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Luminaire Level Lighting Controls: Market Progress Evaluation Report #3

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Acronyms

ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
DLC	DesignLights Consortium
IECC	International Energy Conservation Code
IES	Illuminating Engineering Society
LDL	Lighting Design Lab
LLLC	Luminaire level lighting controls
MPER	Market Progress Evaluation Report
MPI	Market progress indicator
NAICS	North American Industry Classification Systems
NEEA	Northwest Energy Efficiency Alliance
NLC	Networked lighting controls
QPL	Qualified product list
ROI	Return on Investment

Executive Summary

This study is the third market progress evaluation report (MPER 3) for the Northwest Energy Efficiency Alliance (NEEA) Luminaire Level Lighting Controls (LLLC) program. MPER 3 builds on the first MPER (MPER 1)[1] completed in 2021 and the second MPER (MPER 2)[2] completed in 2023.

LLLC Program Background

The NEEA LLLC program is designed to overcome barriers to adoption of LLLC in the commercial lighting market, so LLLC become standard technology for commercial lighting projects. LLLC are a type of networked lighting control (NLC) system in which each individual light fixture has a built-in sensor and controller so the luminaires can communicate and transmit data wirelessly and be flexibly programmed in a variety of groupings.

From 2016 to early 2019, NEEA pursued foundational program development activities to overcome key barriers, such as initial cost, lack of skilled trade allies, product readiness, and lack of market understanding, that were identified in the LLLC Logic Model. These foundational activities included helping to create a detailed product specification, conducting cost and energy savings research to support the development of utility incentives, conducting marketing and media outreach, training installers and designers/specifiers, and influencing commercial building code so that LLLC becomes the best solution for meeting code to manage lighting needs in relevant spaces.

In early 2019 the LLLC program gained approval to move into market development. NEEA has continued to pursue foundational program development activities, while also working with manufacturers and their sales channels to increase LLLC promotion in their regions, working with trade and industry associations to educate their members, collaborating with utilities to educate their trade ally networks, partnering with early adopter specifiers to influence others, and developing case studies to highlight the LLLC value proposition. NEEA also engages organizations like DesignLights Consortium (DLC), Illuminating Engineering Society (IES) and the American Society of Heating, Refrigerating, and Air condition Engineers (ASHRAE) on LLLC technical requirements and standard practices to ensure national alignment. NEEA's ongoing development activities have successfully built on early efforts to broaden the range of market actors that work with the program.

MPER Objectives and Research Activities

The main goal of an MPER is to understand a program's progress toward its outcomes by measuring market progress indicators (MPIs). NEEA teams develop outcomes and MPIs before programmatic activity begins that predict how the market should change based on the planned interventions. In other

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[1] Cadmus. Luminaire Level Lighting Controls: Market Progress Report #1. November 29, 2021. https://neea.org/wp-content/uploads/2025/03/Luminaire-Level-Lighting-Controls-Market-Progress-Evaluation-Report-1.pdf

[2] Cadmus. Luminaire Level Lighting Controls: Market Progress Report #2. November 29, 2023. https://neea.org/wp-content/uploads/2025/03/LLLC-Market-Progress-Evaluation-Report-2.pdf

words, the outcomes reflect key changes that the program aims to achieve, while the MPIs provide a framework to gauge progress toward these outcomes using evidence-based data.

While the aim of MPER 3 was to track the LLLC program's progress toward predicted outcomes, the Cadmus team also verified the completion of program activities and conducted additional LLLC market research on topics of interest. In short, the three core research objectives included:

- Verify the activities that the LLLC program has completed since the previous MPER.
- Conduct analysis to track MPIs related to reducing market barriers and other program outcomes.
- Understand the rationale of buyers and sellers who include LLLC in their initial project plans, but do not follow through with the purchase or sale.

To address these objectives, the Cadmus team conducted the research activities described in Table 1.

