
X1942D Cross-cutting NEI Study – SBEA NEIs

FINAL REPORT

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SUBMITTED TO:
Connecticut Energy Efficiency Board

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Table of Contents

EXECUTIVE SUMMARY.....	1
PURPOSE	1
STUDY GOAL	1
FINDINGS.....	2
RECOMMENDATIONS.....	3
SECTION 1 METHODOLOGY	5
1.1 PARTICIPANT END-USER SURVEYS	5
1.2 IDENTIFYING NEIS	5
1.3 QUANTIFYING NEIS.....	5
SECTION 2 FINDINGS.....	9
2.1 LIGHTING AND LIGHTING CONTROLS	10
2.2 NON-LIGHTING MEASURES.....	12
APPENDIX A DETAILED METHODOLOGY.....	15
A.1 PARTICIPANT END-USER SURVEY.....	15
A.2 NON-ENERGY IMPACTS METHODOLOGY.....	15
APPENDIX B DETAILED RESULTS	16
B.1 PARTICIPANT ANNUAL SAVINGS.....	16
B.2 LMS INPUTS.....	17
B.2.1 LMS Magnitude Scales	17
B.2.2 Overlapping NEI Effects	20
B.2.3 Normalized NEI Effects	20
B.3 ADDITIONAL NEI RESULTS	21

Executive Summary

PURPOSE

As part of the X1942 Non-Energy Impacts (NEIs) study, the NMR study team conducted an analysis to quantify NEIs from lighting and non-lighting program participants who participated in the Small Business Energy Advantage (SBEA) program. This study used web surveys to collect data to quantify NEIs associated with lighting (including lighting controls) and non-lighting measures (heating and cooling, water heating, refrigeration). The analysis applied algorithms used in past studies to establish NEI values for each measure and NEI category. This report, which is part of the larger X1942 study, uses the same methodology described in *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs*¹ and discusses the results from this analysis and presents the NEIs the study was able to quantify.

STUDY GOAL

The goal the X1942C study is to quantify NEIs from lighting (including lighting controls)² and non-lighting measures. This study aims to fill gaps and provide measure-specific NEIs not currently included in the Connecticut PSD or not used in cost effectiveness (C/E) testing but should be used in the appropriate cost-effectiveness tests as allowed now and in the future.³ This study includes the following high priority NEIs listed in [Table 1](#).

Table 1: NEIs by Measure

NEIs	Non-lighting Measures			Lighting Measures	
	Heating & cooling	Water Heating	Refrigeration	Lighting	Lighting Controls
Annual operations and maintenance (O&M) costs	✓	✓	✓	✓	✓
Disruption of business during installation	✓	✓	✓	✓	✓
Employee productivity and sales output	✓		✓	✓	✓
Change in humidity or dampness and mold in your business	✓				
Comfort during the summer	✓				
Comfort during the winter	✓				
Equipment noise	✓				

¹ NMR Group, Inc. 2023. *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs*. For the Connecticut Energy Efficiency Board, Eversource, and United Illuminated. (In Progress)

² Types of lighting controls installed through the program include integrated controls, occupancy sensors, digital and astronomic timers, daylight sensors, and emergency lighting.

³ The Companies currently quantify and claim several NEIs for HES-IE only in the CTET and TRC Test: costs associated with “arrearsages, debt write-off costs, or administrative costs”. See Appendix A of the [2023 PSD](#).

NEIs	Non-lighting Measures			Lighting Measures	
	Heating & cooling	Water Heating	Refrigeration	Lighting	Lighting Controls
Tenant satisfaction with comfort; tenant complaints about comfort	✓				
Equipment footprint		✓	✓		
Water and sewer cost		✓			
Equipment performance		✓			
Tenant satisfaction with hot water; tenant complaints about hot water		✓			
Food spoilage			✓		
Quality/quantity of the lighting provided by the new lighting or lighting controls equipment				✓	✓
Tenant satisfaction with lighting; tenant complaints about lighting				✓	✓
Complex lighting system operations					✓
Space flexibility					✓

✓ = NEI included in survey with results reported; ✓ = NEI included in survey but results not reported due to lack of responses

FINDINGS

Table 1 presents the NEIs that the study was able to quantify using information from end-user surveys. Currently, none of these NEIs are included in Appendix Six (Non-Energy Impacts) in Connecticut’s 2022 Program Savings Document (PSD) for the SBEA program. Appendix Six does include NEIs for the Business & Energy Sustainability programs, but these are only for informational purposes and the NEIs are not included in any B/C tests.⁴ The NEI values presented in [Table 2](#) and [Table 3](#) are annual values per kWh specific for lighting and the SBEA program, which are expected to last through the life of the measures.

Participants who received incentives for lighting and non-lighting measures through the program experienced positive net impacts from the program. For most of the NEIs studied, the NEIs were net positive as shown in [Table 2](#). Lighting and lighting controls had a net average annual value of \$0.158/kWh (49% of the value of their expected energy savings).⁵ Lighting and non-lighting measures make up the overall program value of \$0.150/kWh or 54% of the value of their expected energy savings.

Disruption of business during installation was the only net negative NEI identified in the study. Respondents valued disruption of business during installation at \$-0.002/kWh for lighting and lighting controls, as shown in [Table 3](#).

⁴ See Appendix 6 of the [2022 PSD](#).

⁵ Bill savings are based off retail energy prices and not wholesale.

This study also provides individual NEI values for non-lighting measures in the main body of the report but only recommends their use for informational and planning purposes only due to small sample sizes.

For benchmarking purposes, this study referenced the Massachusetts Technical Resource Manual (TRM)⁶ which reports the NEI values associated with C&I measures. Overall, the NEI values in this study trend higher than those reported in the MA TRM. Table 12 in Appendix B.3 provides the comparison of the C&I NEIs in more detail.

RECOMMENDATIONS

Recommendation 1: SBEA participant NEIs for lighting, lighting controls, and overall program should be used in future planning, marketing efforts, and to estimate return on investments for businesses. Commercial NEIs are not currently included in UCT and MUCT B/C analysis testing. These NEI values should be considered for inclusion in the PSD should there be future changes to cost-effectiveness testing that allows for the inclusion of commercial NEIs in the MUCT.

Table 2: Summary of Monetized NEIs and Percent of Measure Savings ^{1,2,3}
(Annual NEI Dollar Per kWh for Participants that Installed the Measure)

Measure	n	NEI Value (\$/kWh)	Percent of Measure Savings ³
Lighting and lighting controls	72	\$0.158 (\$0.135, \$0.180)	49% (43%, 55%)
Lighting only	60	\$0.144 (\$0.121, \$0.167)	
Lighting controls only	36	\$0.011 (\$0.005, \$0.017)	
All measures (Program) ⁴	103	\$0.150 (\$0.132, \$0.169)	54% (47%, 60%)

¹ NEIs are for participants who received incentives for lighting, lighting controls, heating and cooling equipment, water heating equipment, and refrigeration measures through the SBEA program. NEI values are in 2020 dollars for consistency with other study chapters. Table 11 in Appendix B.3 reports detailed results by measure and NEI dollar value by unit and kWh.

² 90% confidence intervals in parentheses

³ Positive or negative impacts as a percentage of expected measure savings.

⁴ Program measures include lighting, lighting controls, heating and cooling equipment, water heating equipment, and refrigeration measures.

