incidence in the participant survey.

For all programmable thermostats, domestic hot water measures (water heaters), and the heat recovery ventilator, Cadmus found the deemed savings reasonable and accepted deemed values as *ex post* savings inputs.

Utility Billing Analysis

For natural gas furnaces and condensing boilers, Cadmus estimated savings for the 80 sites included in the billing analysis using the methodology described in the section on **Utility Billing Analysis**, above. Based on discussions with the EM&V Working Group, Cadmus calculated savings for a number of different furnace and boiler baselines.

The Working Group had varying opinions on which baseline would be most appropriate for these measures, citing recent research in neighboring jurisdictions as justification for a baseline that exceeded federal requirements. On the other hand, some members of the group thought the program was probably influencing some customers to perform early replacement of their existing equipment. Based on this discussion, in Table 105 Cadmus presents three tiers of savings—early replacement, federal standard, and recent research—for boilers and furnaces.

Table 105. Weather-Normalized MMBtu Savings for Furnaces and Boilers by Baseline and Installed Efficiency

Savings Type	Per-Unit Savings by Measure (MMBtu)				Precision at 90% Confidence
	90% AFUE Boiler	95% AFUE Boiler	95% AFUE Furnace	97% AFUE Furnace	
<i>Ex Post</i> – Early Replacement (78% AFUE for Furnace; 80% AFUE for Boiler)	10.1	13.8	14.5	15.7	14.5%
<i>Ex Post</i> – Federal Standard (80% AFUE for Furnace; 82% AFUE for Boiler)	7.9	11.7	12.4	13.7	14.9%
<i>Ex Post</i> – Recent Research (85% AFUE for Furnaces and Boilers)	4.8	8.7	7.8	9.1	15.0%

Table 106 shows the furnace and boiler baselines Cadmus assumed to evaluate program savings.

Table 106. Assumed Baseline and Savings for 2016 Evaluation

Measure	Baseline	Annual Savings (MMBtu)
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	Federal Standard (82% AFUE for Boiler)	7.9
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	Federal Standard (82% AFUE for Boiler)	11.7
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	Early Replacement (80% AFUE for Boiler)	10.1
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	Early Replacement (80% AFUE for Boiler)	10.1
Furnace ≥ 95% AFUE w/ECM	Recent Research (85% AFUE for Furnaces)	7.8
Furnace ≥ 97% AFUE w/ECM	Recent Research (85% AFUE for Furnaces)	9.1

Overall, Cadmus found gas program measures achieved 85.0% of *ex ante* savings. Table 107 displays the gas program *ex ante* and *ex post* savings by measure. Aside from furnace and boiler measures, which

had savings evaluated through billing analysis, most other gas measures received a realization rate of 100%. The exception is Wi-Fi thermostats, which received a realization rate of 96.1%, driven by differences in the *ex ante* and *ex post* savings assumptions; Liberty assumed a savings of 6.9 MMBtu instead of the 6.6 MMBtu used by Unitil and Cadmus.

Table 107. Gas Program *Ex Ante* and *Ex Post* Savings

Measure Name	<i>Ex Ante</i> MMBtu Savings	<i>Ex Ante</i> Lifetime MMBtu Savings	Realization Rate	<i>Ex Post</i> MMBtu Savings	<i>Ex Post</i> Lifetime MMBtu Savings	Precision at 90% Confidence
Heating and Domestic Hot Water						
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	1,010	20,200	67.4%	681	13,624	14.9%
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	2,457	49,140	84.7%	2,081	41,623	14.9%
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	566	5,664	43.0%	244	2,436	14.5%
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	250	4,992	97.6%	244	4,872	14.5%
Furnace ≥ 95% AFUE w/ECM	2,003	36,061	49.1%	983	17,696	15.0%
Furnace ≥ 97% AFUE w/ECM	1,990	35,811	52.6%	1,046	18,827	15.0%
Heat Recovery Ventilator	23	462	100.0%	23	462	--
Thermostat: Standard 7-day Programmable	547	8,208	100.0%	547	8,208	0.0%
Thermostat: Wi-Fi (Cooling & Heating) ¹	4,957	74,354	96.1%	4,765	71,478	0.0%
Thermostat: Wi-Fi (Heating Only)	726	10,890	100.0%	726	10,890	0.0%
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	968	19,360	100.0%	968	19,360	--
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	1,952	39,032	100.0%	1,952	39,032	--
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	1,452	29,036	100.0%	1,452	29,036	--
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	13	164	100.0%	13	164	--
Water Heater: Tankless, On Demand, EF ≥ 0.82	143	2,713	100.0%	143	2,713	0.0%
Water Heater: Tankless, On Demand, EF ≥ 0.94	2,258	42,893	100.0%	2,258	42,893	0.0%
Gas Measures Total	21,313	378,979	85.0%	18,124	323,313	--

¹ Unitil assumes an *ex ante* savings of 6.6 MMBtu; Liberty assumes an *ex ante* savings of 6.9 MMBtu. The value of 6.9 MMBtu is sourced to a memo Cadmus issued to Liberty in 2013 and represents the average savings per home. Because savings are claimed on a per-thermostat basis, Cadmus evaluated *ex post* savings using a value of 6.6 MMBtu. Note: Values in table may not match exactly due to rounding.

HVAC Metering Study

To supplement the billing analysis and check calculated consumption, Cadmus installed state loggers in 16 homes that upgraded their gas furnaces. State loggers track the on/off operation of mechanical equipment—in this instance, Cadmus tracked the furnace fan motor to determine when the unit was in operation. Of the 16 sites where HVAC meters were installed, 11 sites had sufficient meter data to use in

the analysis. Cadmus calculated typical year full load hours, then combined these hours with system capacities to determine consumption. The process involved first modeling runtime as a function of heating degree days, then apply these models to TMY3 HDDs. For two-stage furnaces, Cadmus estimated the portion of time in low fire mode, so the metered values are approximate. The results of this analysis are shown in Table 108.

Table 108. Metering Analysis Typical Meteorological Year Consumption

Measure	Sample Size	AFUE	Average Typical Year Consumption MMBtu (Metered Values)	Average Typical Year Consumption MMBtu (Comparable Values from Billing Analysis)
Boiler	1	91%	74.0	80.4
Furnace	10	91%-98% (95% on average)	60.2	65.2

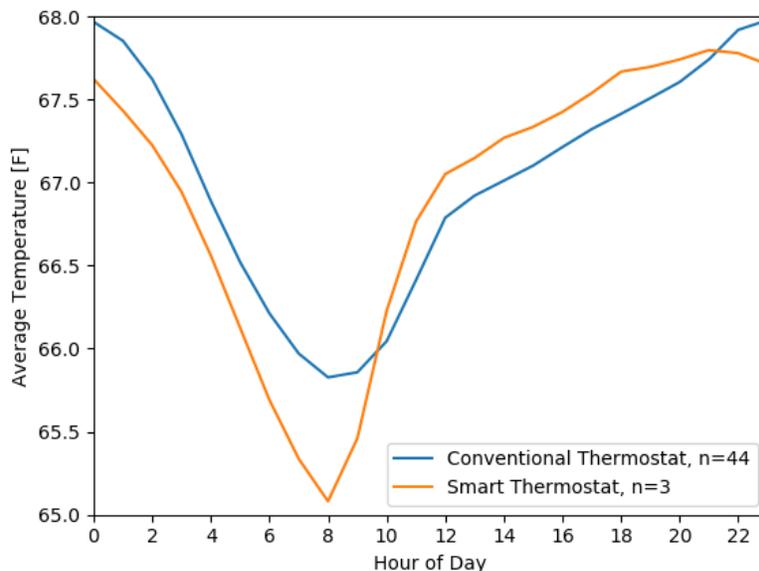
The estimated consumptions were similar to those from the billing analysis. Because of the relatively small sample sizes for the metered sites and approximations for two-stage units, Cadmus used the meter data as a check; however, final savings are from the billing analysis.

Analysis of the metering data yielded equipment consumption estimates similar to the consumption determined through billing analysis.

Indoor Air Temperature Data

Cadmus collected indoor air temperature data for each of the homes visited in the study. The data were separated into two groups based on thermostat type then aggregated. Figure 42 shows how indoor air temperature varies throughout the day during the metered period of late January through May. Cadmus did not extrapolate the indoor temperature data for an entire year.

Figure 42. Average Indoor Temperature vs. Hour of Day



Cadmus found that, on average, homes with conventional thermostats tended to be 0.5 to 1.0 degrees warmer overnight and in the mornings than homes with smart thermostats. Homes with smart thermostats tended to be slightly warmer during the day than homes with conventional thermostats. Both sets of homes show a nighttime setback of approximately 2.0 to 2.5 degrees.

Process Evaluation

The process evaluation activities for the appliances, water heating, and space heating and cooling products were completed as a cross-cutting effort in conjunction with activities performed for the program’s lighting measures. Methods and findings from these efforts are provided in the Cross-Cutting Process Evaluation section.

Conclusions and Recommendations

Conclusion: The ENERGY STAR Products program’s assumptions for clothes washers’ propane and fuel oil savings were low compared with other jurisdictions and did not match the fuel distribution found through the evaluation.

- **Recommendation:** Adopt the water heating fuel distribution identified during the Cadmus evaluation to inform clothes washer savings for the 2018–2020 evaluation cycle. Cadmus found 25% of participants heated water with propane, 27% with fuel oil, and 15% with natural gas, resulting in the savings shown in Table 109.

Table 109. Comparison of Ex Ante and Ex Post Clothes Washer MMBtu Inputs

Savings Source	Fuel Type	Ex Ante		Ex Post	
		Fuel Share	MMBtu	Fuel Share	MMBtu
Water Heater Savings	Natural Gas	23%	0.1541	15%	0.1003
	Fuel Oil	38%	0.2546	27%	0.1792
	Propane	2%	0.0134	25%	0.1653
Dryer Savings	Natural Gas	9%	0.0315	9%	0.0315
Total		--	0.4536	--	0.4763

Conclusion: Savings for the boiler and furnace measures vary significantly depending on which baseline is assumed.

- **Recommendation:** Conduct further research into the market baseline for boilers and furnaces in New Hampshire to inform the program baseline. The research should also include activities to inform estimates for the percentage of equipment that are replaced before the end of their useful lives (early replacement measures).

- **Recommendation:** Adopt the savings assumptions developed through the Cadmus billing analysis, presented in Table 110, for the 2018–2020 evaluation cycle.

Table 110. Typical Energy Savings for Furnaces and Boilers

Measure	Baseline	Proposed Savings	Precision at 90% Confidence
Boiler: ≥ 90% AFUE (up to 300 MBH)	Early Replacement	10.1	14.5%
	Federal Standard	7.9	14.9%
	Market Research	4.8	15.0%
Boiler: ≥ 95% AFUE (up to 300 MBH)	Early Replacement	13.8	14.5%
	Federal Standard	11.7	14.9%
	Market Research	8.7	15.0%
Furnace ≥ 95% AFUE w/ECM	Early Replacement	14.5	14.5%
	Federal Standard	12.4	14.9%
	Market Research	7.8	15.0%
Furnace ≥ 97% AFUE w/ECM	Early Replacement	15.7	14.5%
	Federal Standard	13.7	14.9%
	Market Research	9.1	15.0%

Appendices

Appendix A. Savings Summary

The following tables provide savings by fuel type and measure for each utility.

Eversource

Table 111. Eversource Savings Summary

Results	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i> Subtotal - Electric Measures	680,532.4	19,713,566	310,015,977	2,371.4	5,794.6	4,436	48,798
<i>Ex Ante</i> Subtotal - Gas Measures	0.0	0	0	0.0	0.0	0	0
<i>Ex Post</i> Subtotal - Electric Measures	680,532.4	18,530,280	286,780,347	2,489.4	6,171.2	4,658	51,239
<i>Ex Post</i> Subtotal - Gas Measures	0.0	0	0	0.0	0.0	0	0
Realization Rate - Electric Measures	100.0%	94.0%	92.5%	105.0%	106.5%	105.0%	105.0%
Realization Rate - Gas Measures	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 112. Eversource *Ex Ante* Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	1.0	28	224	0.0	0.0	0	0
CFL Multi-Packs	20,050.0	362,006	1,810,030	37.7	112.6	0	0
CFL Single-Packs	17,503.0	316,020	1,580,098	32.9	98.3	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	7,496.0	177,823	1,422,585	18.5	55.3	0	0
LED Multi-Packs	0.0	0	0	0.0	0.0	0	0
LED Single-Packs	173,212.0	4,049,330	80,986,604	421.6	1,259.2	0	0
Subtotal	218,262.0	4,905,207	85,799,540	510.7	1,525.3	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
White Goods							
Energy Star Clothes Washers	3,260.0	592,538	6,517,914	61.0	90.1	1,479	16,266
Energy Star Freezers	0.0	0	0	0.0	0.0	0	0
Energy Star Refrigerators	1,720.0	68,164	817,963	7.8	7.0	0	0
Energy Star Room Air Conditioners	1,038.0	16,770	150,934	14.0	0.0	0	0
Energy Star Room Air Purifier	157.0	61,329	551,957	7.0	6.4	0	0
Subtotal	6,175.0	738,800	8,038,768	89.8	103.5	1,479	16,266
Appliance Recycling							
Secondary Freezer Recycling	116.0	76,328	610,624	8.7	7.8	0	0
Secondary Refrigerator Recycling	277.0	209,135	1,673,080	23.9	21.5	0	0
Subtotal	393.0	285,463	2,283,704	32.6	29.3	0	0
Smartstrips							
Advanced Power Strip	6.0	474	2,372	0.1	0.2	0	0
Subtotal	6.0	474	2,372	0.1	0.2	0	0
Heating and Cooling							
Energy Star Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	7.5	575	6,898	1.3	0.0	0	0
Energy Star Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	16.2	4,156	49,867	1.3	0.0	0	0
Energy Star Air Source Heat Pumps (Heating, HSPF ≥ 10)	16.2	39,422	473,069	0.0	14.9	0	0
Energy Star Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	7.5	3,564	42,772	0.0	1.3	0	0
Energy Star Central AC (3 Ton)	21.9	3,112	43,570	6.9	0.0	0	0
Energy Star DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	706.4	51,804	621,650	114.4	0.0	0	0
Energy Star DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	142.6	3,137	37,644	6.9	0.0	0	0
Energy Star DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	706.4	278,483	3,341,798	0.0	210.9	0	0
Energy Star DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	142.6	11,022	132,262	0.0	8.3	0	0
Energy Star Ductless AC (Cooling only)	6.9	326	3,918	0.7	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	111.0	2,201	26,416	0.7	0.7	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	1,885.1	397,803	4,779,864	132.2	236.3	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	95.0	168,625	1,686,250	17.4	25.6	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	28.0	74,816	748,160	7.7	11.4	0	0
Subtotal	123.0	243,441	2,434,410	25.1	37.0	0	0
Total	226,844.1	6,571,189	103,338,659	790.5	1,931.5	1,479	16,266