Table 1. Research Activities for NEEA LLLC MPER 3

Task	Research Objectives Addressed	Target Group/Documents	Completions Achieved
Document review	1, 2	Program quarterly progress reports, code documentation for Northwest states (Idaho, Montana, Oregon, and Washington), and email review	N/A
Staff interviews	1, 2, 3	NEEA program staff and implementation contractor staff	5
Supply-chain market actor interviews	2, 3	Lighting and controls manufacturers and manufacturer representatives	10
Installer survey	2, 3	Northwest commercial lighting and controls installers	59
Designer/specifier survey	2, 3	Northwest commercial lighting and controls designer/specifiers	37
Decision-maker interviews	2, 3	Northwest building owners and managers who installed new lighting systems	10

As shown in Table 2, the LLLC program has realized several of its short-term (one to two years) outcomes and is making progress on medium-term (three to five years) and long-term (five or more years) outcomes. The table below does not show MPIs measured in previous MPERs; only those measured in MPER 3 and their previous scores for comparison. Across nearly all MPIs, NEEA has made progress or held the indicator constant, demonstrating positive development of the LLLC market.

Table 2. 2024 Estimated Value for LLLC MPIs Assessed in MPER 3

Expected LLLC Program Outcome (Logic Model)	LLLC Program MPI	MPI 2021 (MPER 1) Estimated Value[a]	MPI 2022 (MPER 2) Estimated Value[a]	MPI 2024 (MPER 3) Estimated Value[a]
Outcome III (short term) 1. Manufacturers formalize and provide LLLC training 2. Lighting Design Lab provides LLLC training 3 NEEA's NXT Level training includes LLLC	**3B.** The percentage of lighting installation companies with at least one installer trained in LLLC[b]	32% (n=66)	71% (n=32)	47% (n=55)
	3D. The percentage of lighting installation companies with the capability to bid on a project that involves LLLC installation	66% (n=145)	71% (n=33)	89% (n=55)
	3E. The percentage of companies with at least one LLLC-trained installer in each state[c]	Not assessed in MPER 1	ID (n=20): 57% MT (n=8): 46% OR (n=23): 69% WA (n=24): 73%	ID (n=16): 41% MT (n=11): 55% OR (n=27): 59% WA (n=37): 52%
Outcome IV (short term) 1. Increase in supply-chain awareness among trade allies and lighting designers	**4A.** The percentage of lighting installation companies and lighting designer/specifier companies that are aware of LLLC	Installation companies: 78% (n=179) Designer/specifier companies: 68% (n=86)	Installation companies: 78% (n=33) Designer/specifier companies: 82% (n=31)	Installation companies: 94% (n=59) Designer/specifier companies: 82% (n=37)
Outcome V (short term) 1. Lighting designers and specifiers recommend LLLC solutions	**5A.** The percentage of companies with lighting designers/ specifiers who have recommended LLLC to a decision-maker for at least one project	44% (n=75)	63% (n=27)	73% (n=29)
	5B. The percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35% (n=78)	61% (n=27)	67% (n=35)

Expected LLLC Program Outcome (Logic Model)	LLLC Program MPI	MPI 2021 (MPER 1) Estimated Value[a]	MPI 2022 (MPER 2) Estimated Value[a]	MPI 2024 (MPER 3) Estimated Value[a]
Outcome VI (short term) Manufacturers increase the number of product types with embedded controls	**6A.** Manufacturers say compared to the previous year, for at least one of these fixture types—low-bay, high-bay, recessed can, and retrofit kits—they have increased the number of products available with embedded controls	Not assessed in MPER 1	4 of 4 manufacturers	5 of 5 manufacturers
	6B. Sales reps say there are sufficient types and styles of fixtures with embedded controls to meet their customers' needs	Not assessed in MPER 1	6 of 7 manufacturer representatives	4 of 4 manufacturer representatives
	6C. The percentage of designers/specifiers who say there are sufficient types and styles of fixtures with embedded controls to meet their LLLC system design and specification needs	Not assessed in MPER 1	Not assessed in MPER 2	87% (n=31)
Outcome IX (medium term) 1. LLLC is accepted as the easiest-to-install lighting controls solution	**9A.** The percentage of installation companies that report having installed at least one LLLC system (in other words, "experienced installation firms")	61% (n=159)	63% (n=32)	65% (n=52)
	9B. The percentage of experienced installation companies that say LLLC systems are easier to install than other NLC systems	43% (n=59)	74% (n=21)	83% (n=28)
	9C. The average number of LLLC projects installation companies have completed in the past 12 months	Not assessed in MPER 1	Not assessed in MPER 2	9.2 projects (n=46)