⁶ Massachusetts Electric and Gas Energy Efficiency Program Administrators. 2023. *Massachusetts TRM 2023 Plan Version*. <https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202023%20Plan%20-%20010323.pdf> Appendix B. <https://api-plus.anbetrack.com/etrm-gateway/etrm/api/v1/etrm/documents/63b4ada052e03925d3412295/view?authToken=e3b8925034aede1d18be0cf5b83eb9c3dd6353c4192e6a7a1b60f8c9285aaffc0f60c5bd650cdd4e351f0d720caa31515526737f6abfce8e7a5001cdb00a736e4abb248183d2f>

Table 3: Summary of Monetized NEIs for Lighting and/or Lighting Controls ^{1,2}
 (Annual NEI Dollar Per kWh for Participants that Installed the Measure)

NEI	Lighting Only (n=60)	Lighting Controls Only (n=36)	Lighting and Lighting Controls (n=72)
Annual O&M costs	\$0.024	\$0.002	\$0.028
Disruption of business during installation	\$-0.002	\$-0.0001	\$-0.002
Employee productivity and sales output	\$0.029	\$0.001	\$0.028
Quality/quantity of the lighting	\$0.092	\$0.008	\$0.093
Tenant satisfaction with lighting (n=2)	\$0.113	\$0.001	\$0.078
Complex lighting system operations (n=36)	NA	\$0.0001	\$0.011
Space flexibility (n=36)	NA	\$0.0003	\$0.008
Total Value	\$0.144 (\$0.121, \$0.167)	\$0.011 (\$0.005, \$0.017)	\$0.158 (\$0.135, \$0.180)

¹ NEIs are for participants who received incentives for lighting and/or lighting controls through the program.

² Table 5 reports the monetized NEI results of this study with 90% confidence intervals.

Section 1 Methodology

1.1 PARTICIPANT END-USER SURVEYS

This study conducted primary data collection via web surveys from SBEA program participant end-users to quantify NEIs associated with lighting, lighting controls, and non-lighting (heating and cooling, water heating, refrigeration) measures in Connecticut from 2019 to 2021. See [Appendix A.1](#) for additional details on the methodology and the targets and achieved completes for this research task.

1.2 IDENTIFYING NEIS

This study identified specific NEIs to be quantified for lighting, lighting controls,⁷ and non-lighting measure scenarios. NEIs for these measures have been studied in the past and there exists well established literature for C&I NEI. Some of the literature used to identify NEIs for the study include:

- Skumatz, Lisa A. 2015. Estimating Participant Non-Energy Benefits For Households and Businesses: SERA Approach
- Apprise. 2018. [CT Non-Energy Impacts Literature Review \(R1709\)](#)
- DNV KEMA / TetraTech. 2012. [Commercial and Industrial Non-Energy Impacts Study](#)

[Table 4](#) describes the rationale for the NEIs identified in this study.

1.3 QUANTIFYING NEIS

This study uses a contingent valuation approach where respondents are asked to place a value on the NEIs they experience using a labeled magnitude scale (LMS) on non-energy related impacts (relative valuations). To develop NEI values, the web survey asked survey respondents if the installation had a positive, negative, or no effect on various non-energy related elements in their businesses or properties.

For any elements where respondents observed positive or negative impacts as a result of the program, the survey asked respondents to explain *how* the measures had positive or negative impacts on the NEIs. The survey also asked them to compare the value of that NEI to the energy savings associated with their participation in the SBEA program. The survey also asked respondents to identify overlapping NEIs to avoid double counting NEI benefits. Furthermore, the survey asked the respondents to consider the net impacts of the NEIs combined. The analysis used these inputs to adjust for NEI overlap and estimate NEI dollar values. For more a detailed description of the methodology used to calculate NEI values, see [Appendix A.2.1 in X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs](#). This study further normalizes the NEI dollar values by respondent measure-specific savings to obtain annual dollars per kWh.

⁷ Types of lighting controls installed through the program include integrated controls, occupancy sensors, dimmers, digital and astronomic timers, daylight sensors, and emergency lighting.

Survey respondents were presented with information about their estimated savings at the start of the survey. The survey asked respondents to confirm the estimate of their energy bill savings associated with the measure installations or indicate whether their bill savings were higher or lower. Most respondents were able to either confirm their bill savings (49%) or provide a revised savings value (15%). This suggests that what the bill savings values respondents were thinking when answering the NEI LMS questions were close in value to the bill savings calculated from program-reported savings.

Table 4: NEI Rationale

NEI	Heating & cooling	Water heating	Refrigeration	Lighting	Lighting Controls	Rationale
Annual operations and maintenance (O&M) costs	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> • Adding new measures can reduce operation, maintenance, and repair costs. Lighting controls can prolong the lifespan of lighting as lights in less occupied spaces can be scheduled to turn on or off or with occupancy sensors. • Retiring a refrigeration system, space heating system, or water heater before it fails can allow the business to avoid some maintenances costs.
Disruption of business during installation	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> • Installation of measures can cause disruptions to a business' operations which can cost the business in sales or reduce productivity.
Employee productivity and sales output	✓		✓	✓	✓	<ul style="list-style-type: none"> • Replacing old measures with new can improve performance and increase employee productivity. Better lighting can attract more customers, which increases sales output. Consistent refrigeration can reduce product spoilage (food, flowers, medication, etc.) and maximize freshness.
Change in humidity or dampness and mold	✓					<ul style="list-style-type: none"> • Replacing old heating or cooling systems with newer systems can improve humidity or dampness which can cause mold.
Comfort during the summer and winter	✓					<ul style="list-style-type: none"> • Replacing old heating or cooling systems with newer systems can provide additional cooling/heating-related comfort by producing a more evenly distributed source of heat for a cooler/warmer home.
Equipment noise	✓					<ul style="list-style-type: none"> • Newer systems can run more efficiently and can be quieter compared to older systems or systems near the end of their life.
Tenant satisfaction lighting/ lighting controls				✓	✓	<ul style="list-style-type: none"> • Improving the atmosphere with better lighting can improve tenant satisfaction.

NEI	Heating & cooling	Water heating	Refrigeration	Lighting	Lighting Controls	Rationale
Equipment footprint		✓	✓			<ul style="list-style-type: none"> Replacing water heaters or refrigeration with a smaller unit with the same performance as the existing system can free up space. Alternatively, adding a system with a larger footprint can take up more space.
Water and sewer cost		✓				<ul style="list-style-type: none"> Improvements in water heating can reduce water and sewer costs.
Equipment performance		✓				<ul style="list-style-type: none"> A new water heater can heat water faster and more consistently.
Food spoilage			✓			<ul style="list-style-type: none"> Refrigeration measures can provide more reliable and consistent refrigeration, resulting in less food spoilage.
Quality and quantity of lighting				✓	✓	<ul style="list-style-type: none"> Replacing old lighting can improve quality such as reducing flickering and other inconsistencies. Adding lighting can also improve visibility. More lighting and brighter lighting can increase the safety of spaces by improving visibility and reducing accidents and crime.
Complex lighting system operations					✓	<ul style="list-style-type: none"> Lighting controls can be complex and may require additional training to operate. Alternatively, lighting systems that are user-friendly can simplify the lighting.
Space flexibility					✓	<ul style="list-style-type: none"> Lighting controls provides the ability to convert space for different uses.