Table 113. Eversource Ex Ante Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 97% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Cooling & Heating)	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.94	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Gas Measures Total	0.0	0	0	0.0	0.0	0	0

Table 114. Eversource Ex Post Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	1.0	18	147	0.0	0.0	0	0
CFL Multipacks	20,050.0	369,424	1,847,119	45.2	134.9	0	0
CFL Single-Packs	17,503.0	322,495	1,612,475	39.4	117.8	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	7,496.0	158,964	1,271,715	19.4	58.1	0	0
LED Multipacks	0.0	0	0	0.0	0.0	0	0
LED Single-Packs	173,212.0	3,673,230	73,464,603	449.2	1,341.7	0	0
Subtotal	218,262.0	4,524,132	78,196,059	553.3	1,652.5	0	0
White Goods							
ENERGY STAR Clothes Washers	3,260.0	581,764	6,399,406	59.9	88.4	1,553	17,080
ENERGY STAR Freezers	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Refrigerators	1,720.0	68,164	817,963	7.8	7.0	0	0
ENERGY STAR Room Air Conditioners	1,038.0	14,190	127,713	11.9	0.0	0	0
ENERGY STAR Room Air Purifier	157.0	61,329	551,957	7.0	6.4	0	0
Subtotal	6,175.0	725,447	7,897,040	86.6	101.9	1,553	17,080
Appliance Recycling							
Secondary Freezer Recycling	116.0	76,328	610,624	8.7	7.8	0	0
Secondary Refrigerator Recycling	277.0	209,135	1,673,080	23.9	21.5	0	0
Subtotal	393.0	285,463	2,283,704	32.6	29.3	0	0
Smartstrips							
Advanced Power Strip	6.0	474	2,372	0.1	0.2	0	0
Subtotal	6.0	474	2,372	0.1	0.2	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	7.5	575	6,898	1.3	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	16.2	4,156	49,867	1.3	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	16.2	39,422	473,069	0.0	14.9	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	7.5	3,564	42,772	0.0	1.3	0	0
ENERGY STAR Central A/C (3 Ton)	21.9	3,112	43,570	6.9	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	706.4	51,804	621,650	114.4	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	142.6	3,137	37,644	6.9	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	706.4	278,483	3,341,798	0.0	210.9	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	142.6	11,022	132,262	0.0	8.3	0	0
ENERGY STAR Ductless A/C (Cooling only)	6.9	326	3,918	0.7	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	111.0	2,201	26,416	0.7	0.7	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	1,885.1	397,803	4,779,864	132.2	236.3	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	95.0	168,625	1,686,250	17.4	25.6	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	28.0	74,816	748,160	7.7	11.4	0	0
Subtotal	123.0	243,441	2,434,410	25.1	37.0	0	0
Total	226,844.1	6,176,760	95,593,449	829.8	2,057.1	1,553	17,080

Table 115. Eversource Ex Post Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 97% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Cooling & Heating)	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.94	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Gas Measures Total	0.0	0	0	0.0	0.0	0	0

Unitil

Table 116. Unitil Savings Summary

Results	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i> Subtotal - Electric Measures	210,375.2	5,292,313	89,400,814	638.9	1,625.3	288	3,165
<i>Ex Ante</i> Subtotal - Gas Measures	875.0	24,311	405,030	3.9	0.6	8,239	147,283
<i>Ex Post</i> Subtotal - Electric Measures	210,375.2	4,880,583	81,126,940	677.3	1,745.8	710	7,812
<i>Ex Post</i> Subtotal - Gas Measures	875.0	24,311	405,030	3.9	0.6	7,040	124,742
Realization Rate - Electric Measures	100.0%	92.2%	90.7%	106.0%	107.4%	246.8%	246.8%
Realization Rate - Gas Measures	100.0%	100.0%	100.0%	100.0%	100.0%	85.4%	84.7%

Table 117. Unitil *Ex Ante* Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	0.0	0	0	0.0	0.0	0	0
CFL Multipacks	12,253.0	221,286	1,106,428	23.0	68.8	0	0
CFL Single-Packs	0.0	0	0	0.0	0.0	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	1,116.0	26,474	211,794	2.8	8.2	0	0
LED Multipacks	46,968.0	1,114,194	22,283,875	114.3	341.4	0	0
LED Single-Packs	8,534.0	199,507	3,990,137	20.8	62.0	0	0
Subtotal	68,871.0	1,561,460	27,592,234	160.9	480.5	0	0
White Goods							
ENERGY STAR Clothes Washers	497.0	90,454	994,994	17.7	19.9	96	1,055
ENERGY STAR Freezers	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Refrigerators	230.0	9,115	109,379	1.0	0.9	0	0
ENERGY STAR Room Air Conditioners	204.0	3,296	29,663	2.8	0.0	0	0
ENERGY STAR Room Air Purifier	24.0	9,362	84,262	1.5	2.0	0	0
Subtotal	955.0	112,227	1,218,298	23.0	22.8	96	1,055

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Appliance Recycling							
Secondary Freezer Recycling	1.0	663	5,304	0.1	0.1	0	0
Secondary Refrigerator Recycling	14.0	10,570	84,560	1.4	1.3	0	0
Subtotal	15.0	11,233	89,864	1.5	1.4	0	0
Smartstrips							
Advanced Power Strip	1.0	79	395	0.0	0.0	0	0
Subtotal	1.0	79	395	0.0	0.0	0	0
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	121.5	10,094	121,126	22.3	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	10.6	233	2,796	0.5	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	121.5	42,245	506,941	0.0	32.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	10.6	819	9,823	0.0	0.6	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	7.0	826	9,915	1.8	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	271.1	54,217	650,601	24.6	32.6	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	8.0	14,200	142,000	2.0	3.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	4.0	10,688	106,880	1.0	1.5	0	0
Subtotal	12.0	24,888	248,880	3.0	4.4	0	0
Total	70,125.1	1,764,104	29,800,271	213.0	541.8	96	1,055

Table 118. Unutil Ex Ante Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer	ISO-NE Winter	Annual Gas	Lifetime Gas
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				Peak kW	Peak kW	MMBtu	MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	22.0	0	0	0.0	0.0	242	4,840
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	86.0	0	0	0.0	0.0	1,178	23,564
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	19.0	3,192	57,456	0.0	0.2	302	5,438
Furnace ≥ 97% AFUE w/ECM	25.0	4,200	75,600	0.0	0.3	433	7,785
Heat Recovery Ventilator	3.0	-399	-7,980	0.0	-0.2	23	462
Thermostat: Standard 7-day Programmable	41.0	0	0	0.0	0.0	131	1,968
Thermostat: Wi-Fi (Cooling & Heating)	83.0	5,163	77,439	2.0	0.0	548	8,217
Thermostat: Wi-Fi (Heating Only)	110.0	0	0	0.0	0.0	726	10,890
Subtotal	389.0	12,156	202,515	2.0	0.3	3,583	63,164
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	39.0	0	0	0.0	0.0	312	6,240
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	2.0	0	0	0.0	0.0	48	952
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	10.0	0	0	0.0	0.0	238	4,760
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	1.0	0	0	0.0	0.0	4	55
Water Heater: Tankless, On Demand, EF ≥ 0.82	5.0	0	0	0.0	0.0	51	969
Water Heater: Tankless, On Demand, EF ≥ 0.94	40.0	0	0	0.0	0.0	420	7,980
Subtotal	97.0	0	0	0.0	0.0	1,073	20,956
Gas Measures Total	486.0	12,156	202,515	2.0	0.3	4,656	84,119

Table 119. Unutil Ex Post Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	0.0	0	0	0.0	0.0	0	0
CFL Multipacks	12,253.0	225,763	1,128,815	27.6	82.5	0	0
CFL Single-Packs	0.0	0	0	0.0	0.0	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	1,116.0	23,667	189,332	2.9	8.6	0	0
LED Multipacks	46,968.0	995,962	19,919,248	121.8	363.8	0	0
LED Single-Packs	8,534.0	180,977	3,619,535	22.1	66.1	0	0
Subtotal	68,871.0	1,426,369	24,856,930	174.4	521.0	0	0
White Goods							
ENERGY STAR Clothes Washers	497.0	88,809	976,903	17.4	19.5	237	2,604
ENERGY STAR Freezers	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Refrigerators	230.0	9,115	109,379	1.0	0.9	0	0
ENERGY STAR Room Air Conditioners	204.0	2,789	25,100	2.3	0.0	0	0
ENERGY STAR Room Air Purifier	24.0	9,362	84,262	1.5	2.0	0	0
Subtotal	955.0	110,076	1,195,643	22.2	22.5	237	2,604
Appliance Recycling							
Secondary Freezer Recycling	1.0	663	5,304	0.1	0.1	0	0
Secondary Refrigerator Recycling	14.0	10,570	84,560	1.4	1.3	0	0
Subtotal	15.0	11,233	89,864	1.5	1.4	0	0
Smartstrips							
Advanced Power Strip	1.0	79	395	0.0	0.0	0	0
Subtotal	1.0	79	395	0.0	0.0	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	121.5	10,094	121,126	22.3	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	10.6	233	2,796	0.5	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	121.5	42,245	506,941	0.0	32.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	10.6	819	9,823	0.0	0.6	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	7.0	826	9,915	1.8	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	271.1	54,217	650,601	24.6	32.6	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	8.0	14,200	142,000	2.0	3.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	4.0	10,688	106,880	1.0	1.5	0	0
Subtotal	12.0	24,888	248,880	3.0	4.4	0	0
Total	70,125.1	1,626,861	27,042,313	225.8	581.9	237	2,604

Table 120. Unitil Ex Post Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	22.0	0	0	0.0	0.0	174	3,485
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	86.0	0	0	0.0	0.0	1,005	20,110
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	19.0	3,192	57,456	0.0	0.2	148	2,668
Furnace ≥ 97% AFUE w/ECM	25.0	4,200	75,600	0.0	0.3	227	4,093
Heat Recovery Ventilator	3.0	-399	-7,980	0.0	-0.2	23	462
Thermostat: Standard 7-day Programmable	41.0	0	0	0.0	0.0	131	1,968
Thermostat: Wi-Fi (Cooling & Heating)	83.0	5,163	77,439	2.0	0.0	548	8,217
Thermostat: Wi-Fi (Heating Only)	110.0	0	0	0.0	0.0	726	10,890
Subtotal	389.0	12,156	202,515	2.0	0.3	2,983	51,893
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	39.0	0	0	0.0	0.0	312	6,240
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	2.0	0	0	0.0	0.0	48	952
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	10.0	0	0	0.0	0.0	238	4,760
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	1.0	0	0	0.0	0.0	4	55
Water Heater: Tankless, On Demand, EF ≥ 0.82	5.0	0	0	0.0	0.0	51	969
Water Heater: Tankless, On Demand, EF ≥ 0.94	40.0	0	0	0.0	0.0	420	7,980
Subtotal	97.0	0	0	0.0	0.0	1,073	20,956
Gas Measures Total	486.0	12,156	202,515	2.0	0.3	4,056	72,849

Liberty

Table 121. Liberty Savings Summary

Results	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Ex Ante Subtotal - Electric Measures	104,115.0	2,690,300	42,626,727	413.0	740.0	279	3,069
Ex Ante Subtotal - Gas Measures	2,739.0	145,684	2,383,830	30.1	4.0	27,604	477,478
Ex Post Subtotal - Electric Measures	104,115.0	2,523,352	39,247,753	442.0	801.2	293	3,222
Ex Post Subtotal - Gas Measures	2,739.0	145,684	2,383,830	30.1	4.0	22,601	392,218
Realization Rate - Electric Measures	100.0%	93.8%	92.1%	107.0%	108.3%	105.0%	105.0%
Realization Rate - Gas Measures	100.0%	100.0%	100.0%	100.0%	100.0%	81.9%	82.1%

Table 122. Liberty Ex Ante Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	0.0	0	0	0.0	0.0	0	0
CFL Multipacks	7,738.0	139,711	698,554	20.5	42.1	0	0
CFL Single-Packs	0.0	0	0	0.0	0.0	0	0
LED Exterior Fixtures	20.0	492	2,461	0.1	0.2	0	0
LED Interior Fixtures	666.0	15,799	126,393	1.6	4.9	0	0
LED Multipacks	15,592.0	364,508	7,290,160	53.8	109.9	0	0
LED Single-Packs	10,141.0	237,075	4,741,503	33.8	71.7	0	0
Subtotal	34,157.0	757,585	12,859,070	109.8	228.8	0	0
White Goods							
ENERGY STAR Clothes Washers	205.0	37,261	409,869	3.8	5.7	93	1,023
ENERGY STAR Freezers	2.0	228	2,736	0.0	0.0	0	0
ENERGY STAR Refrigerators	108.0	4,280	51,360	0.5	0.4	0	0
ENERGY STAR Room Air Conditioners	87.0	1,406	12,651	1.2	0.0	0	0
ENERGY STAR Room Air Purifier	9.0	3,516	31,641	0.4	0.4	0	0
Subtotal	411.0	46,690	508,257	5.9	6.5	93	1,023

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Appliance Recycling							
Secondary Freezer Recycling	17.0	11,186	89,488	1.3	1.1	0	0
Secondary Refrigerator Recycling	47.0	35,485	283,880	4.5	4.0	0	0
Subtotal	64.0	46,671	373,368	5.8	5.1	0	0
Smartstrips							
Advanced Power Strip	3.0	237	1,186	0.0	0.1	0	0
Subtotal	3.0	237	1,186	0.0	0.1	0	0
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	46.0	5,443	65,315	12.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	4.0	155	1,863	0.1	0.1	0	0
Subtotal	50.0	5,598	67,178	12.1	0.1	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	15.0	26,625	266,250	2.7	4.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	5.0	13,360	133,600	1.4	2.0	0	0
Subtotal	20.0	39,985	399,850	4.1	6.1	0	0
Total	34,705.0	896,767	14,208,909	137.7	246.7	93	1,023