Expected LLLC Program Outcome (Logic Model)	LLLC Program MPI	MPI 2021 (MPER 1) Estimated Value[a]	MPI 2022 (MPER 2) Estimated Value[a]	MPI 2024 (MPER 3) Estimated Value[a]
Outcome X (medium term) LLLC are priced competitively in comparison with non-connected lighting	**10A.** The number of aware and knowledgeable customer-side decision-makers willing to pay for a higher cost LLLC system	Not assessed in MPER 1	Not assessed in MPER 2	Same price: 4 $15 more: 3 $45 more: 3 (n=10)
Outcome XII (medium term) LLLC referenced in all Northwest codes	**12.** LLLC becomes an Optional Compliance Path in all NW states	Not assessed in MPER 1	Not assessed in MPER 2	3 of 4 states[d]
Outcome XV (long term) LLLC solutions become standard practice	**15A.** The percentage of experienced installation firms who say an LLLC is their first choice in controls where technically applicable	Not assessed in MPER 1	Not assessed in MPER 2	81% (n=30)
	15B. The percentage of designers/ specifiers who have recommended LLLC to a decision-maker for at least one project who say LLLC is their first choice where technically feasible	Not assessed in MPER 1	Not assessed in MPER 2	73% (n=21)

[a] For each MPER conducted, respondents were asked to reflect on the completed, previous year when providing insights. So, for example, although this MPER is being published in 2025, data reflects trends from 2024. Each time findings are referenced and compared across years, these years reflect the timeframe for which respondents were providing data.

[b] The MPER 1 used a more narrow definition of 'trained' that did not account for market actors with a different business plan (i.e., to subcontract some of the work in some cases, or to specialize in some aspects of their role). For the MPER 2 and MPER 3, Cadmus decided to do broaden the definition to more accurately reflect the functional business practices of these market actors, which resulted in a reanalysis of the MPER 1 data as well to provide a comparison. This is why these results do not match with the results in the MPER 1 report.

[c] While the sample size at the total region level is sufficient for analysis, it is smaller at the state level. Thus, state-level differences are directional.

[d] One state (Oregon) uses the ASHRAE code, which does not provide optional compliance pathways.

Conclusions and Recommendations

As shown in Table 3, Cadmus formed conclusions about the LLLC market and program based on extensive qualitative and quantitative research and developed recommendations to support ongoing market transformation.

The Research Objectives column links to the appropriate subsection in the *Conclusions and Recommendations* section, where supporting findings for conclusions and additional details on recommendations are included.

Table 3. Summary of Conclusions and Recommendations

Research Objectives	Conclusion	Recommendation
RO #1: Assess Program Foundation	Conclusion 1: LLLC program activities have contributed to expected program outcomes.	-
RO #2: Track Market Progress	Conclusion 2: The LLLC Program is well positioned to grow its market share in the commercial lighting market.	Recommendation 2: Focus future program activities on supporting manufacturers, utilities, professional organizations, and trade organizations with trainings that help installers and designers/specifiers with converting LLLC opportunities to installations, with an emphasis on appropriate LLLC programming and operations.
	Conclusion 3: While installation companies' ability to install LLLC remained strong, a decrease in reported formal training indicates further opportunity for engagement.	Recommendation 3a: Encourage formal training providers to conduct additional outreach to lighting market actors in order to increase participation in LLLC training. Advise these training providers to emphasize that formal training can provide market actors with the skills necessary to fully utilize LLLC. Additionally, encourage training providers to host trainings that go beyond introductory and awareness building to cover more nuanced value propositions and how to fully utilize the many benefits of LLLC in different space types. Recommendation 3b: Identify any potential training gaps in the LLLC market and, should a gap be identified, work with manufacturers, utilities, and professional organizations to either incorporate this topic into existing trainings or create a new training module.
RO #3: Lighting Controls Market Research	Conclusion 4: While knowledgeable users found value in their LLLC systems, building owners and managers' understanding of LLLC features and value proposition remains low.	Recommendation 4: Work with formal training providers to develop opportunities for lighting installers and designers to highlight the benefits of LLLC during sales conversations, focusing on higher quality light and the adaptability of LLLC fixtures as well as the benefits from energy efficiency. This will provide market actors with the ability to educate their customers on the full breadth