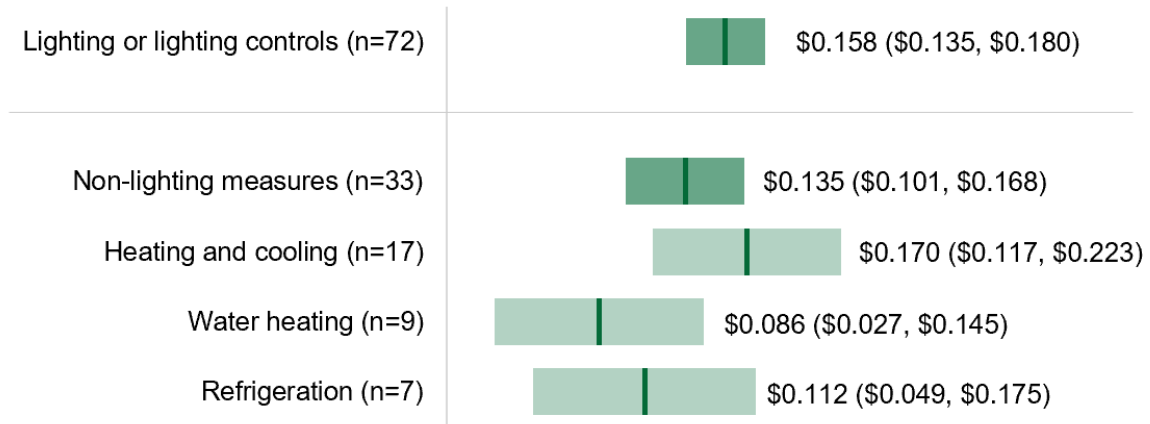
Section 2 Findings

The annual dollar for total NEIs is **\$0.158/kWh for lighting measures** and **\$0.135/kWh for non-lighting measures**. Figure 1 shows the annual dollar per kWh for total NEIs for participants who received incentives for lighting measures, which included lighting and lighting controls, as well as non-lighting measures, which included water heating equipment, heating and cooling equipment, and refrigeration equipment. Respondents valued lighting measures higher (\$0.158/kWh) non-lighting measures (\$0.135/kWh). Among the non-lighting measures, heating and cooling equipment had the highest NEI value (\$0.170/kWh) compared to water heating equipment installations with the lowest NEI value (\$0.086/kWh).

Figure 2 reports value of the NEIs as a percent of measure savings. The total NEI percentage of measure savings for lighting measures is lower (49%) than that of non-lighting measures (64%).

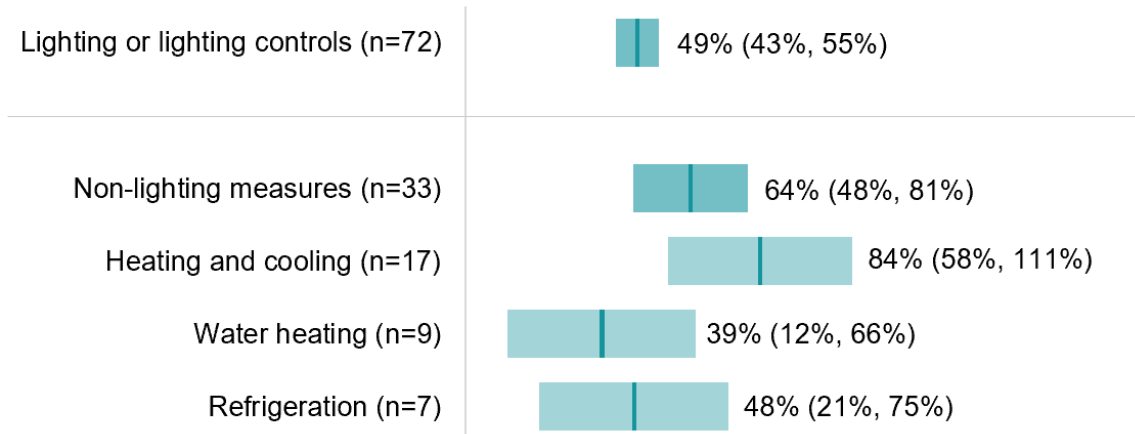
Figure 1: Annual Total NEI Dollar per kWh by Measure

(Annual NEI Dollar Per kWh for Participants that Installed the Measure)



¹ Bars show 90% confidence intervals.

Figure 2: Percent of Measure Savings



¹ Bars show 90% confidence intervals.

2.1 LIGHTING AND LIGHTING CONTROLS

Figure 3 shows the average annual NEI dollar values per kWh for participants who installed lighting and lighting controls. This study also does not distinguish the benefits of lighting quantity with quality. Respondents were often unable to disentangle the benefits of lighting quality from lighting quantity. When asked to describe the effects of the NEIs associated with lighting quality and quantity, respondents mentioned *natural, better, brighter, and more consistent* lighting for lighting quality. For lighting quantity, respondents mentioned *brighter and more lighting*.

On average, the NEI with the highest values is increased quality and quantity of lighting (\$0.093/kWh). Respondents reported increased quantity and quality of lighting improved the atmosphere and attracted new members and customers which boosted sales. Respondents also valued safety due to increased lighting quality and/or quantity. When asked about how lighting improved safety, respondents reported fewer accidents from improved visibility. Other respondents reported additional lighting helped with surveillance and deterred thefts and crime. Employees and customers of the businesses felt safer in better lit spaces that were previously dark or were poorly lit. Better-quality LED lighting also reduces the frequency of having to change burned out lighting, which reduces falls.

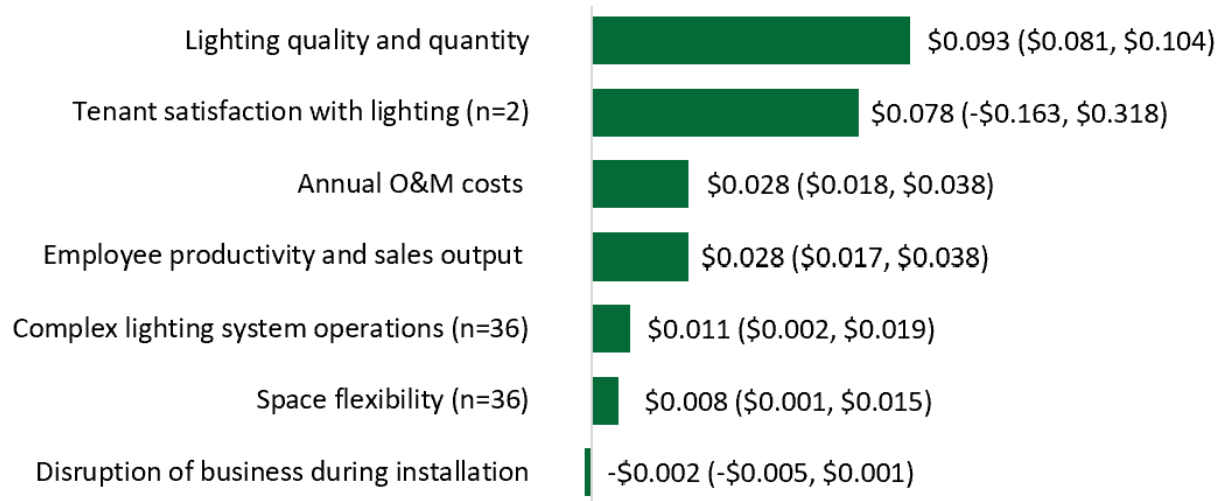
Respondents valued both reduced O&M and employee productivity and sales output from installing lighting through the program at \$0.028/kWh. Respondents indicated that a brighter environment improved productivity as employees were more awake and alert. Another respondent reported improved lighting aided in quality checks of their products. When asked about how the lighting measures affected annual O&M costs, respondents mentioned reduced emergency repair and maintenance costs.

Disruption of business during installation was the only negative NEI covered in this study, and it was valued at \$-0.002. Only one respondent indicated they experienced an impact from the NEIs suggesting weak evidence of the NEI.

Two respondents owned the space where the lighting and lighting controls were installed. These respondents stated they have received positive comments from their tenants and employees and valued the NEI at \$0.078/kWh.

Space flexibility and complex system operations associated with lighting controls were the lowest valued NEIs. Only five respondents indicated they experienced an impact for each NEI, suggesting weaker evidence of the NEIs.

Figure 3: Annual NEI Dollar Per kWh for Lighting and Lighting Controls (n=60) ^{1,2}
 (Dollars per kWh for Participants that Installed Lighting and Lighting Controls)



¹ 90% confidence intervals shown in parentheses

² Complex lighting system operations and space flexibility were only asked of respondents who installed lighting controls

To avoid double counting of NEIs, this study presents combined NEIs for lighting and lighting controls. This study attempted to survey respondents who only installed lighting controls to isolate lighting controls NEIs from lighting NEIs. However, the lighting controls sample was small and 94% of respondents had installed lighting controls with lighting. When asked to explain how the NEI effects resulted from the installation of lighting controls, respondents were often unable to disentangle the NEI effects of lighting from those of the lighting controls.