Table 123. Liberty Ex Ante Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	64.0	0	0	0.0	0.0	768	15,360
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	92.0	0	0	0.0	0.0	1,279	25,576
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	24.0	0	0	0.0	0.0	566	5,664
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	24.0	0	0	0.0	0.0	250	4,992
Furnace ≥ 95% AFUE w/ECM	107.0	17,976	323,568	0.0	1.1	1,701	30,623
Furnace ≥ 97% AFUE w/ECM	90.0	15,120	272,160	0.0	0.9	1,557	28,026
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	130.0	0	0	0.0	0.0	416	6,240
Thermostat: Wi-Fi (Cooling & Heating)	639.0	39,746	596,187	15.0	0.0	4,409	66,137
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	1,170.0	72,842	1,191,915	15.0	2.0	10,946	182,618
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	82.0	0	0	0.0	0.0	656	13,120
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	80.0	0	0	0.0	0.0	1,904	38,080
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	51.0	0	0	0.0	0.0	1,214	24,276
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	2.0	0	0	0.0	0.0	8	109
Water Heater: Tankless, On Demand, EF ≥ 0.82	9.0	0	0	0.0	0.0	92	1,744
Water Heater: Tankless, On Demand, EF ≥ 0.94	175.0	0	0	0.0	0.0	1,838	34,913
Subtotal	399.0	0	0	0.0	0.0	5,712	112,242
Gas Measures Total	1,569.0	72,842	1,191,915	15.0	2.0	16,658	294,860

Table 124. Liberty Ex Post Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	0.0	0	0	0.0	0.0	0	0
CFL Multipacks	7,738.0	142,574	712,868	24.5	50.5	0	0
CFL Single-Packs	0.0	0	0	0.0	0.0	0	0
LED Exterior Fixtures	20.0	424	2,121	0.1	0.2	0	0
LED Interior Fixtures	666.0	14,124	112,989	1.7	5.2	0	0
LED Multipacks	15,592.0	330,653	6,613,053	57.3	117.1	0	0
LED Single-Packs	10,141.0	215,056	4,301,114	36.0	76.4	0	0
Subtotal	34,157.0	702,830	11,742,144	119.7	249.3	0	0
White Goods							
ENERGY STAR Clothes Washers	205.0	36,583	402,417	3.8	5.6	98	1,074
ENERGY STAR Freezers	2.0	228	2,736	0.0	0.0	0	0
ENERGY STAR Refrigerators	108.0	4,280	51,360	0.5	0.4	0	0
ENERGY STAR Room Air Conditioners	87.0	1,189	10,704	1.0	0.0	0	0
ENERGY STAR Room Air Purifier	9.0	3,516	31,641	0.4	0.4	0	0
Subtotal	411.0	45,796	498,858	5.7	6.4	98	1,074
Appliance Recycling							
Secondary Freezer Recycling	17.0	11,186	89,488	1.3	1.1	0	0
Secondary Refrigerator Recycling	47.0	35,485	283,880	4.5	4.0	0	0
Subtotal	64.0	46,671	373,368	5.8	5.1	0	0
Smartstrips							
Advanced Power Strip	3.0	237	1,186	0.0	0.1	0	0
Subtotal	3.0	237	1,186	0.0	0.1	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	46.0	5,443	65,315	12.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	4.0	155	1,863	0.1	0.1	0	0
Subtotal	50.0	5,598	67,178	12.1	0.1	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	15.0	26,625	266,250	2.7	4.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	5.0	13,360	133,600	1.4	2.0	0	0
Subtotal	20.0	39,985	399,850	4.1	6.1	0	0
Total	34,705.0	841,117	13,082,584	147.3	267.1	98	1,074

Table 125. Liberty Ex Post Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	64.0	0	0	0.0	0.0	507	10,139
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	92.0	0	0	0.0	0.0	1,076	21,513
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	24.0	0	0	0.0	0.0	244	2,436
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	24.0	0	0	0.0	0.0	244	4,872
Furnace ≥ 95% AFUE w/ECM	107.0	17,976	323,568	0.0	1.1	835	15,028
Furnace ≥ 97% AFUE w/ECM	90.0	15,120	272,160	0.0	0.9	819	14,734
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	130.0	0	0	0.0	0.0	416	6,240
Thermostat: Wi-Fi (Cooling & Heating)	639.0	39,746	596,187	15.0	0.0	4,217	63,261
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	1,170.0	72,842	1,191,915	15.0	2.0	8,357	138,222
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	82.0	0	0	0.0	0.0	656	13,120
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	80.0	0	0	0.0	0.0	1,904	38,080
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	51.0	0	0	0.0	0.0	1,214	24,276
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	2.0	0	0	0.0	0.0	8	109
Water Heater: Tankless, On Demand, EF ≥ 0.82	9.0	0	0	0.0	0.0	92	1,744
Water Heater: Tankless, On Demand, EF ≥ 0.94	175.0	0	0	0.0	0.0	1,838	34,913
Subtotal	399.0	0	0	0.0	0.0	5,712	112,242
Gas Measures Total	1,569.0	72,842	1,191,915	15.0	2.0	14,068	250,464

Table 126. NHEC Savings Summary

Results	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
<i>Ex Ante</i> Subtotal - Electric Measures	94,827.0	2,590,588	41,095,833	277.7	703.2	604	6,646
<i>Ex Ante</i> Subtotal - Gas Measures	0.0	0	0	0.0	0.0	0	0
<i>Ex Post</i> Subtotal - Electric Measures	94,827.0	2,434,800	37,928,434	295.1	758.6	634	6,979
<i>Ex Post</i> Subtotal - Gas Measures	0.0	0	0	0.0	0.0	0	0
Realization Rate - Electric Measures	100.0%	94.0%	92.3%	106.3%	107.9%	105.0%	105.0%
Realization Rate - Gas Measures	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 127. NHEC *Ex Ante* Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	1,235.0	22,298	178,385	2.3	6.9	0	0
CFL Multipacks	5,199.0	93,869	469,344	9.8	29.2	0	0
CFL Single-Packs	23.0	415	2,076	0.0	0.1	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Multipacks	9,499.0	222,067	4,441,331	23.1	69.1	0	0
LED Single-Packs	14,672.0	343,000	6,860,007	35.7	106.7	0	0
Subtotal	30,628.0	681,649	11,951,142	71.0	212.0	0	0
White Goods							
ENERGY STAR Clothes Washers	444.0	80,701	887,716	8.3	12.3	201	2,215
ENERGY STAR Freezers	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Refrigerators	258.0	10,225	122,694	1.2	1.0	0	0
ENERGY STAR Room Air Conditioners	148.0	2,391	21,520	2.0	0.0	0	0
ENERGY STAR Room Air Purifier	18.0	7,031	63,282	0.8	0.7	0	0
Subtotal	868.0	100,348	1,095,212	12.3	14.1	201	2,215

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Appliance Recycling							
Secondary Freezer Recycling	39.0	25,662	205,296	2.9	2.6	0	0
Secondary Refrigerator Recycling	74.0	55,870	446,960	6.4	5.7	0	0
Subtotal	113.0	81,532	652,256	9.3	8.4	0	0
Smartstrips							
Advanced Power Strip	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	0.0	0	0	0.0	0.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Total	31,609.0	863,529	13,698,611	92.6	234.4	201	2,215

Table 128. NHEC Ex Ante Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer	ISO-NE Winter	Annual Gas	Lifetime Gas
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				Peak kW	Peak kW	MMBtu	MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 97% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Cooling & Heating)	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.94	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Gas Measures Total	0.0	0	0	0.0	0.0	0	0

Table 129. NHEC Ex Post Electric Measure Savings

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Lighting							
CFL Interior Fixtures	1,235.0	22,755	182,040	2.8	8.3	0	0
CFL Multipacks	5,199.0	95,792	478,961	11.7	35.0	0	0
CFL Single-Packs	23.0	424	2,119	0.1	0.2	0	0
LED Exterior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Interior Fixtures	0.0	0	0	0.0	0.0	0	0
LED Multipacks	9,499.0	201,441	4,028,822	24.6	73.6	0	0
LED Single-Packs	14,672.0	311,143	6,222,852	38.0	113.6	0	0
Subtotal	30,628.0	631,555	10,914,794	77.2	230.7	0	0
White Goods							
ENERGY STAR Clothes Washers	444.0	79,234	871,576	8.2	12.0	211	2,326
ENERGY STAR Freezers	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Refrigerators	258.0	10,225	122,694	1.2	1.0	0	0
ENERGY STAR Room Air Conditioners	148.0	2,023	18,210	1.7	0.0	0	0
ENERGY STAR Room Air Purifier	18.0	7,031	63,282	0.8	0.7	0	0
Subtotal	868.0	98,513	1,075,761	11.8	13.8	211	2,326
Appliance Recycling							
Secondary Freezer Recycling	39.0	25,662	205,296	2.9	2.6	0	0
Secondary Refrigerator Recycling	74.0	55,870	446,960	6.4	5.7	0	0
Subtotal	113.0	81,532	652,256	9.3	8.4	0	0
Smartstrips							
Advanced Power Strip	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0

Utility	Measure Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating and Cooling							
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Central A/C (3 Ton)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0	0	0	0.0	0.0	0	0
ENERGY STAR Ductless A/C (Cooling only)	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Air Conditioners	0.0	0	0	0.0	0.0	0	0
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	0.0	0	0	0.0	0.0	0	0
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Total	31,609.0	811,600	12,642,811	98.4	252.9	211	2,326

Table 130. NHEC Ex Post Gas Measure Savings

Measure Name	Quantity	Annual kWh	Lifetime kWh	ISO-NE Summer Peak kW	ISO-NE Winter Peak kW	Annual Gas MMBtu	Lifetime Gas MMBtu
Heating							
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 65% AFUE	0.0	0	0	0.0	0.0	0	0
Boiler Early Replacement: 90% AFUE replacing 80% AFUE	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 95% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Furnace ≥ 97% AFUE w/ECM	0.0	0	0	0.0	0.0	0	0
Heat Recovery Ventilator	0.0	0	0	0.0	0.0	0	0
Thermostat: Standard 7-day Programmable	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Cooling & Heating)	0.0	0	0	0.0	0.0	0	0
Thermostat: Wi-Fi (Heating Only)	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Domestic Hot Water							
Water Heater: Indirect, attached to boiler, combined eff rating ≥85%, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 90% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Integrated w/Condensing Boiler ≥ 95% AFUE	0.0	0	0	0.0	0.0	0	0
Water Heater: Stand Alone Storage Tank, EF ≥ 0.67	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.82	0.0	0	0	0.0	0.0	0	0
Water Heater: Tankless, On Demand, EF ≥ 0.94	0.0	0	0	0.0	0.0	0	0
Subtotal	0.0	0	0	0.0	0.0	0	0
Gas Measures Total	0.0	0	0	0.0	0.0	0	0

Appendix B. Survey Demographics

Participant Online Survey Demographics

Most participant survey respondents, 98% (n=202), were owner occupants; the remaining identified as tenants (2%) that pay the electric bill. Participants most commonly live in a single-family home (89%; n=204), followed by an apartment or condo in a 2-4-unit building (4%) or 5 or more-unit building (4%).

Table 131: Including yourself, how many individuals normally live in your home? (Do not include anyone who is just visiting, those away in the military, or children who are away at college.)

Table 131. Individuals in Household

Individuals in Household	% of Total (n=201)
1	6%
2	55%
3	15%
4	15%
5	6%
6	1%
7	1%

Table 132: What is the approximate square footage of your home? PLEASE INCLUDE ONLY HEATED LIVING SPACE.

Table 132. Approximate Square Footage

Square Footage	% of Total (n=205)
Less than 1000 sq. ft.	4%
1,000 – 1,499 sq. ft.	19%
1,500 – 1,999 sq. ft.	31%
2,000 – 2,499 sq. ft.	27%
2,500 – 2,999 sq. ft.	9%
3,000 sq. ft. or larger	10%

Table 133: What is your annual household income?

Table 133. Annual Household Income

Household Income	% of Total (n=194)
Less than \$24,000	1%
\$24,000 to \$32,999	3%
\$33,000 to \$41,000	1%
\$42,000 to \$49,000	4%
\$50,000 to \$58,000	3%
\$59,000 to \$66,000	3%
\$67,000 to \$74,000	6%
\$75,000 to \$83,000	6%
\$84,000 to \$99,999	5%

Household Income	% of Total (n=194)
\$100,000 to \$149,999	22%
\$150,000 to \$199,999	8%
\$200,000 or more	8%
Prefer not to answer	32%

Table 134: Do you own or rent your home?

Table 134. Own v. Rent

Response	% of Total (n=202)
Own	98%
Rent	2%

*The renter indicated they pay their electric bill

Table 135: Please select the term that most closely describes your home:

Table 135. Type of Home

Type of Home	% of Total (n=204)
Single family detached home	89%
An apartment or condo in a 2-4-unit building	4%
An apartment or condo in a building with 5 or more units	4%
Other	2%

Table 136: What type of fuel do you use primarily to heat your home?

Table 136. Primary Heating Fuel Type

Fuel	% of Total (n=203)
Natural Gas	19%
Bottled, tank or LP gas	19%
Electricity	4%
Oil	44%
Kerosene	1%
Coal (coke)	-
Wood	10%
Solar	1%
Geothermal	1%

Table 137: Do you have a secondary home heating source?

Table 137. Uses Secondary Heating Sources

Response	% of Total (n=203)
Yes	55%
No	45%

Table 138: Please specify the type of secondary home heating source.

Table 138. Secondary Heating Sources

Yes, please specify what it is: (n=112)	QTY
Wood Stove	41
Heat Pump, Heat Pump Minisplit	17
Pellet Stove	14
Electric, General	11
Propane Heater, Stove	9
Heating Oil	9
Gas Fireplace	3
Fireplace, General	3
Electric Fireplace	2
Other	3

Table 139: What type of fuel do you use to heat water in your home?

Table 139. Domestic Hot Water Fuel Type

Fuel	% of Total (n=202)
Natural Gas	14%
Bottled, tank or LP gas	22%
Electricity	31%
Oil	29%
Kerosene	1%
Solar	1%
Other	2%

Table 140: Do you have a ducted central air conditioning system?

Table 140. Presence of Central AC

Response	% of Total (n=202)
Yes	23%
No	77%

In-Home Lighting Inventory Study Demographics

Table 141: Including yourself, how many individuals normally live in your home? (Do not include anyone who is just visiting, those away in the military, or children who are away at college.)

Table 141. Individuals in Household

Individuals in Household	% of Total (n=43)
1	7%
2	47%
3	27%
4	11%
5	2%
6	2%

Table 142: What is the approximate square footage of your home? Please include only heated living space.

Table 142. Approximate Square Footage

Square Footage	% of Total (n=43)
Less than 1000 sq. ft.	2%
1,000 – 1,499 sq. ft.	16%
1,500 – 1,999 sq. ft.	26%
2,000 – 2,499 sq. ft.	23%
2,500 – 2,999 sq. ft.	19%
3,000 sq. ft. or larger	14%

Table 143: Does anyone in your household regularly telecommute or work from home during the day on weekdays?