Research Objectives	Conclusion	Recommendation
		of features and the value of LLLC systems to provide savings on a longer-term basis.
	Conclusion 5: While the technological capabilities of LLLC fixtures have grown, market barriers remain.	-

Introduction

The NEEA Luminaire Level Lighting Controls (LLLC) program is designed to overcome barriers to the adoption of LLLC in the commercial lighting market so that they become standard technology for commercial lighting projects. LLLC are a type of networked lighting control (NLC) system in which each individual light fixture has a built-in sensor and controller, enabling the luminaires to communicate and transmit data wirelessly and be flexibly programmed and re-programmed in any grouping needed. In other NLC systems, the sensor and controller are external to the fixtures, and one sensor and controller—typically mounted in the ceiling—controls a group of fixtures, usually wirelessly.

From 2016 to early 2019, NEEA focused on foundational program development activities. NEEA developed a Market Transformation Theory and LLLC Logic Model that identified barriers to LLLC adoption, LLLC market opportunities, a path to market transformation, and a number of market progress indicators (MPIs) for tracking program progress. Barriers consisted of first cost, lack of skilled trade allies, product readiness, and lack of market understanding. Opportunities consisted of rapid market adoption of solid-state lighting and incorporation into building codes.

During these years, NEEA began addressing barriers and leveraging opportunities, such as working with the DesignLights Consortium (DLC) to create a specification for LLLC features and operation, reaching out to manufacturers to influence the development of qualifying products, and conducting LLLC energy savings and incremental cost studies. More direct market interventions, which are ongoing, include encouraging the development of building energy codes that make LLLC the best lighting solution for relevant commercial spaces, sharing information about LLLC with utilities as they develop incentives to mitigate the initial cost of LLLC installation, and co-sponsoring utility training for lighting professionals to address the lack of skilled supply-chain market actors.

In early 2019, the program received approval from NEEA's director-level staff and funding utilities to move into the market development phase[3]. In addition to continuing the activities described above, the program team hired field implementation and marketing contractors. Implementation has focused on leveraging previously established relationships with manufacturers and establishing direct working relationships with local manufacturer sales channels that champion LLLC in the Northwest. Additionally, the implementation and marketing contractors have collaborated with local manufacturer representatives and distributors to bolster effective LLLC messaging and sales techniques and have partnered with these stakeholders, along with local and national professional and trade associations, to deliver utility- and professional and trade association-hosted educational events for installers, designers, specifiers, and end-use customers such as building operators. NEEA also engages organizations like DesignLights Consortium (DLC), Illumination Engineering Society (IES) and the American Society of Heating, Refrigerating, and Air condition Engineers (ASHRAE) on LLLC technical requirements and standard practices to ensure national alignment. The implementation team further raises awareness and

[3] During the market development phase, a NEEA program invests significant resources to support strategic interventions that are meant to remove market barriers and create lasting market change.

acceptance of LLLC by placing articles in industry publications, spotlighting influential early adopter customers and market actors, and holding informational webinars for a range of audiences. The LLLC program has continued these activities and has broadened the market actors they work with over the past several years, building on the success of earlier work.