While the majority of program participants received lighting through the program, lighting controls installation occurred at a lower rate. [Table 5](#) reports the NEI values for lighting-only and lighting controls-only installations. For the measure-specific NEI values, the study split out the combined lighting and lighting controls NEI values by the share of total respondent energy savings associated with the two measures, as reported in [Table 8](#) in [Appendix B.1](#). The study multiplied the combined NEI values by the shares of the total respondent energy savings for lighting (96%) and lighting controls (4%) to get lighting and lighting controls-only values, respectively.

Table 5: Summary of Monetized NEIs for Lighting and/or Lighting Controls ^{1,2}
(Annual NEI Dollar Per kWh for Participants that Installed the Measure)

NEI	Lighting Only (n=60)	Lighting Controls Only (n=36)	Lighting and Lighting Controls (n=72)
Annual O&M costs	\$0.024 (\$0.013, \$0.034)	\$0.002 (\$0.0005, \$0.003)	\$0.028 (\$0.018, \$0.038)
Disruption of business during installation	-\$0.002 (-\$0.006, \$0.001)	-\$0.0001 (-\$0.0004, \$0.0001)	-\$0.002 (-\$0.005, \$0.001)
Employee productivity and sales output	\$0.029 (\$0.017, \$0.040)	\$0.001 (-\$0.0002, \$0.003)	\$0.028 (\$0.017, \$0.038)
Quality/quantity of the lighting	\$0.092 (\$0.079, \$0.105)	\$0.008 (\$0.002, \$0.013)	\$0.093 (\$0.081, \$0.104)
Tenant satisfaction with lighting (n=2)	\$0.113	\$0.001 (-\$0.004, \$0.007)	\$0.078 (-\$0.163, \$0.318)
Complex lighting system operations (n=36)	NA	\$0.0001 (-\$0.000001, \$0.0002)	\$0.011 (\$0.002, \$0.019)
Space flexibility (n=36)	NA	\$0.0003 (-\$0.00004, \$0.0007)	\$0.008 (\$0.001, \$0.015)
Total Value	\$0.144 (\$0.121, \$0.167)	\$0.011 (\$0.005, \$0.017)	\$0.158 (\$0.135, \$0.180)

¹ NEIs are for participants who received incentives for lighting and/or lighting controls through the program.

² 90% confidence intervals in parentheses

2.2 NON-LIGHTING MEASURES

Figure 4, Figure 5, and Figure 6 report the annual dollar values per kWh for program participants that installed heating and cooling equipment, water heating equipment, and refrigeration measures, respectively. Given the small sample of respondents for each measure, the individual NEI results in this section should be used for informational and future study planning purposes only.

Few to no respondents reported experiencing changes to employee productivity and sales output nor to changes to water and sewer costs from water heating. No respondents owned the space where the measures were installed so information on tenant satisfaction with comfort and water heating was not collected.

Heating and cooling. Respondents that installed cooling equipment reported experiencing improved comfort during summer (valued at \$0.050/kWh) as well as reduced humidity and dampness (\$0.016/kWh). Similarly, respondents that replaced heating equipment reported improved comfort during the winter valued at \$0.051/kWh. Both heating and cooling equipment respondents reported reduced equipment noise (\$0.041/kWh).

Few respondents reported experiencing disruptions to their business during installation of their heating and cooling equipment. One respondent said the heating had to be turned off for the installation and the staff had to supplement their heating with space heaters to avoid the cold. On average, respondents valued business disruptions at \$-0.005/kWh.

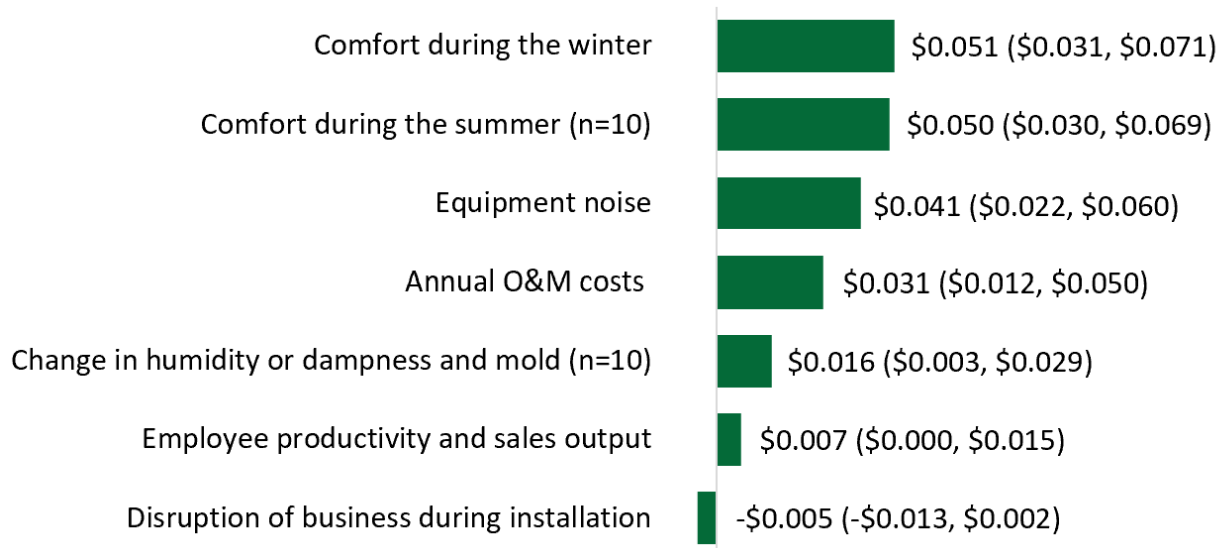
NEI values for heating and cooling have been converted to dollars per kWh for comparison. Table 13 in Appendix B.3 reports NEI values corresponding to electric (\$/kWh) and gas (\$/CCF) savings.

Water heating. Respondents that installed water heating equipment reported experiencing improved equipment performance (valued at \$0.044/kWh) and reduced maintenance costs (\$0.030/kWh) from having to get their water heater serviced. Few respondents had issues with equipment footprint from their water heater prior to program participation. Another respondent mentioned that the smaller footprint of their new water heater allows for more room to move around more easily. Two respondents reported the loss of hot water for several hours during the installation disrupted their business. Respondents did not experience any changes to their water and sewer costs.

NEI values for water heating have been converted to dollars per kWh for comparison. Table 14 in Appendix B.3 reports NEI values corresponding to electric (\$/kWh) and gas (\$/CCF) savings.

Refrigeration. Few respondents installed refrigeration measures. Respondents experienced reduced food spoilage (valued at \$0.034/kWh) and reduced O&M (\$0.066/kWh). One respondent also indicated the improved refrigeration helped retain the freshness of their products longer and reduced O&M costs. Respondents did not report experiencing any disruptions to their business during installation or change in water and sewer costs.