Table 143. Telecommute

Response	% of Total (n=43)
Yes	56%
No	44%

Table 144: On average, how many weekdays does someone in your household work from home each week?

Table 144. How Often Do Participants Work from Home?

How Often?	% of Total (n=24)
1 Weekday.	13%
2 Weekdays	13%
3 Weekdays	21%
4 Weekdays	4%
5 Weekdays	50%

Table 145: Other than those that work from home or telecommute, are there any individuals in your home that regularly stay at home all or most weekdays?

Table 145. How Often Participants Have Family Member That Regularly Are Home

Response	% of Total (n=38)
Yes	61%
No	39%

Table 146. Do you own/rent your home?

Table 146. Own v. Rent

Response	% of Total (n=43)
Own	98%
Rent	2%
*The renter indicated they pay their electric bill	

Table 147: What type of fuel do you use primarily to heat your home?

Table 147. Primary Heating Fuel Type

Fuel	% of Total (n=48)
Natural Gas	40%
Bottled, tank or LP gas	19%
Electricity	10%
Oil, kerosene	19%
Coal (coke)	0%
Wood	6%
Solar	2%
Geothermal	4%

Table 148: Do you have a secondary home heating source?

Table 148. Secondary Heating Sources

Yes, please specify what it is: (n=4)	QTY	Please specify the time period heats:
Wood Stove	1	Weekends
Gas Fireplace	1	10 days a month
Electric Space Heater	1	1-2 hours a day
Pellet Stove	1	Not much

Table 149: What type of fuel do you use to heat water in your home?

Table 149. Domestic Hot Water Fuel Type

Fuel	% of Total (n=47)
Natural Gas	19%
Bottled, tank or LP gas	36%
Electricity	19%
Oil, kerosene	17%
Solar	6%
Geothermal	2%

Table 150: Do you have a ducted Central Air Conditioning System?

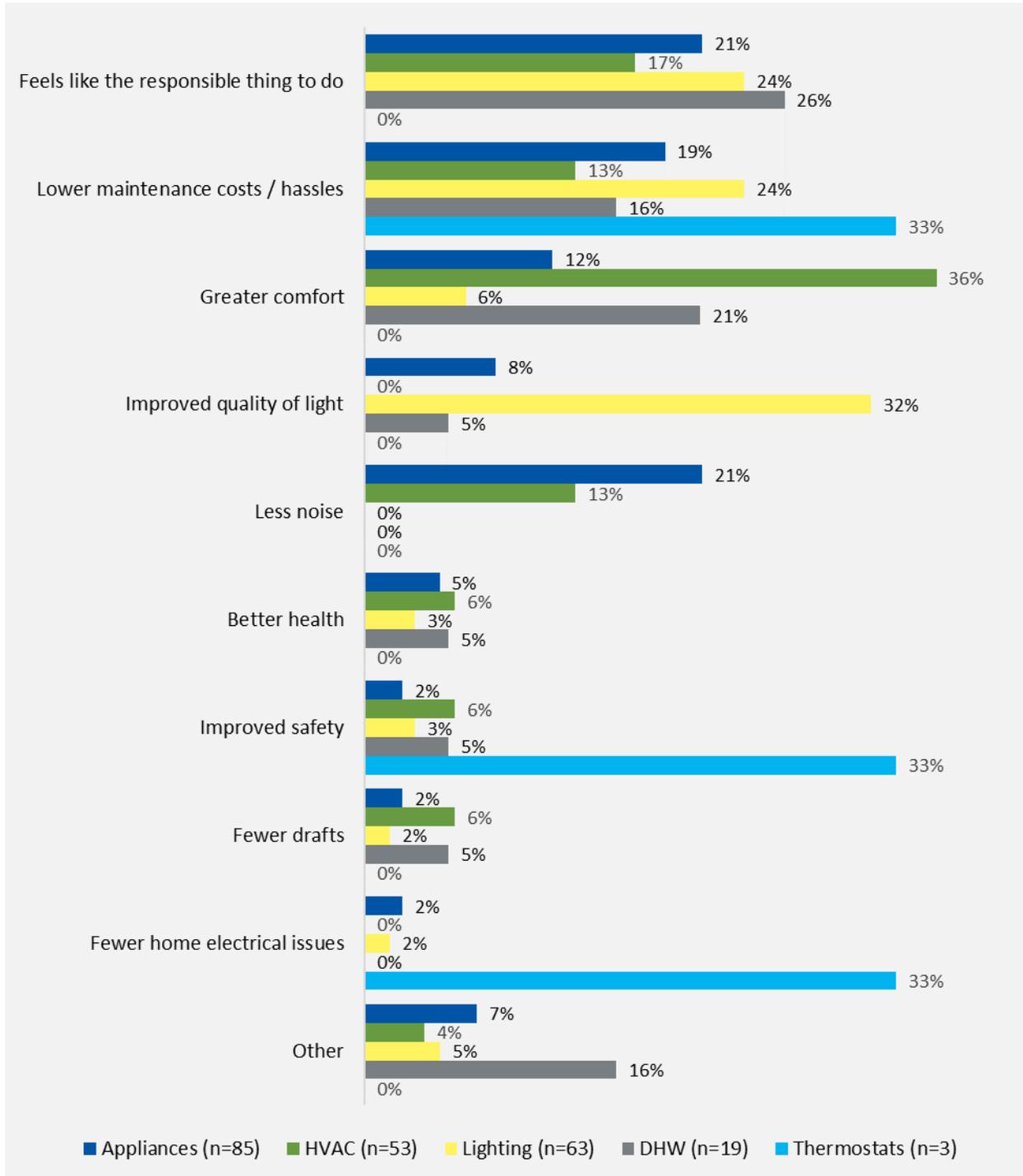
Table 150. Presence of Central AC

Response	% of Total (n=38)
Yes	39%
No	61%

Appendix C. Additional Survey Findings

Figure 43: Have you noticed any other positive impacts resulting from the energy efficiency improvements made to your home? What are they?"

Figure 43. Positive Impacts From Energy Efficiency Improvements



Appendix D. Available Measure Comparison

Measure	New Hampshire Public Utility Commission	Efficiency Vermont	National Grid	Cape Light Compact	Unitil	National Grid	Eversource
	ENERGY STAR Products	Electric Efficient Products	Residential Products				
	NH	VT	RI	MA	MA	MA	MA
Lighting							
CFL Bulbs	X	X	X	X	X	X	X
LED Fixtures	X	X	X	X	X	X	X
LED Bulbs	X	X	X	X	X	X	X
LED Downlights		X					
White Goods							
ENERGY STAR Clothes Washer	X	X		X	X	X	X
ENERGY STAR Clothes Dryer	X	X	X	X	X	X	X
ENERGY STAR Room Air Conditioner	X		X	X	X	X	X
ENERGY STAR Room Air Purifier	X		X	X	X	X	X
ENERGY STAR Refrigerator	X	X		X	X	X	X
ENERGY STAR Dehumidifier	X	X	X	X	X	X	X
Appliance Recycling							
Refrigerator Recycling	X		X	X	X	X	X
Freezer Recycling	X		X	X	X	X	X
Room Air Conditioner Recycling	X						
Smartstrips							
Smartstrip Power Strips	X	X	X	X	X	X	X
Heating and Cooling							
ENERGY STAR Central AC (3 tons)	X			X	X	X	X
Central AC SEER ≥ 16; EER ≥ 13			X	X	X	X	X
Early Replacement: Central A/C; SEER ≥ 16, EER ≥ 13; at least 12 years old				X	X	X	X
ENERGY STAR Ductless AC (Cooling only)	X						
Wi-Fi Enabled Thermostats for Air Conditioners	X	X	X				
Air Source Heat Pump (Cooling SEER≥ 15, EER ≥12.5; Heating HSPF ≥8.5)	X						

	New Hampshire Public Utility Commission	Efficiency Vermont	National Grid	Cape Light Compact	Unitil	National Grid	Eversource
	ENERGY STAR Products	Electric Efficient Products	Residential Products				
	NH	VT	RI	MA	MA	MA	MA
Air Source Heat Pump (Cooling SEER≥ 18, EER ≥12.5: Heating HSPF ≥10)	x						
Wi-Fi Enabled Thermostats for Air Source Heat Pump	x						
Early Replacement: Central heat pump; SEER ≥ 16, HSPF ≥ 8.5; at least 12 years old				x	x	x	x
Early Replacement: Central heat pump; SEER ≥ 18, HSPF ≥ 9.6; at least 12 years old				x	x	x	x
High performance circulator pumps		x					
Boiler: 90% AFUE (65%-95%)	x			x	x	x	x
Boiler: 90%+ AFUE (80%-90%)	x			x	x	x	x
Boiler: ≥95% AFUE; propane		x					
Boiler: ≥87% AFUE; Fuel #2		x					
Boiler: Forced hot water, ≥ 90% AFUE			x	x	x	x	x
Boiler: Forced hot water, ≥ 95% AFUE			x	x	x	x	x
Boiler: Condensing, ≥ 90% AFUE (up to 300 MBH)	x			x	x	x	x
Boiler: Condensing, ≥ 95% AFUE (up to 300 MBH)	x			x	x	x	x
Boiler: Central Wood Pellet		x					
Boiler Reset Controls	x		x	x	x	x	x
Early replacement: Forced hot water boiler; AFUE ≥ 90%; at least 30 years old				x	x	x	x
Thermostat: Wi-Fi (Heating Only)	x	x	x	x	x	x	x
Thermostat: Wi-Fi (Cooling & Heating)	x	x	x	x	x	x	x
Ductless Heat Pump Mini-Split (Cooling SEER≥ 15, EER ≥12.5: Heating HSPF ≥8.5)	x						
Ductless Heat Pump Mini-Split (Cooling SEER≥ 14.5: Heating HSPF ≥8.2)	x						
Ductless Heat Pump Mini-Split (Cooling SEER≥18, EER≥12.5: Heating HSPF ≥10)	x		x	x	x	x	x
Mini-Split Heat Pump (Cooling SEER≥ 20; HSPF ≥12)	x		x	x	x	x	x
Central Heat Pump: SEER ≥ 16; HSPF ≥ 8.5			x	x	x	x	x
Central Heat Pump: SEER ≥ 18; HSPF ≥ 9.6			x	x	x	x	x

	New Hampshire Public Utility Commission	Efficiency Vermont	National Grid	Cape Light Compact	Unitil	National Grid	Eversource
	ENERGY STAR Products	Electric Efficient Products	Residential Products				
	NH	VT	RI	MA	MA	MA	MA
Heat pump: Single zone; multi zone ≤2 tons		x					
Heat pump: Multi zone >2 tons		x					
Wi-Fi Enabled Thermostats for Ductless Heat Pump Mini-Split	x						
Boiler: Early Replacement, Steam - Retirement: 82%+ AFUE	x			x	x	x	x
Boiler: Early Replacement, Steam - EE: 82%+ AFUE	x			x	x	x	x
Boiler: Early Replacement, forced hot water AFUE ≥ 90%; gas or propane; 30 years				x	x	x	x
Boiler: Early Replacement, forced hot water AFUE ≥ 86%; oil; 30 years old				x	x	x	x
Furnace: 95+ AFUE (< 150) w/ECM Motor	x		x	x	x	x	x
Furnace: 97+ AFUE (< 150) w/ECM Motor	x		x	x	x	x	x
Furnace: Central Wood Pellet Furnace							
Furnace: Early Replacement w/ECM, AFUE≥95%; at least 12 years old				x	x	x	x
Furnace: Early Replacement w/ECM, AFUE≥86%; at least 12 years old; oil				x	x	x	x
Furnace: Early Replacement w/ECM, AFUE ≥90%; at least 12 years old; propane				x	x	x	x
Heat Recovery Ventilator (-133 kWh Penalty)	x		x	x	x	x	x
Thermostat: Standard 7-day programmable	x		x	x	x	x	x
Pool Pump							
ENERGY STAR Pool Pumps (two-speed and variable-speed)	x	x	x				
Domestic Hot Water							
Heat Pump Water Heater: 50 Gal Elec, (EF>2.3)	x	x					
Heat Pump Water Heater: 80 Gal Elec, (EF>2.3)	x	x					
Heat Pump Water Heater: 55 Gal Elec, UEF 2.0			x	x	x	x	x
Heat Pump Water Heater: >55 Gal Elec, UEF 2.7			x	x	x	x	x
Heat Pump Water Heater: meets AWHS Toer 1, 2, or 3		x					
Water Heater: Tankless, On Demand, ≥0.82 EF	x						
Water Heater: Tankless, On Demand, ≥ 0.87 EF			x	x	x	x	x

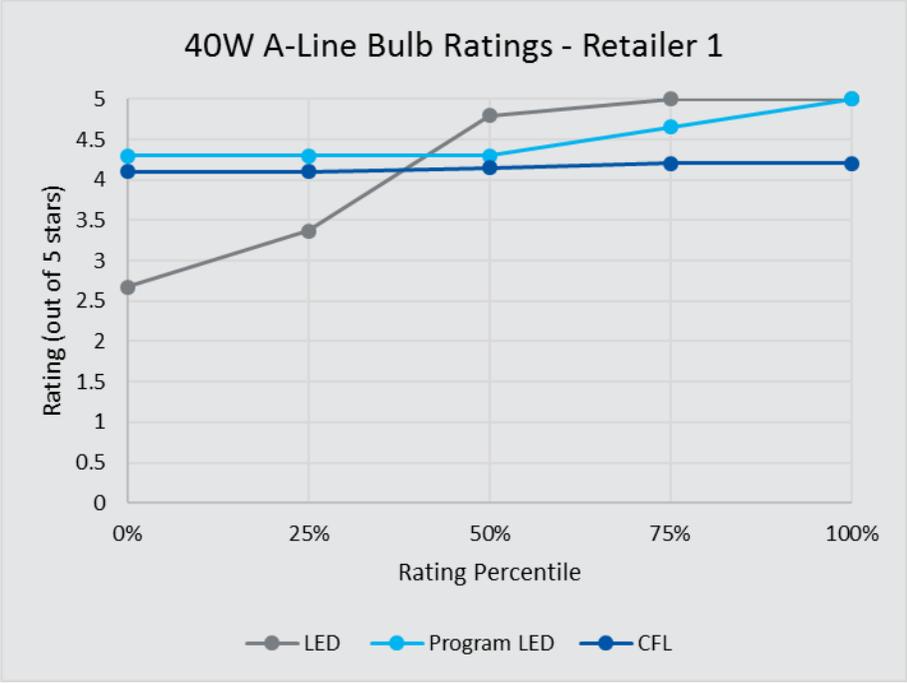
	New Hampshire Public Utility Commission	Efficiency Vermont	National Grid	Cape Light Compact	Unitil	National Grid	Eversource
	ENERGY STAR Products	Electric Efficient Products	Residential Products				
	NH	VT	RI	MA	MA	MA	MA
Water Heater: Tankless, On Demand, ≥ 0.94 EF	x						
Water Heater: Indirect, Attached to Boiler, Combined Efficiency Rating $\geq 85\%$ (EF=0.82)	x						
Water Heater: Indirect, Attached to Boiler, No Efficiency Required				x	x	x	X
Water Heater: Condensing (EF ≥ 0.95)	x						
Water Heater: ENERGY STAR Condensing (EF ≥ 0.80)			x	x	x	x	X
Water Heater: Stand Alone Storage Tank (Eff ≥ 0.67)	x						
Water Heater: ENERGY STAR Storage Tank (Eff medium draw ≥ 0.64 , high draw ≥ 0.68)			x	x	x	x	X
Water Heater: Integrated w/Condensing Boiler $\geq 90\%$ AFUE	x		x	x	x	x	X
Water Heater: Integrated w/Condensing Boiler $\geq 95\%$ AFUE	x		x	x	x	x	X
Water Heater: Indirect, propane				x	x	x	X
Water Heater: Indirect, oil				x	x	x	X
Water Heater: Solar		x					
Other							
DIY Insulation and Air Sealing		x					
Shower fixtures			x	x	x	x	x