Figure 4: Annual NEI Dollar Per kWh for Heating and Cooling (n=17) ^{1,2}
 (Dollars per kWh for Participants that Installed Heating or Cooling Equipment)

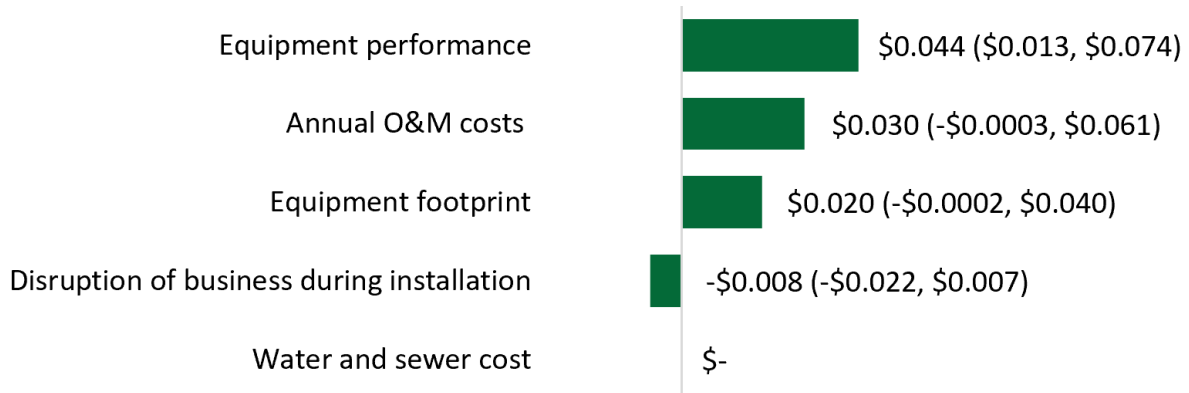


¹ 90% confidence intervals shown in parentheses.

² Comfort during the summer and change in humidity or dampness and mold were only asked of respondents that installed cooling through the program.

Figure 5: Annual NEI Dollar Per kWh for Water Heating (n=9) ¹

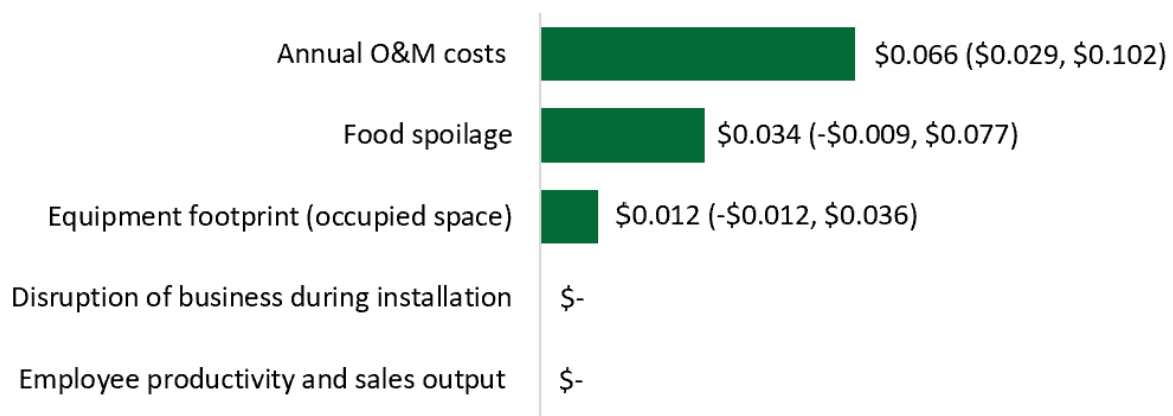
(Dollars per kWh for Participants that Installed Water Heating Equipment)



¹ 90% confidence intervals shown in parentheses.

Figure 6: Annual NEI Dollar Per kWh for Refrigeration (n=7) ¹

(Dollars per kWh for Participants that Installed Refrigeration Equipment)



¹ 90% confidence intervals shown in parentheses.

Appendix A Detailed Methodology

This section describes the SBEA participant end-user survey. For a detailed description of the study methodology, see *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs* Appendix A.2.1.

A.1 PARTICIPANT END-USER SURVEY

The sample frame for the end-user survey included small business program participants who received heating and cooling, water heating, refrigeration, lighting, and light controls incentives from the SBEA program between January 1, 2019, and October 31, 2021.

Recruitment letters were mailed to every potential respondent. Participants with email addresses included in the program tracking data were also sent emails. The letters and emails explained the purpose of the survey and provided contact information for participants to verify the legitimacy of the study and to complete the survey by phone. Respondents were sent a \$100 digital Visa gift card via email after completing the survey. Two reminder emails were sent to participants that did not respond to the survey.

The end-user survey yielded a total of 77 responses. Each respondent was asked to provide NEI responses for up to two measures, resulting in responses for 130 measures (Table 6). The number of responses met the original study quota of 70 responses. The overall response rate was 4%, not accounting for returned recruitment letters.⁸

Table 6: End-user Survey Targets and Completes

Measure Types	Recruitment		Survey results	
	Mailers	Email	Target	Completes
Lighting	1,535	491	30	60
Non-lighting	451	130	70	69
↳ Heating and cooling				17
↳ Water heating				9
↳ Refrigeration				7
↳ Lighting controls				36
Total (n participants)	1,735	529	70+ (up to 100)	77

A.2 NON-ENERGY IMPACTS METHODOLOGY

For a detailed description of the study methodology, see *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs* Appendix A.2.1.

⁸ Response Rate = Responded ÷ Mailed, 77 ÷ 1,735 = 4%

Appendix B Detailed Results

B.1 PARTICIPANT ANNUAL SAVINGS

Table 7 reports the average annual reported gross energy savings of the end-user survey respondents, the adjusted gross energy savings after applying a realization rate, and the corresponding energy bill savings resulting from the adjusted gross energy savings. The study applied realization rates obtained from the C1639: Impact Evaluation of the Connecticut Small Business Energy Advantage (SBEA) Program report to adjust the gross energy savings. After adjustments, lighting measures had the largest savings (11,431 kWh or \$2,294 in bill savings) followed by non-lighting measures (4,805 kWh or \$1,106 in bill savings).

Table 8 calculates the share of total respondent adjusted gross savings for lighting and lighting controls. Lighting consisted of 96% of overall savings compared to 4% for lighting controls. The study used these percentages to break out NEI values for lighting-only and lighting controls-only installations in the program.

Table 7: Average Annual Participant Savings

Measure	n	Gross Energy Savings (kWh)		Adjusted Gross Energy Savings (kWh) ¹		Dollar Bill Savings ²	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Lighting Measures	96	10,487	17,816	11,431	1,9419	\$2,294	\$3,896
↳ Lighting	60	15,746	20,412	17,163	22,249	\$3,444	\$4,464
↳ Lighting controls	36	1,722	5,720	1,877	6,235	\$377	\$1,251
Non-lighting Measures	33	5,056	7,138	4,805	6,725	\$1,106	\$1,561
↳ Heating and cooling	17	6,434	7,977	7,427	8,336	\$1,407	\$1,745
↳ Water heating	9	829	649	904	707	\$181	\$142
↳ Refrigeration	7	7,142	8,015	7,427	8,336	\$1,562	\$1,753
Average	129	9,098	15,936	9,736	17,309	\$1,990	\$3,486

¹ The study applied the following realization rates from the C1639 study to the gross energy savings: 104% for refrigeration, 109% for water heating (low flow aerators), 90% for HVAC, 109% for lighting and lighting controls.

Source: Energy & Resource Solutions. 2018. *C1639: Impact Evaluation of the Connecticut Small Business Energy Advantage (SBEA) Program*. For the Connecticut Energy Efficiency Board (EEB).

https://energizect.com/sites/default/files/documents/C1639%20SBEA%20Impact%20Evaluation_Final%20Report_3.2_0.18.pdf

² Bill savings were calculated by multiplying ex-ante savings with 2019 residential energy price data at \$0.2187/kWh for electricity, \$3.09/gal for heating oil, and \$2.95/gal for propane. To update the dollar bill savings to 2020 dollars, the study applied the BLS CPI Inflation Calculator. Sources: U.S. Energy Information Agency. "Weekly Heating Oil and Propane Prices" https://www.eia.gov/dnav/pet/PET_PRI_WFR_DCUS_SCT_W.htm; U.S. Energy Information Administration. "Natural Gas Prices". https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_sct_m.htm; U.S. Energy Information Administration. "Average retail price of electricity, annual.";

<https://www.eia.gov/electricity/data/browser/#/topic/7?agg=0.1&geo=008&endsec=o&freq=A&start=2001&end=2019&ctype=linechart<ype=pin&rtype=s&maptype=0&rse=0&pin=>

BLS CPI Inflation Calculator. https://www.bls.gov/data/inflation_calculator.htm

Table 8: Total Annual Respondent Gross Energy Savings for Lighting and Lighting Controls

	SBEA		
	<i>n</i>	Savings (MWh)	% of total savings
Lighting	60	1,484	96%
Lighting Controls	36	63	4%
Total	96	1,547	

B.2 LMS INPUTS

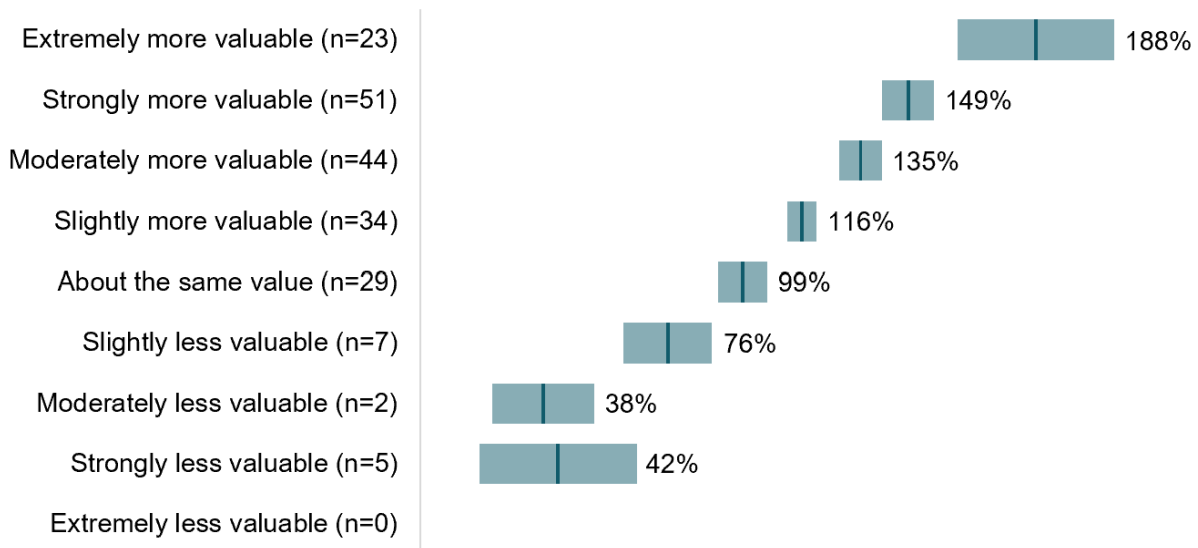
This section describes the inputs from the end-user survey used to estimate LMS magnitude scales. For a detailed description of the study methodology, see *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs* Appendix A.2.1.

B.2.1 LMS Magnitude Scales

For each respondent who reported a positive or negative effect, the survey asked how the effect compared to their energy savings. The study used the responses to those questions, as described in *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs* Appendix A.2.1, to develop positive magnitude scales shown in [Figure 7](#). Negative magnitude scales not shown as the survey only collected 9 responses in total for the nine magnitudes.

Figure 7: Average Positive LMS Magnitude Scales

(You say that the positive effect on [NEI] was [NP1] than the energy savings from that [MEASURE]s. How much more or less value – in percentage terms – would you say you received?)

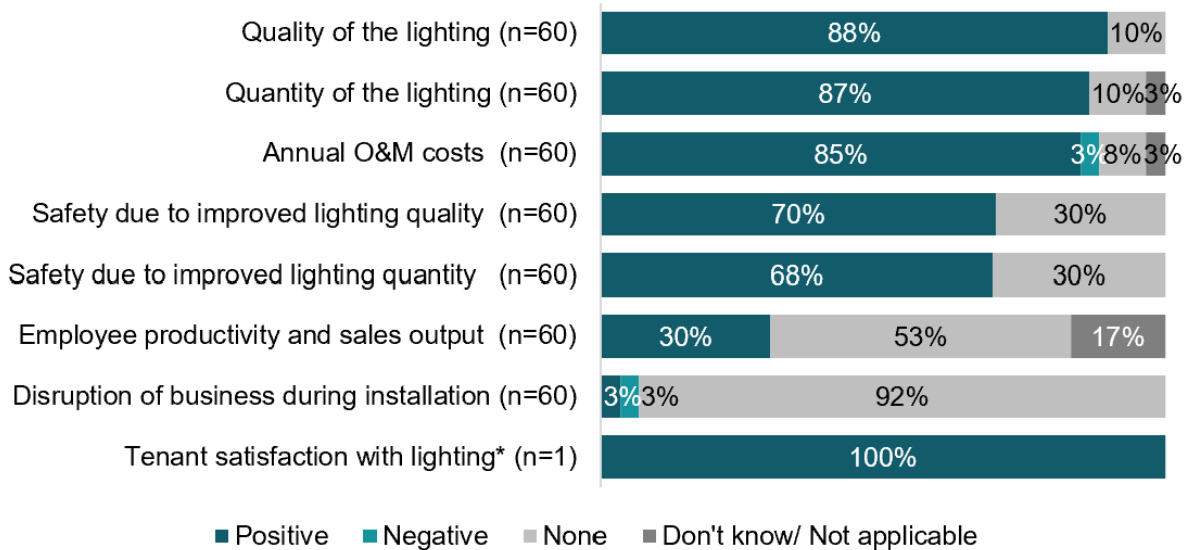


[Figure 8](#) thru [Figure 12](#) show the positive and negative NEI effects for respondents as well as respondents who said no effects, don't know, or not applicable. The most frequently reported positive NEI was annual O&M costs across all measures. Other frequently reported positive NEIs include quality and quantity of lighting for lighting and lighting controls ([Figure 8](#), [Figure 9](#)); equipment noise and comfort during the winter and summer for heating and cooling ([Figure 10](#));

equipment performance for water heating (Figure 11); equipment performance, and water and sewer cost for refrigeration (Figure 12).

Figure 8: Summary of Lighting NEI Effects

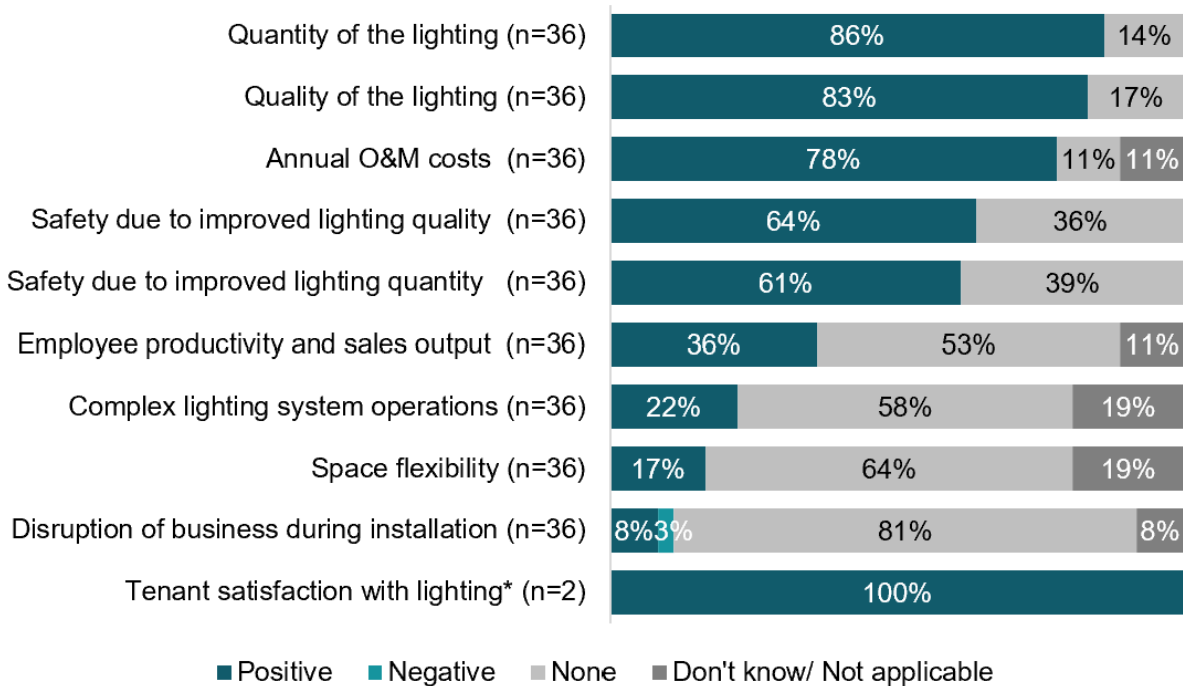
(For each of the items listed below, indicate if the installation of the [MEASURE] positively affected it, negatively affected it, or did not affect it at all.)