Appendix E. Lighting Pricing Assessment Tables and Figures

Product Ratings by Technology and Incandescent-Equivalent Category

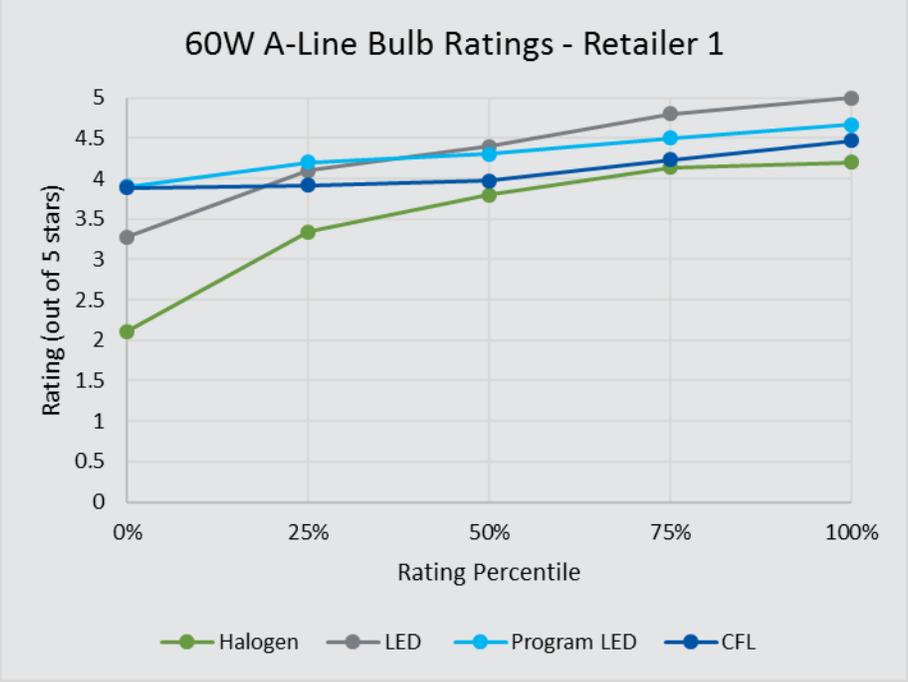
Quartiles show the distribution of ratings rather than just the mean rating. If a technology had a large number of very ratings and a number of very high ratings, the mean would not capture this. If it were the case that non-program LEDs were unique in having a significant number of low quality, low price products, we would expect to see this reflected in the distribution of ratings.

Figure 44. Customer Ratings Quartiles 40W Equivalent A-Line – Retailer 1



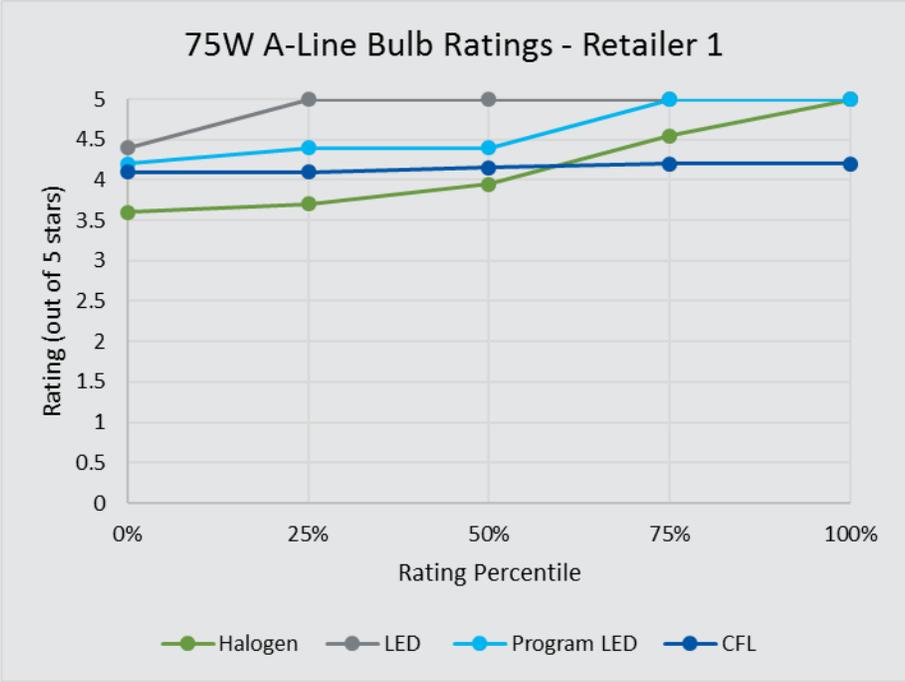
Reviews were collected from eight unique non-program LED models with an average of 24 reviews per model, five program LED models with an average of 182 reviews per model, and one CFL with 161 reviews

Figure 45. Customer Ratings Quartiles 60W Equivalent A-Line – Retailer 1



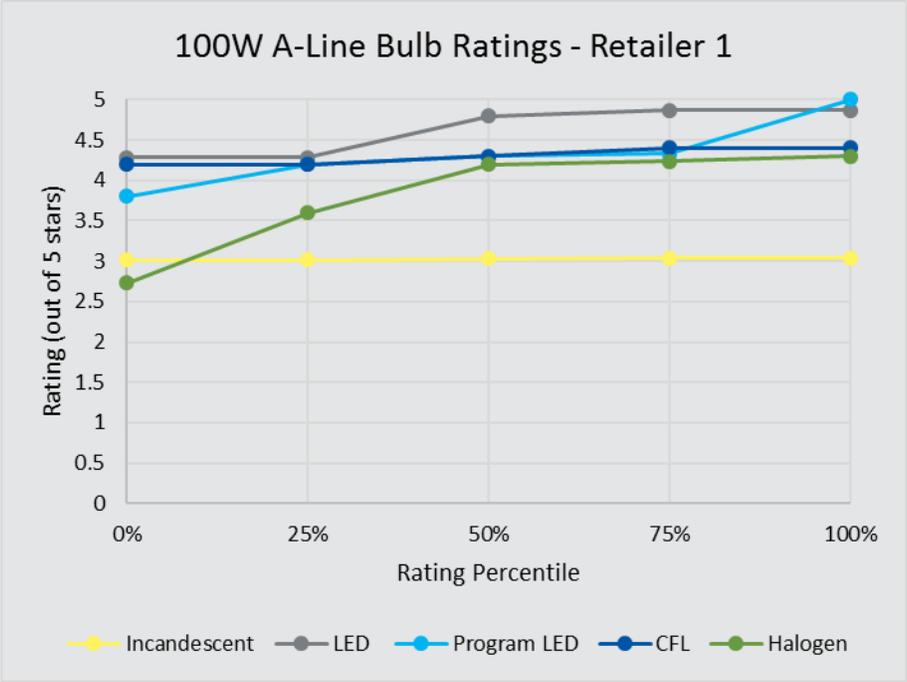
Reviews were collected from six unique halogen models with an average of 39 reviews per model, 21 non-program LED models with an average of 114 reviews, eight program LED model with an average of 129 reviews, and four CFLs with 152 reviews.

Figure 46. Customer Ratings Quartiles 75W Equivalent A-Line – Retailer 1



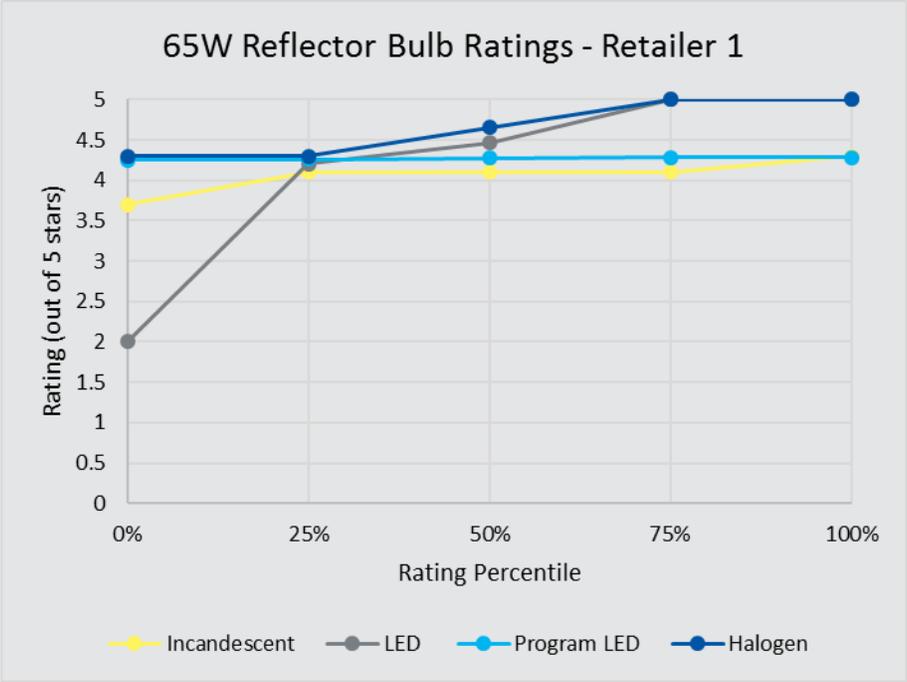
Reviews were collected from four unique halogen models with an average of 16 reviews per model, three non-program LED models with an average of eight reviews, five program LED model with an average of 48 reviews, and two CFLs with 71 reviews.

Figure 47. Customer Ratings Quartiles 100W Equivalent A-Line – Retailer 1



Reviews were collected from six unique halogen models with an average of 19 reviews per model, three non-program LED models with an average of 14 reviews, six program LED model with an average of 90 reviews, two incandescent model with an average of 13 reviews, and two CFLs with 217 reviews.

Figure 48. Customer Ratings Quartiles 65W Equivalent Reflector – Retailer 1



Reviews were collected from two unique halogen models with an average of 22 reviews per model, 12 non-program LED models with an average of 131 reviews, two program LED model with an average of 6 reviews, and five incandescent model with an average of 124 reviews.

Technology and Market Share by Bulb Style and Incandescent Equivalent Wattage

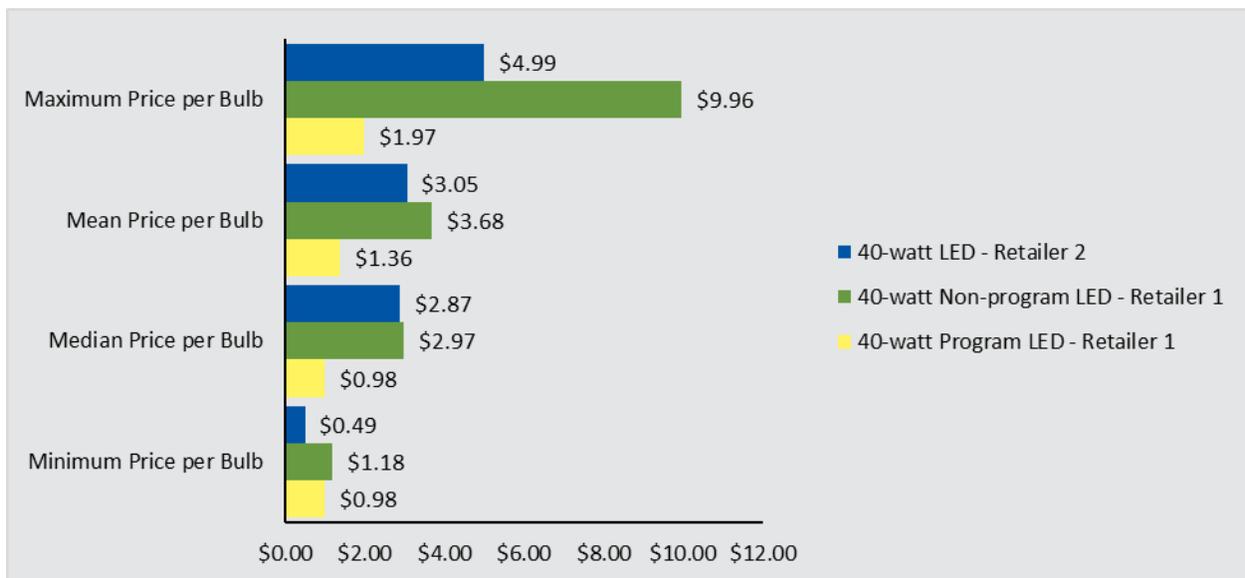
Figure 49. Proportion of Lamps Available at Retailer 1 by Style and Incandescent Equivalent Wattage

Bulb Style	Incandescent Equivalent	Proportion of Lamps Available for Purchase	
		By Bulb Style	Overall
Decorative	40-watt	20.6%	3.2%
	60-watt	78.7%	12.4%
	Other wattages ¹	0.7%	0.1%
General Purpose	40-watt	19.3%	12.2%
	60-watt	61.7%	39.0%
	75-watt	4.6%	2.9%
	100-watt	13.8%	8.7%
	Other wattages ¹	0.5%	0.3%
Reflector	45-watt	2.6%	0.6%
	50-watt	14.7%	3.1%
	65-watt	39.4%	8.3%
	75-watt	17.6%	3.7%
	100-watt	1.3%	0.3%
	120-watt	4.9%	1.0%
	Other wattages ¹	19.5%	4.1%

¹These products either represent less than 1% of lamps within that style, or no LED products were identified at that wattage.