* Asked only of respondents who owned the space where measure was installed

Figure 9: Summary of Lighting Controls NEI Effects

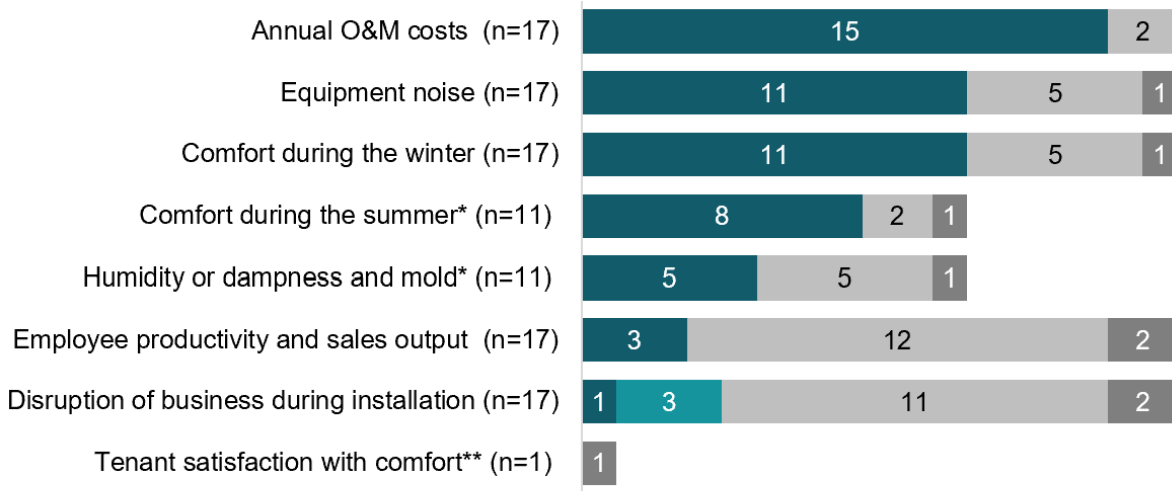
(For each of the items listed below, indicate if the installation of the [MEASURE] positively affected it, negatively affected it, or did not affect it at all.)



* Asked only of respondents who owned the space where measure was installed

Figure 10: Summary of Heating and Cooling NEI Effects ¹

(For each of the items listed below, indicate if the installation of the [MEASURE] positively affected it, negatively affected it, or did not affect it at all.)



■ Positive ■ Negative ■ None ■ Don't know/ Not applicable

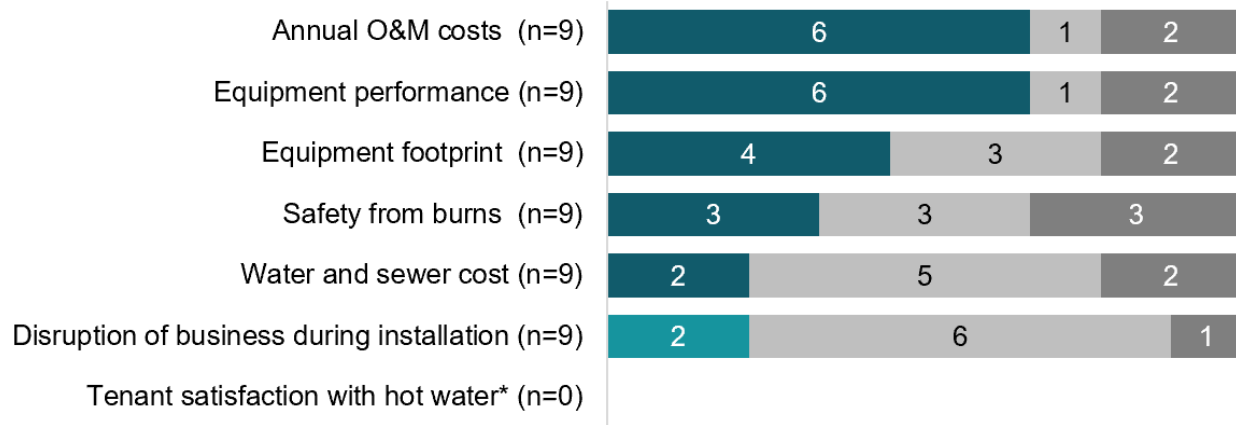
¹ Counts reported for sample sizes less than 20.

* Asked only of respondents who installed cooling measures

** Asked only of respondents who owned the space where measure was installed

Figure 11: Summary of Water Heating NEI Effects ¹

(For each of the items listed below, indicate if the installation of the [MEASURE] positively affected it, negatively affected it, or did not affect it at all.)



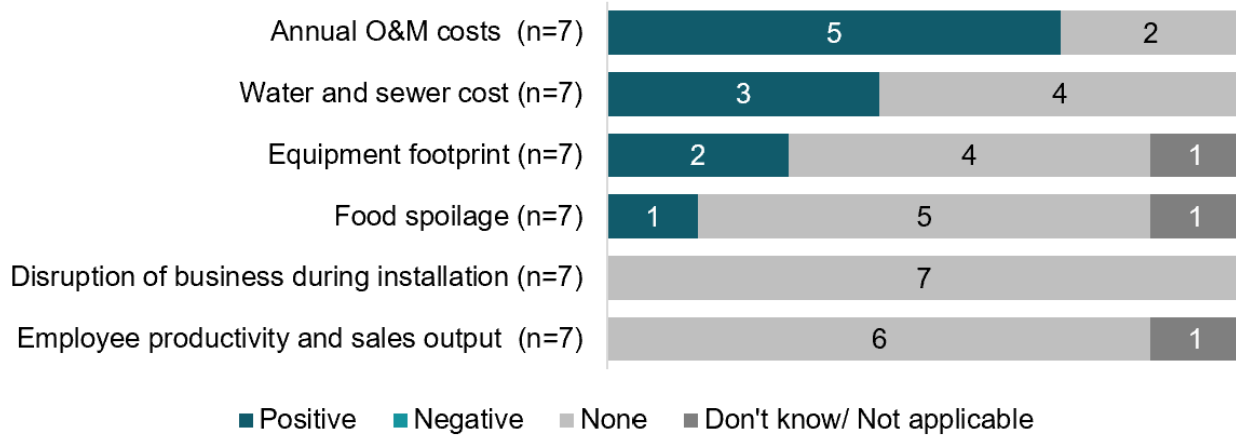
■ Positive ■ Negative ■ None ■ Don't know/ Not applicable

¹ Counts reported for sample sizes less than 20.

* Asked only of respondents who owned the space where measure was installed. No responses indicates that none of the respondents were owners of the space.