Product Ratings by Technology and Incandescent-Equivalent Category

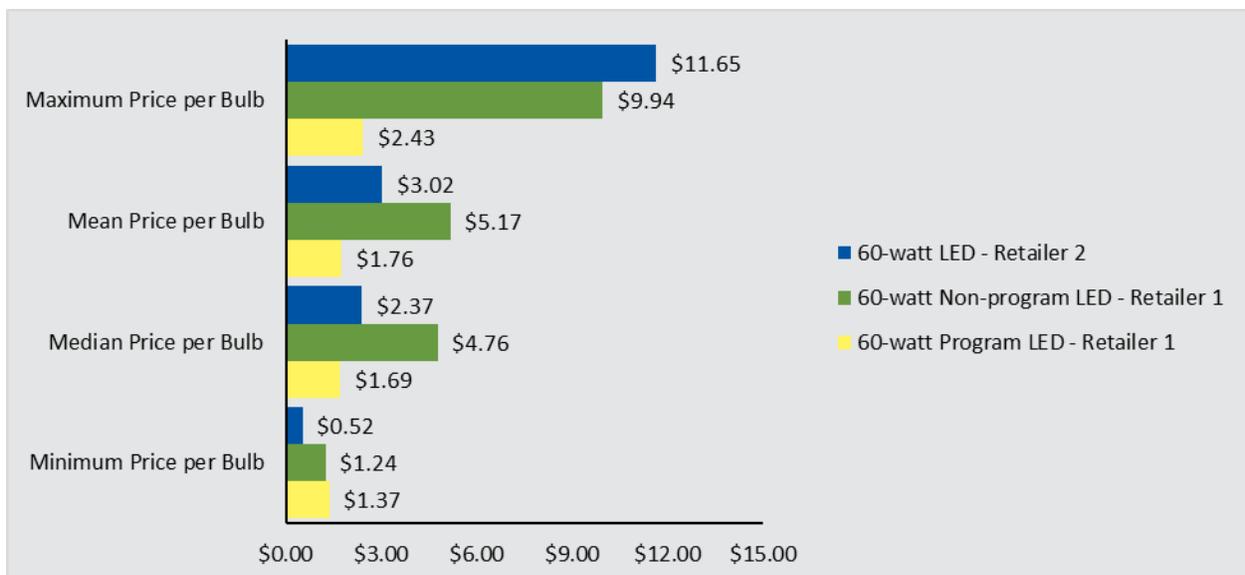
Figure 50. LED Price Comparison – General Service 40-watt Incandescent Equivalent



Source: Lighting Pricing Assessment

For 60-watt equivalent LEDs, as shown in **Error! Reference source not found.**, the program-discounted bulbs at Retailer 1 have the lowest mean and median prices. Mean and median prices of similar bulbs at Retailer 2 are lower than the non-program LEDs at retailer 1 but slightly higher than the program-discounted bulbs. Retailer 2 has the highest priced and lowest priced bulbs overall. The maximum price for program LEDs is much lower than both the non-program LEDs at Retailer 1 and bulbs at Retailer 2.

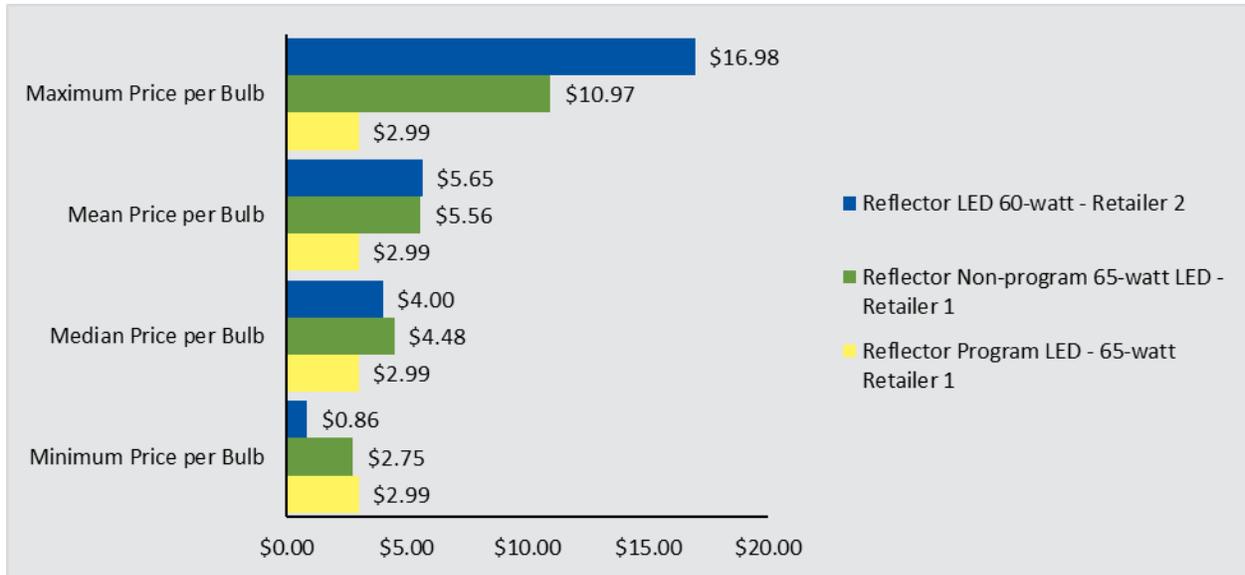
Figure 51. LED Price Comparison – General Service 60-watt Incandescent Equivalent



Source: Lighting Pricing Assessment

For reflector bulbs, Retailer 2 and Retailer 1 defined their watt categories differently. Since there were no program LEDs in the 60-watt reflector category for Retailer 1, Cadmus compared 65-watt reflectors from Retailer 1 with 60-watt reflectors at Retailer 2 (as shown in **Error! Reference source not found.**).

Figure 52. LED Price Comparison – Reflector 60-watt and 65-watt Incandescent Equivalent



Source: Lighting Pricing Assessment

For comparable reflector LEDs, the mean and median prices of program-discounted bulbs at Retailer 1 are lower than non-program LEDs or LEDs at Retailer 2. Mean and median prices of similar bulbs at Retailer 2 are lower than the non-program LEDs at Retailer 1 but slightly higher than the program-discounted bulbs. Retailer 2 has the highest priced and lowest priced bulbs overall. The maximum price for program LEDs is much lower than both the non-program LEDs at Retailer 1 and bulbs at Retailer 2.

Appendix F. Comparison of Coincidence Factors Against MA and VT

Table 151. Comparison of Coincidence Factors for Lighting Measures

Reporting Measure Name	New Hampshire		MA 2016 - 2018 TRM		MA 2013-2015 TRM		VT 2017 TRM		VT 2015 TRM	
	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor
CFL Interior Fixtures	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
CFL Multi-Packs	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
CFL Single-Packs	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
LED Exterior Fixtures	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
LED Interior Fixtures	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
LED Multi-Packs	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%
LED Single-Packs	7.6%	22.7%	14.0%	18.0%	11.0%	22.0%	8.2%	29.8%	8.2%	29.8%

Table 152. Comparison of Coincidence Factors for Electric Non-Lighting Measures

Reporting Measure Name	New Hampshire		MA 2016 - 2018 TRM		MA 2013-2015 TRM		VT 2017 TRM		VT 2015 TRM	
	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor
Advanced Power Strip	35.0%	100.0%	73.0%	100.0%	73.0%	100.0%	90.0%	72.5%	90.0%	72.5%
Energy Star Clothes Washers	67.8%	100.0%	100.0%	90.0%	100.0%	90.0%	3.3%	4.4%	3.3%	4.4%
Energy Star Freezers	100.0%	89.9%	100.0%	93.0%	100.0%	93.0%	100.0%	79.6%	100.0%	79.6%
Energy Star Refrigerators	100.0%	89.9%	100.0%	93.0%	100.0%	93.0%	100.0%	79.6%	100.0%	79.6%
Energy Star Room Air Conditioners	14.3%	0.0%	100.0%	0.0%	100.0%	0.0%	--	--	--	--

Reporting Measure Name	New Hampshire		MA 2016 - 2018 TRM		MA 2013-2015 TRM		VT 2017 TRM		VT 2015 TRM	
	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor
Energy Star Room Air Purifier	100.0%	92.0%	--	--	--	--	--	--	--	--
Secondary Freezer Recycling	100.0%	89.9%	100.0%	93.0%	100.0%	93.0%	100.0%	79.6%	100.0%	79.6%
Secondary Refrigerator Recycling	100.0%	89.9%	100.0%	93.0%	100.0%	93.0%	100.0%	79.6%	100.0%	79.6%
Energy Star Air Source Heat Pumps (Cooling, SEER ≥ 15, EER ≥ 12.5)	85.0%	0.0%	29.0%	--	25.0%	--	--	--	--	--
Energy Star Air Source Heat Pumps (Cooling, SEER ≥ 18, EER ≥ 12.5)	85.0%	0.0%	17.0%	--	25.0%	--	--	--	--	--
Energy Star Air Source Heat Pumps (Heating, HSPF ≥ 10)	0.0%	100.0%	--	54.0%	--	50.0%	--	--	--	--
Energy Star Air Source Heat Pumps (Heating, HSPF ≥ 8.5)	0.0%	100.0%	--	31.0%	--	50.0%	--	--	--	--
Energy Star Central AC (3 Ton)	85.0%	0.0%	25.0%	0.0%	25.0%	0.0%	82.9%	0.0%	82.9%	0.0%
Energy Star DMSHP (Cooling, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	85.0%	0.0%	7.0%	--	25.0%	--	3.8%	--	4.9%	--
Energy Star DMSHP (Cooling, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	85.0%	0.0%	7.0%	--	25.0%	--	3.8%	--	4.9%	--
Energy Star DMSHP (Heating, HSPF ≥ 10, SEER ≥ 18, EER ≥ 12.5)	0.0%	100.0%	--	50.0%	--	50.0%	--	36.9%	--	100.0%
Energy Star DMSHP (Heating, HSPF ≥ 8.5, SEER ≥ 15, EER ≥ 12.5)	0.0%	100.0%	--	50.0%	--	50.0%	--	36.9%	--	100.0%
Energy Star Ductless AC (Cooling only)	85.0%	0.0%	--	--	--	--	--	--	--	--
Heat Pump Water Heater 50 Gallon Electric, EF ≥ 2.3	67.8%	100.0%	47.0%	100.0%	47.0%	100.0%	20.3%	40.1%	--	--
Heat Pump Water Heater 80 Gallon Electric, EF ≥ 2.3	67.8%	100.0%	47.0%	100.0%	47.0%	100.0%	20.3%	40.1%	--	--
Wi-Fi Enabled Thermostats for Air Conditioners	100.0%	100.0%	100.0%	--	--	--	--	--	--	--
Wi-Fi Enabled Thermostats for Ductless Heat Pump Minisplit	100.0%	100.0%	100.0%	--	--	--	6.0%	45.4%	--	--

Table 153. Comparison of Coincidence Factors for Gas Non-Lighting Measures

Reporting Measure Name	New Hampshire		MA 2016 - 2018 TRM		MA 2013-2015 TRM		VT 2017 TRM		VT 2015 TRM	
	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor	ISO-NE Summer Capacity Factor	ISO-NE Winter Capacity Factor
Furnace ≥ 95% AFUE w/ECM	0.0%	16.0%	0.0%	16.0%	0.0%	16.0%	0.0%	45.4%	0.0%	45.4%
Furnace ≥ 97% AFUE w/ECM	0.0%	16.0%	0.0%	16.0%	0.0%	16.0%	0.0%	45.4%	0.0%	45.4%
Heat Recovery Ventilator	0.3%	100.0%	0.0%	100.0%	0.0%	100.0%	--	--	--	--
Thermostat: Wi-Fi (Cooling & Heating)	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	11.9%	8.4%	--	--
Thermostat: Wi-Fi (Heating Only)	0.0%	0.0%	--	--	--	--	--	8.4%	--	--

Appendix G. New Hampshire ENERGY STAR Products Program 2016 Participant Survey

Research Objectives
Measure verification (regarding measure installation, retention, removal)
Awareness (how participants learned of the program, best medium for outreach)
Program satisfaction (with the program, measure performance, utility, and contractors)
Program challenges (with program processes, suggested improvements)
Participant decision-making (participation reasons)
Participant profiles (demographics, energy behaviors)
Home and equipment specifications (e.g., occupancy, home size and age, informing input savings assumptions analysis)

A. Email Invitation

Initial Invitation:

Subject: “[UTILITY] would like to hear about your New Hampshire ENERGY STAR Products Program experience!”

Dear [FIRSTNAME],

[UTILITY] is conducting a survey among their residential customers who participated in the New Hampshire ENERGY STAR Products Program in 2016 by purchasing an ENERGY STAR appliance, thermostat, lighting, or HVAC equipment for which they received a rebate or a discount. You have been randomly selected from this group as a potential voluntary participant in the survey.

Cadmus, an independent energy evaluation firm, is conducting this survey on behalf of [UTILITY]. We would like to learn more about your experience with the New Hampshire ENERGY STAR Products Program. Your input is very important to us and will be kept strictly confidential. Your feedback will help us improve our energy efficiency programs for customers like you.

Please take a moment to answer a few short questions about the New Hampshire ENERGY STAR Products Program (NHSaves) in an online survey. The survey will take most people less than 10 minutes to complete. To thank you, we would like to give you a \$5 gift card that can be used at a wide variety of vendors.

[Click HERE to take the survey](#)

Or copy and paste the URL below into your internet browser:

[\[INWIN survey link\]](#)

If you have any questions about this research, or any difficulties taking the survey please contact Robert McCormack at The Cadmus Group, the national research firm conducting this survey on our behalf. You can reach Robert McCormack at (303) 389-2528 or Robert.McCormack@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

Regards,

[\[XXX Utility Contact\]](#)

Reminder Invitation:

Subject: "Don't forget to tell us about your New Hampshire ENERGY STAR Products Program experience!"

Dear [\[FIRST AND LAST NAME\]](#),

Recently, we sent you an email inviting you to participate in a survey about your experience with the New Hampshire ENERGY STAR Products Program (NHSaves). If you've already completed this survey, thank you! If not, we would still like to hear from you. Your input is very important to us, will be kept strictly confidential, and used only to improve [\[UTILITY\]](#)'s programs for customers like you.

Please take a moment to answer a few short questions about your participation in the program. This online survey will take most people less than 10 minutes to complete. To thank you, we would like to give you a \$5 gift card that can be used at a wide variety of vendors.