Figure 12: Summary of Refrigeration NEI Effects ¹

(For each of the items listed below, indicate if the installation of the [MEASURE] positively affected it, negatively affected it, or did not affect it at all.)



¹ Counts reported for sample sizes less than 20.

B.2.2 Overlapping NEI Effects

The survey asked respondents whether they experienced overlap of effects and to indicate which effects overlapped. Less than one-fifth (14%) of respondents indicated they had trouble separating out the effects (Table 9). NEI overlap occurred most frequently for lighting and lighting controls. O&M, lighting quality and quantity, and safety from lighting quality and quantity most commonly overlapped with each other. Other NEIS with overlap include comfort during summer with change in humidity or dampness for heating and cooling measures.

Table 9: Percent of Respondents Who Reported Overlapping NEIs

(Did you have trouble separating out the effects we asked about? Did any overlap for you? Which effects overlapped?)

Measure	n	Percent with Overlapping NEIs
Lighting	60	8 (13%)
Lighting controls	36	8 (22%)
Heating and cooling	17	2 (12%)
Water heating	9	No overlap
Refrigeration	7	No overlap
Average	129	19 (14%)

B.2.3 Normalized NEI Effects

Table 10 the total qualitative value of individual NEIs with the qualitative value of the combined effects of all NEIs by program. The sum of the individual effects is, on average, more than three times as large as the combined effects. For detailed methodology on normalizing NEI effects, see Appendix A.2.1 in X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs.

Table 10: Comparison of Combined Effects^{1, 2}

Program	<i>n</i>	Sum of Individual Effects ³	Combination of all Effects ⁴	Magnitude
Lighting	60	571% (502%, 639%)	130% (117%, 143%)	4.5
Lighting controls	36	570% (478%, 661%)	123% (115%, 132%)	4.7
Non-lighting	33	361% (-10%, 1,192%)	104% (-3%, 345%)	3.6
Heating and Cooling	17	439% (320%, 557%)	81% (39%, 123%)	3.7
Water Heating	9	304% (135%, 474%)	126% (91%, 160%)	3.7
Refrigeration	7	247% (104%, 390%)	81% (48%, 114%)	3.1
Average	129	517% (470%, 563%)	121% (113%, 130%)	4.3

¹ Combined effects in table includes ‘other’ NEIs as reported in the survey. These totals may not equal those reported in Figure 2.

² 90% confidence intervals provided in parentheses.

³ Individual effects correspond to the survey question in Row B of Table A-2 in *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs*.

⁴ Combination of all effects corresponds to the survey question in Row E of Table A-2 in *X1942B Cross-cutting NEI Study – Residential HP & HPWH NEIs*.

B.3 ADDITIONAL NEI RESULTS

Table 11 reports the main monetized NEIs results in this study by dollars per unit as well as dollars per kWh.

Table 11: Summary of Monetized NEIs for SBEA Measures^{1,2}

Measure	<i>n</i>	Dollars per unit	Dollars per kWh
Lighting and lighting controls	72	\$1,646 (\$1,064, \$2,228)	\$0.158 (\$0.135, \$0.180)
Heating and cooling	17	\$1,185 (\$344, \$2,025)	\$0.170 (\$0.117, \$0.223)
Water heating	9	\$90 (\$14, \$166)	\$0.086 (\$0.027, \$0.145)
Refrigeration	7	\$787 (\$209, \$1,366)	\$0.112 (\$0.049, \$0.175)
All measures (Program)	103	\$1,381 (\$956, \$1,805)	\$0.150 (\$0.131, \$0.168)

¹ NEIs are for participants who received incentives for lighting, lighting controls, heating and cooling, water heating, and refrigeration through the program. NEI values are in 2020 dollars.

² 90% confidence intervals in parentheses

Table 12 provides benchmarking comparisons of the SBEA measures with C&I values in the Massachusetts TRM.

Table 12: NEI Benchmarking Comparison - Annual per kWh

Measure	Massachusetts 2016 ¹	CT SBEA 2023
Custom Hot Water & Other	\$0.065	\$0.086
New Prescriptive HVAC	\$0.095	\$0.170
Retrofit Custom Refrigeration	\$0.077	\$0.112
New Custom Refrigeration	\$0.070	
Custom lighting	\$0.096	\$0.158
Prescriptive lighting	\$0.047	
Retrofit lighting controls	\$0.130	\$0.156

¹ Massachusetts Electric and Gas Energy Efficiency Program Administrators. 2023. *Massachusetts TRM 2023 Plan Version*. <https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202023%20Plan%20-%20010323.pdf> Appendix B. <https://api-plus.anbetrack.com/etrm-gateway/etrm/api/v1/etrm/documents/63b4ada052e03925d3412295/view?authToken=e3b8925034aede1d18be0cf5b83eb9c3dd6353c4192e6a7a1b60f8c9285aaffc0f60c5bd650cdd4e351f0d720caa31515526737f6abfce8e7a5001cdb00a736e4abb248183d2f>

Table 13 reports the annual dollar value per kWh and per CCF for heating and cooling equipment. Column C combines columns A and B to \$/kWh for comparison and are the values reported in the main report. Table 14 provides the corresponding \$/kWh and \$/CCF values for water heating.

Table 13: Monetized NEIS for Heating and Cooling Equipment ¹

NEI	\$/kWh (A)	\$/CCF (B)	Total \$/kWh (C)
Comfort during the winter	\$0.036 (\$0.020, \$0.052)	\$0.025 (\$0.011, \$0.039)	\$0.051 (\$0.031, \$0.071)
Comfort during the summer (n=10)	\$0.027 (\$0.012, \$0.042)	\$0.008 (\$0.000, \$0.016)	\$0.050 (\$0.030, \$0.069)
Equipment noise	\$0.031 (\$0.013, \$0.049)	\$0.023 (\$0.009, \$0.036)	\$0.041 (\$0.022, \$0.060)
Annual O&M costs	\$0.031 (\$0.012, \$0.050)	\$0.015 (\$0.002, \$0.027)	\$0.031 (\$0.012, \$0.050)
Change in humidity or dampness and mold (n=10)	\$0.014 (\$0.001, \$0.027)	\$0.005 (-\$0.001, \$0.011)	\$0.016 (\$0.003, \$0.029)
Employee productivity and sales output	\$0.007 (\$0.000, \$0.015)	\$0.001 (-\$0.001, \$0.004)	\$0.007 (\$0.000, \$0.015)
Disruption of business during installation	-\$0.005 (-\$0.013, \$0.002)	N/A	-\$0.005 (-\$0.013, \$0.002)
Total Value	\$0.140 (\$0.081, \$0.199)	\$0.076 (\$0.035, \$0.118)	\$0.170 (\$0.117, \$0.223)

¹ 90% confidence intervals in parentheses

Table 14: Monetized NEIS for Water Heating Equipment ¹

NEI	\$/kWh (A)	\$/CCF (B)	Total \$/kWh (C)
Equipment performance	\$0.028 (-\$0.002, \$0.059)	\$0.010 (-\$0.003, \$0.023)	\$0.044 (\$0.013, \$0.074)
Annual O&M costs	\$0.024 (-\$0.0064, \$0.055)	\$0.004 (-\$0.0036, \$0.012)	\$0.030 (-\$0.0003, \$0.061)
Equipment footprint	\$0.012 (-\$0.0045, \$0.029)	\$0.005 (-\$0.0045, \$0.015)	\$0.020 (-\$0.0002, \$0.040)
Disruption of business during installation	N/A	-\$0.005 (-\$0.015, \$0.005)	-\$0.008 (-\$0.022, \$0.007)
Total Value	\$0.065 (\$0.002, \$0.128)	\$0.014 (-\$0.004, \$0.032)	\$0.086 (\$0.027, \$0.145)

¹ 90% confidence intervals in parentheses