[Click HERE to take the survey](#)

Or copy and paste the URL below into your internet browser:

[\[INWIN survey link\]](#)

If you have any questions about this research, or any difficulties taking the survey please contact Robert McCormack at The Cadmus Group, the national research firm conducting this survey. You can reach Robert McCormack at (303) 389-2528 or Robert.McCormack@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

Sincerely,

[\[XXX Utility Contact\]](#)

SAMPLE FIELDS

[FIRST AND LAST NAME]: Customer name

[UTILITY]: Utility Name

[MEAS]: The measure (or measures, up to 3) the customer received, per the program tracking data QTY_ Quantity listed in the program tracking data specific to each measure

[ADDRESS] : Address where the equipment was installed

[LED_QTY] LED bulbs and fixtures

[CFL_QTY] CFL bulbs and fixtures

[CWS_QTY] Clothes washer/s

[CDS_QTY] Clothes dryer/s

[RAC_QTY]: Room air conditioner/s

[REF_QTY]: Refrigerator/s

[FRE_QTY]: Freezer/s

[DEH_QTY]: Dehumidifier/s

[RRR_QTY]: Refrigerator and/or Freezer Recycling

[ACR_QTY]: Room Air Conditioner Recycling

[CAC_QTY]: Central Air Conditioner

[DAC_QTY]: Ductless Air Conditioner

[AHP_QTY]: Air Source Heat Pump

[DHP_QTY]: Ductless Heat Pump

[WTH_QTY]: Wi-Fi Enabled Thermostat

[PTH_QTY]: Programmable Thermostat

[BOI_QTY]: Boiler

[FUR_QTY]: Furnace

[HRV_QTY]: Heat Recovery Ventilator

[PHW_QTY]: Heat Pump Water Heater

[BHW_QTY]: Water Heater Integrated with Boiler

[THW_QTY]: Tankless Water Heater

[CHW_QTY]: Condensing Water Heater

[SHW_QTY]: Storage Tank Water Heater

[SPS_QTY] Smartstrip Power Strips

[AR_ONLY] Customer only participated in appliance recycling component (i.e., no other measures)

B. Survey Introduction

Survey Introduction:

Welcome! Thank you for participating in the New Hampshire ENERGY STAR Products Program. Your feedback is very important to us and will help us improve our programs for customers like you. Your responses are confidential and will be used for research purposes only.

Open drop down menus by clicking on this icon  within the survey.

Click on the "Next" and "Back" buttons at the bottom of each page to navigate through the survey.

C. Measure Installation

C1. **[IF AR_ONLY = 1]** Our records indicate you recycled **IF [RRR_QTY] > 0 [RRR_QTY]** refrigerator and/or freezer **IF [ACR_QTY] > 0 IF [RRR_QTY] > 0 AND [ACR_QTY] > 0** and **[ACR_QTY]** room air conditioner.

[IF AR_ONLY = 0] Our records indicate you purchased **[MEAS]** with a rebate or in-store discount from the New Hampshire ENERGY STAR Products Program in 2016 **IF [ACR_QTY] > 0 OR**

[RRR_QTY] > 0 and recycled **IF [RRR_QTY] > 0 [RRR_QTY]** refrigerator and/or freezer **IF [ACR_QTY] > 0 IF [RRR_QTY] > 0 AND [ACR_QTY] > 0** and **[ACR_QTY]** room air conditioner. Is this correct?

- Yes **[PROCEED TO C3]**
- No **[PROCEED TO C2]**
- Not Sure **[PROCEED TO C2]**

[If C1= Not Sure]

C2. Are you sure you did not participate in the New Hampshire ENERGY STAR Products Program in 2016?

- Yes, I participated in the program [Proceed to C3]
- No, I did not participate in the program [Proceed to 'Terminate']
- Not Sure [Proceed to 'Terminate']

['TERMINATE' REDIRECT PAGE] You indicated that you did not participating in the New Hampshire ENERGY STAR Products Program in 2016. Unfortunately, you are not eligible for this survey. Thank you for your time.

- C3. **SKIP IF [IF AR_ONLY = 1]** Our records indicate you purchased [MEAS_QTY] with an incentive from the New Hampshire ENERGY STAR Products Program in 2016. Is this the correct quantity?
- Yes, this is the correct quantity
 - No, I purchased a different quantity. Please specify quantity: _____
 - Other, Please describe: _____
 - Not Sure

- C4. **IF [ACR_QTY] > 0 OR [RRR_QTY] > 0** Our records indicate you recycled [MEAS_QTY] with an incentive from the New Hampshire ENERGY STAR Products Program in 2016. Is this the correct quantity?
- Yes, this is the correct quantity
 - No, I purchased a different quantity. Please specify quantity: _____
 - Other, Please describe: _____
 - Not Sure

- C5. **SKIP IF [IF AR_ONLY = 1]** Is the [MEAS] currently installed in your home? **[IF V_[MEAS]_QTY > 1]**
Are all V_[MEAS]_QTY of the [MEAS] currently installed?
- Yes, all [MEAS_QTY] are installed
 - No
 - I am no longer living in that home
 - Not Sure

[ASK IF C5= NO]

- C6. How many of the V_[MEAS]_QTY of the [MEAS] you purchased at that time are installed today?
- Please enter a number of amount currently installed _____ (Numeric, open end)
 - Not Sure

[ASK IF C5 = NO]

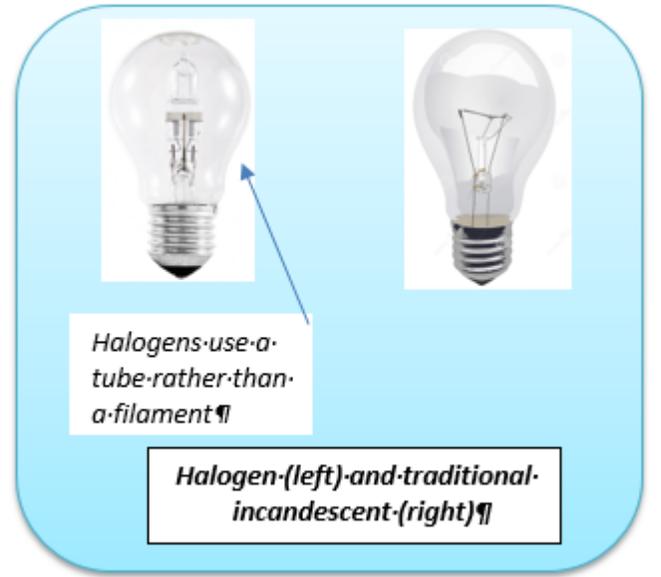
- C7. Why are some of the [MEAS] not installed in your home?
- I am storing the [MEAS]/s for later use
 - The [MEAS]/s stopped working
 - I gave the [MEAS]/s away
 - [OPEN ENDED, WRITE RESPONSE]
 - Not Sure

[ASK IF MEAS = LED, MEAS=CFL AND C5 = NOE]

- C8. If you removed the light bulb(s), what type of light bulb did you replace [IT/THEM] with, if any?
(Please see images for reference if needed)
- Did not remove any bulbs
 - The socket is currently empty
 - CFL lightbulb
 - LED lightbulb

CADMUS

- Halogen lightbulb
- Regular incandescent light bulb
- Other, Please Specify: _____
- Not Sure



D. Program Process

D1. What were the two most important reasons you decided to participate in the New Hampshire ENERGY STAR Products Program with [MEAS] in 2016? **PLEASE SELECT UP TO TWO RESPONSES**
[RANDOMIZE ORDER]

- Make home more comfortable
- Reduce my utility bill, save money
- Not waste energy, stop wasting energy
- Take advantage of **[UTILITY]** rebates or incentives
- Equipment no longer worked and needed to be replaced
- Take advantage of contractor or manufacturer incentives
- Maintain my home or fix an issue that might cause damage
- Reduce the amount I am spending on maintaining equipment
- Make home healthier for my family
- Increase home value
- Reduce my impact on the environment
- Improve lighting quality in home
- Get rid of an older refrigerator, freezer or room air conditioner
- Other (Please describe)_____
- Don't know

[Ask if MEAS does not = LED, CFL, ACR, RRR]

D2. Did you replace non-working equipment? (Multiple responses allowed)

- Yes, old equipment was not working
- No, old equipment was working.
- No, I did not replace existing equipment (this is a new home or new system), which equipment is new_____
- Don't know

D3. Have you noticed a reduction in your energy bill since you installed the **[MEAS]**?

- Yes
- No
- Don't know

D4. **SKIP IF [IF AR_ONLY = 1]** Have you noticed any other positive impacts resulting from the energy efficiency improvements made to your home?

1. Yes **[ASK D4a]**
2. No
3. (Don't know)
4. (Prefer not to answer)

D4a. What are they? **SELECT ALL THAT APPLY**

- (Greater comfort)
- (Improved safety)
- (Better health)
- (Fewer home electrical issues (e.g., overloaded circuits))
- (Feels like the responsible thing to do)
- (Lower maintenance costs / hassles)
- (Improved quality of light)
- (Fewer drafts)
- (Less noise)
- Any others, Please Specify _____

D5. On a scale of 1 to 5, where 1 is extremely burdensome and 5 is extremely easy, how would you rate the following aspects of the application process?

1. Completing the application form
2. Obtaining the supporting documentation required for the rebate (for example, a copy of your sales receipt)
3. Submitting the application form
4. Submitting the supporting documentation
5. Waiting for the rebate to arrive in the mail

Not Applicable	Extremely difficult 1	2	3	4	Extremely easy 5	Don't know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

D6. On a scale of 1 to 5, where 1 is unacceptable and 5 is outstanding, how would you rate the length of time it took to receive the rebate?

Not Applicable	Unacceptable 1	2	3	4	Outstanding 5	Don't know
<input type="radio"/>						

D7. **SKIP IF [IF AR_ONLY = 1]** Who installed your **[MEAS]**? (please check only one)

- Contractor/professional (1)
- I or someone in my household installed it (2)
- Contractor installed some and I did some myself (3)

[IF D7=1 OR 3]

D8. How did you identify which contractor or service provider to work with on this project? (Select all

that apply) **[RANDOMIZE]**

- Previous/ongoing experience with contractor
- Internet search, website, online ad
- Referral from friend/family/neighbor
- Referral from another contractor or service provider
- Promotion or advertising (for example, coupon book)
- Retailer/store promotion or advertising (for example, a sign in a store)
- Yellow pages/phone book search
- My utility recommended them
- Other [SPECIFY]
- Don't know

D9. **SKIP IF [IF AR_ONLY = 1]** On a scale of 1 to 5, where 1 is unacceptable and 5 is outstanding, how would you rate the following?

1. The performance of the product(s) you purchased
2. **[If (1) or (3) in D7]** Your satisfaction with the contractor(s) you worked with

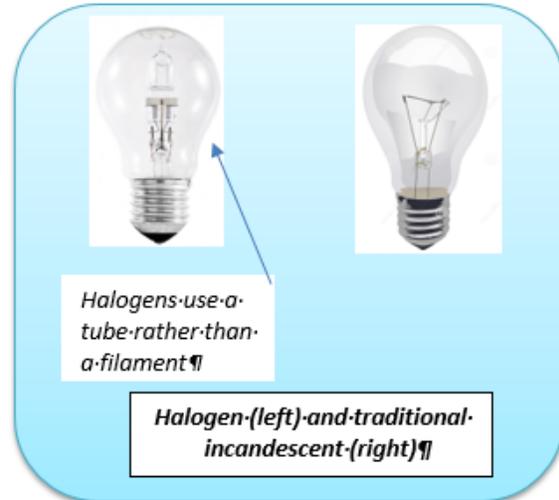
Unacceptable 1	2	3	4	Outstanding 5	Don't know
<input type="radio"/>					

E. Lighting Purchases

[DO NOT ASK IF MEAS=LED]

E1. Have you ever purchased an LED bulb? **PLEASE CHECK ONE**

- Yes
- No **[SKIP TO QUESTION ERROR! REFERENCE SOURCE NOT FOUND.]**
- Don't know **[SKIP TO QUESTION E5]**



[IF Error! Reference source not found.= Yes OR MEAS=LED]

- E2. Were all the LEDs you purchased shaped like light bulbs for standard fixtures (lamps and overheads), or were some “directional” (flood or spot lights or for recessed fixtures), or globe or candle shaped?
- 1. All were shaped like regular light bulbs / fit into a regular lighting socket **[SKIP TO Question Error! Reference source not found.]**
 - 2. Some or all were shaped differently / fit into a different kind of lighting socket
 - 98. Don't Know
- E3. From which store, or stores, do you typically purchase screw-in light bulbs? **PLEASE SELECT ALL THAT APPLY**
- (Ace Hardware)
 - (Aubuchon Hardware)
 - (Batteries Plus)
 - (Best Buy)
 - (Costco)
 - (Do it Best)
 - (Dollar Tree)
 - (Goodwill)
 - (Grocery Outlet)
 - (Lowe's)
 - (Sam's Club)
 - (Sears)
 - (Target)
 - (The Home Depot)
 - (True Value)
 - (Walmart)
 - (Super Market or Grocery Store)
 - (Online, [Specify_____])
 - (Other, [SPECIFY:_____])
 - (Don't know)
 - (Prefer not to answer)

E4. **[ASK IF MEAS=LED OR E1 = "YES"]** How satisfied have you been with the LEDs you have installed in your home? **PLEASE CHECK ONE**

- Very satisfied
- Somewhat satisfied
- Not too satisfied
- Not at all satisfied
- Too early to tell
- Haven't installed any

Why do you say that? Please specify: _____

E5. Are you aware that your NH electric utility provides discounts on energy-saving LED light bulbs sold at local stores and through the NH Saves online marketplace? **PLEASE CHECK ALL THAT APPLY**

- Yes, I am aware of utility-provided discounts at local stores
- Yes, I am aware of the NHSaves® online marketplace
- I knew there were discounts, but I didn't know they were sponsored by my utility **[SKIP TO Question E7]**
- No, I was not aware **[SKIP TO Question E7]**

E6. Where did you hear about the discounts? **PLEASE CHECK ONE**

- Utility Website
- NHSaves® Website
- Home Energy Audit
- Advertising
- Television ad
- Radio ad
- Utility bill insert
- General utility communications
- Signage at a store
- Salesperson at a store
- Friend, neighbor, or family member
- Other, Please specify where: _____
- Don't know

E7. **[ASK IF E5 = 1]** Have you purchased any LED bulbs in retail stores discounted by your utility?

PLEASE CHECK ONE

- Yes
- No [SKIP TO Question E9]
- Not sure [SKIP TO Question E9]

E8. **[ASK IF E7= 1]** How influential was the discounted price on your decision to purchase an LED bulb instead of a less efficient bulb? **PLEASE CHECK ONE**

- very influential
- somewhat influential
- not very influential
- not at all influential

E9. Please put a **1** next to the quality you consider most important when you buy a new light bulb, put a **2** next the quality you consider second most important when you buy a new light bulb. **PLEASE SELECT ONLY THE TWO MOST IMPORTANT FACTORS.**

- _____ Purchase Price
- _____ Total costs including purchase price and electricity costs to use
- _____ Brightness/color
- _____ The look or appearance of the bulb
- _____ Energy savings
- _____ Environmentally friendly
- _____ Other, Please Specify: _____

If you needed to replace a typical light bulb in your home today, how likely are you to install an LED? PLEASE CHECK ONE 1 (Would definitely not install an LED)	2	3 (Might install an LED)	4	5 (Would definitely install an LED)	Don't know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

[ASK IF E7=YES]

E10. **ASK IF [LED_QTY] > 0** Did you purchase bulbs in 2016 online from the NHSaves Online Marketplace?

- Yes
- No **[SKIP TO F1**
- Don't Know **[SKIP TO F1**
- Prefer not to answer **[SKIP TO F1** [ASK IF E10=Yes]

E11. What motivated you to purchase these LEDs from the NHSaves/**[UTILITY]** Online Marketplace?
[RANDOMIZE] Please select one:

- Convenience of buying online
- Trust in buying them through NHSaves /**[UTILITY]**
- Low prices
- I was buying something else at the same time
- Other reason. Please record _____
- (Don't know)

[ASK IF E10=YES]

E12. How did you find out about NHSaves Online Marketplace? **PLEASE SELECT ALL THAT APPLY.**

- Utility email
- NHSaves website
- Found via search engine
- Saw marketing materials online
- Saw a social media post (Twitter, Facebook, Nextdoor)
- Read about it in my utility bill
- Discount was advertised in newspaper/TV/radio
- Retail store employee made me aware of the online marketplace
- Saw a retail lighting demonstration
- Friend or family
- Other, Please Record: _____
- Don't know

E13. How often do you shop online, in general?

- I do all of my shopping online
- I do most of my shopping online
- I do some shopping online
- I don't regularly shop online
- Not sure

F. Demographics

We ask the following questions to help us understand how energy use varies among customers. If you do not wish to answer any particular question, simply leave it blank and move on to the next question in the survey.

F1. **Including yourself**, how many individuals normally live in your home? (*Do not include anyone who is just visiting, those away in the military, or children who are away at college.*)

Please Record: _____

F2. What is the approximate square footage of your home? **PLEASE INCLUDE ONLY HEATED LIVING SPACE. PLEASE CHECK ONE.**

- Less than 1000 sq. ft.
- 1,000 – 1,499
- 1,500 – 1,999
- 2,000 – 2,499
- 2,500 – 2,999
- 3,000 sq. ft. or larger

F3. What year was your home built? (estimates are fine)

- Input number
- Don't know

F4. How many people, including yourself, live in the household full time? (Select one)

- One
- Two
- Three
- Four
- Five
- Six
- Seven or more
- Prefer not to answer

F5. What is your annual household income?

- Less than \$24,000
- \$24,000 to \$32,999
- \$33,000 to \$41,000
- \$42,000 to \$49,000
- \$50,000 to \$58,000
- \$59,000 to \$66,000
- \$67,000 to \$74,000
- \$75,000 to \$83,000
- \$84,000 to \$99,999
- \$100,000 to \$149,999
- \$150,000 to \$199,999
- \$200,000 or more
- Prefer not to answer

F6. Do you own or rent your home? **PLEASE CHECK ONE**

- Own
- Rent
- Prefer not to answer

F7. Please select the term that most closely describes your home from the following list:

- Single family detached home
- An apartment or condo in a 2-4 unit building
- An apartment or condo in a building with 5 or more units
- Other; Specify _____
- Prefer not to answer

[ASK IF F6=Rent]

F8. Do you pay the electric bill or does your landlord? **PLEASE CHECK ONE**

- I pay the electric bill
- My landlord pays the electric bill
- Prefer not to answer

F9. What type of fuel do you use primarily to heat your home? **PLEASE CHECK ONE**

- Natural gas
- Bottled, tank or LP ("propane") gas
- Electricity
- Home heating oil
- Kerosene
- Coal (coke)
- Wood pellets
- Cord wood
- Solar
- Other, Please specify _____
- Prefer not to answer

F10. Do you have a secondary home heating source?

- No
- Yes, Please Specify what it is: _____

a) Please specify the space it heats: _____

b) How often is your secondary heat used during the heating season: _____

- If cord wood, how many cords do you burn annually: _____
- If pellets, how many tons do you burn annually: _____
- Don't Know
- Prefer not to answer

F11. What type of fuel do you use to heat water in your home? **PLEASE CHECK ONE**

- Natural gas
- Bottled, tank or LP ("propane") gas
- Electricity
- Oil
- Kerosene
- Solar

- Other, Please specify _____
- Prefer not to answer

F12. Do you have a ducted Central Air Conditioning System? **PLEASE CHECK ONE**

- Yes
- No
- Prefer not to answer

G. Overall Satisfaction

G1. What are the best ways for your utility to inform you about energy-efficiency offerings? **PLEASE CHECK ALL THAT APPLY**

- Community events
- Emails
- Rebate form at the store
- Signs/displays at the store
- Salesperson or other store staff
- Retail lighting demonstration/retail store
- Utility website
- NHSaves website
- Other website; Please Specify:

- Social Media post or ad (Facebook, Twitter, Instagram)
- Online ads (Not social media)
- Mailing/direct mail
- Bill insert/information in the mail with my bill
- Newspaper
- TV
- Radio
- Other, Please specify:

G2. Taking everything into consideration, how would you rate your overall experience with the New Hampshire ENERGY STAR Products Program?

Unacceptable 1	2	3	4	Outstanding 5	Don't know
<input type="radio"/>					

G3. Based on your experience with the New Hampshire ENERGY STAR Products Program, how likely would you be to recommend it to a friend?

Extremely unlikely 1	2	3	4	Extremely likely 5	Already did recommend	Don't know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

G4. Which of the following are you likely to start within the next 12 months? **SELECT ALL THAT APPLY**
[RANDOMIZE]

- Install LED bulbs
- Weatherize your home (apply caulking, weather stripping)
- Have your home undergo an energy assessment or audit (to identify energy efficiency opportunities in your home)
- Install insulation (in walls, ceiling/attic, basement/crawl space, etc.)
- Install new windows
- Install a new clothes washer, room air conditioner, or dehumidifier
- Tune-up existing heating or cooling equipment
- Install new heating, cooling, or water heating equipment
- Install a Wi-Fi enabled thermostat
- Dispose of a second refrigerator, freezer, room air conditioner, or dehumidifier
- A kitchen, bath or other remodeling project
- Other [SPECIFY]
- Don't know
- Not planning any additional improvements

G5. Do you have any recommendations to improve the New Hampshire ENERGY STAR Products Program?

Those are all the questions we have. Thank you again for your participation in the New Hampshire ENERGY STAR Products Program.

NH SAVES also offers a variety of other energy efficiency programs that could help you manage your monthly energy bills. For more information on other ways to save please visit <http://www.nhsaves.com/>

Appendix H. New Hampshire ENERGY STAR Lighting Program 2016 In-Home Participant Survey

<p>1. Before today, how familiar were you with LED light bulbs? {Please check one}</p>	Very familiar
	Somewhat familiar
	Not too familiar
	Not at all familiar [SKIP TO Question 13]
<p>2. How did you first become aware of LEDs? {Please check one}</p>	Saw them for sale at a store
	Heard about their benefits at a store
	Through utility communications
	Found out about it on my own
	Learned of them just now
	Other, Please Specify:
<p>3. Have you ever purchased an LED bulb? {Please check one}</p>	Yes
	No [SKIP TO Question 13]
	Don't know [SKIP TO Question 13]
<p>4. Were all of the LEDs you purchased shaped like regular light bulbs, or were some flood lights, recessed bulbs, or globe or candle shaped?</p>	All were shaped like regular light bulbs [SKIP TO Question 6]
	Some or all were shaped differently
<p>5. What other types of LEDs did you purchase?</p>	Candle
	Globe
	Recessed
	Flood/reflector
	Torpedo
	Flat
	Other, Please Specify:
Don't know	
<p>6. Approximately, what was the price of the regularly-shaped LED light bulb that you purchased most recently?</p>	Please specify dollar amount per bulb: \$

<p>7. Where did you buy the LED light bulb that you purchased most recently? {Please check one}</p>	Home Depot
	Lowe's
	Walmart
	Dollar Tree
	Dollar General
	Ace Hardware
	True Value Hardware
	Local Hardware Store
	Supermarket
	NH Saves website
	Other, Please Specify:
<p>8. How satisfied have you been with the LEDs you have installed in your home? {Please check one}</p>	Very satisfied
	Somewhat satisfied
	Not too satisfied
	Not at all satisfied
	Never had one in the house
	Why do you say that? Please specify:
<p>9. In the past two years, have you removed any LED bulbs that you had installed? {Please check one}</p>	Yes
	No [SKIP TO Question 13]
<p>10. How many LED bulbs have you removed in the past two years?</p>	Please provide a number:
<p>11. Why did you remove the LED bulb/s that you had installed? {Please check one}</p>	Burned out
	I didn't like the light
	Other, Please specify:
	Don't know
<p>12. What did you replace the LED bulb/s that you removed with? {Please check one}</p>	Another LED
	CFL
	Halogen
	Traditional incandescent
	Other, Please specify:
	Don't know

<p>13. Are you aware that your utility offers discounts on energy-saving LED light bulbs sold at local stores and through the NH Saves online marketplace? {Please check one}</p>	Yes, I am aware of the discounts at local stores
	Yes, I am aware of the NH Saves online marketplace
	Yes, I am aware of both options for purchase.
	I knew there were discounts, but I didn't know they were sponsored by my utility [SKIP TO Question 15]
	No, I was not aware [SKIP TO Question 15]
<p>14. Where did you hear about the discounts? {Please check one}</p>	Utility Website
	NH Saves Website
	Personal Energy Report
	Energy Audit
	General utility communications
	Signage at a store
	Salesperson at a store
	Friend, neighbor, or family member
	Other, Please specify where:
Don't know	
<p>15. Have you purchased any LED bulbs discounted by your utility? (A typical LED is pictured on the first page on this survey.) {Please check one}</p>	Yes
	No [SKIP TO Question 18]
	Not sure [SKIP TO Question 18]
<p>16. If you have purchased utility discounted LED bulbs, how influential was the price after the utility discount on your decision to purchase an LED bulb instead of incandescent or halogen? {Please check one}</p>	The utility discounted price was very influential
	The utility discounted price was somewhat influential
	The utility discounted price was not very influential
	The utility discounted price was not at all influential
	Why do you say that? Please specify:
<p>17. Are you satisfied with the type of utility discounted LED bulbs offered? {Please check one}</p>	Very satisfied
	Somewhat satisfied
	Not too satisfied
	Not at all satisfied
	Why do you say that? Please specify:

<p>18. Please put a 1 next to the quality you consider most important when you buy a new light bulb, put a 2 next the quality you consider second most important when you buy a new light bulb. Please select only the two most important factors.</p>	Purchase Price
	Total costs including purchase price and electricity costs to use
	Brightness/color
	The look or appearance of the bulb
	Energy savings
	Environmentally friendly
	Other, Please Specify:
<p>19. Have you heard about your utility's programs to help customers save energy? {Please check one}</p>	Yes
	No [SKIP TO Question 21]
	Not sure [SKIP TO Question 21]
<p>20. Since hearing about your utility's programs, have you purchased any energy-efficient products other than light bulbs, for which you did not receive a utility rebate? {Please check one}</p>	Yes, what have you purchased:
	No
	Not sure
<p>21. What are the best ways for your utility to inform you about energy-efficiency offerings like their lighting program? {Check all that apply}</p>	Community event
	Email from your utility
	Rebate form at the store
	Signs/displays at the store
	Salesperson or other store staff
	Retail lighting demonstration/retail store
	Utility website
	Other website; Please Specify:
	Social Media post or ad (Facebook, Twitter, Instagram)
	Online ads (Not social media)
	Mailing/direct mail
	Bill insert/information in the mail with my bill
	Newspaper
	TV
	Radio
Other, Please specify:	
<p>22. If you needed to replace a typical light bulb in your home today, which type of bulb would you purchase? {Please check one}</p>	Halogen; Please share why:
	Compact fluorescent; Please share why:
	LED; Please share why:
	Other, Please Specify:

<p>23. Including yourself, how many individuals normally live in your home? (Do not include anyone who is just visiting, those away in the military, or children who are away at college.)</p>	<p>Please Record:</p>
<p>24. What is the approximate square footage of your home? Please include only heated living space. {Please check one}</p>	<p>Less than 1000 sq. ft.</p>
	<p>1,000 – 1,499</p>
	<p>1,500 – 1,999</p>
	<p>2,000 – 2,499</p>
	<p>2,500 – 2,999</p>
	<p>3,000 sq. ft. or larger</p>
<p>25. Does anyone in your household regularly telecommute or work from home during the day on weekdays? {Please check one}</p>	<p>Yes</p>
	<p>No [SKIP TO Question 27]</p>
<p>26. On average, how many weekdays does someone in your household work from home each week? {Please check one}</p>	<p>1 weekday</p>
	<p>2 weekdays</p>
	<p>3 weekdays</p>
	<p>4 weekdays</p>
	<p>5 weekdays</p>
<p>27. Other than those that work from home or telecommute, are there any individuals in your home that regularly stay at home all or most weekdays? {Please check one}</p>	<p>Yes</p>
	<p>No</p>
<p>28. Do you own/rent your home? {Please check one}</p>	<p>Own</p>
	<p>Rent</p>
<p>29. If you rent, do you pay the electric bill or does your landlord? {Please check one}</p>	<p>I pay the electric bill</p>
	<p>My landlord pays the electric bill</p>
<p>30. What type of fuel do you use primarily to heat your home? {Please check one}</p>	<p>Natural gas</p>
	<p>Bottled, tank or LP gas</p>
	<p>Electricity</p>
	<p>Oil, kerosene</p>
	<p>Coal (coke)</p>
	<p>Wood</p>
	<p>Solar</p> <p>Other, Please specify</p>
<p>31. Do you have a secondary home heating source?</p>	<p>No</p>
	<p>Yes, Please specify what it is:</p>
	<p>Please specify the space it heats:</p>
	<p>How often is your secondary heat used:</p>
	<p>If wood, how many cords do you burn annually:</p> <p>Don't Know:</p>

31. What type of fuel do you use to heat water in your home? {Please check one}	Bottled, tank or LP gas
	Hydro / Electricity
	Oil, kerosene
	Solar
	Other, Please specify
32. Do you have a ducted Central Air Conditioning System? {Please check one}	Yes
	No