This study is the third of several LLLC market progress evaluation reports (MPERs) that track the LLLC MPIs and provide continuing market research to refine NEEA's outreach and intervention activities.

Methodology

Cadmus' evaluation addressed three core research objectives:

- Verify the activities that the LLLC program has completed since the previous MPER.
- Conduct annual analysis to track MPIs related to reducing market barriers and other program outcomes
- Understand the rationale of buyers and sellers who include LLLC in their initial project plans, but do not follow through with the purchase or sale.

To inform MPER 3, the Cadmus team conducted several primary and secondary research tasks, each designed to address a specific subset of research questions related to the core research objectives. This section provides additional detail on the methods and purpose for each task listed in Table 4.

Table 4. Research Activities for NEEA LLLC MPER 3

Task	Research Objectives Addressed	Target Group/Documents	Completions Achieved
Document review	1, 2	Program quarterly progress reports, code documentation for Northwest states, and email review	N/A
Stakeholder interviews	1, 2, 3	NEEA program staff and implementation contractor staff	5
Supply-chain market actor Interviews	2, 3	Lighting and controls manufacturers and manufacturer representatives	10
Installer survey	2, 3	Northwest commercial lighting and controls installers	59
Designer/specifier survey	2, 3	Northwest commercial lighting and controls designer/specifiers	37
Decision-maker interviews	2, 3	Northwest building owners and managers who installed new lighting systems	10

A full explanation of the methodology for each task is included in *Appendix A. Detailed Methodology*.

Detailed Findings

This section presents the detailed findings from Cadmus' research, organized by research objective. Results are synthesized across tasks in the *Conclusions* section that follows. Several tasks informed each research objective, as noted in Table 4.

RO #1: Review and Verify Program Activities

As the first step in this evaluation, Cadmus reviewed the quarterly program reports developed since MPER 2 and interviewed NEEA program and implementation contractor staff to understand changes to program design and market progress. Cadmus used the program reports to identify the activities completed, which Cadmus then confirmed via the interviews.

LLLC program activities have contributed to expected program outcomes.

Staff reported that they have kept the same high level program strategy while continuing to refine implementation tactics, which has resulted in a variety of successes in 2024. Program staff said that the number of LLLC stakeholders they are engaging with has dynamically increased, indicating that NEEA has succeeded in its goal to broaden its audience of manufacturer representatives and manufacturers. Staff stated that working with an expanded audience of stakeholders has further raised awareness of LLLC and generated future opportunities to add technological capacities based on various manufacturing approaches.

According to program staff, NEEA's involvement and influence have catalyzed changes in the market for LLLC. Staff noted that LLLC is written into more standards and recommended best practices and is now an accepted control strategy by the Illuminating Engineering Society (IES) (Lighting Practice-6). Staff reported that these successes have increased LLLC's legitimacy. For example, staff mentioned that IES published a new guide with LLLC cited as a best practice, further advancing LLLC as a technology standard. The program implementer reported that the DLC reviewed technical reference manuals throughout the country to assess LLLC adoption nationally. Additionally, the DLC conducted a "Pathways to Connected Lighting" interview project, which produced recommendations for incorporating LLLC and NLC into utility programs. Beyond research, program staff expanded on how regions across the country are looking into LLLC utility incentives for control/sensor integration. The additional interest and changes in incentives, according to staff, have been driven by an increase in LLLC manufacturers and products, as well as data demonstrating LLLC's energy savings to utilities. Program implementers reported that the success of LLLC adoption into standards and practices illustrates that LLLC are meeting a business need to find additional opportunities for energy savings from lighting.

RO #2: Track Market Progress

The main goal of this study is to understand how the LLLC program is progressing towards its intended outcomes through the detailed tracking of MPIs. Every research activity (as shown in Table 4) contributed to Cadmus' assessment of LLLC MPIs; Table 5 presents the estimated MPI values from 2021 through 2024, with additional details following the table.

Table 5. Estimated Values for MPIs Assessed in MPER 3

Expected LLLC Program Outcome (Logic Model)	LLLC Program MPI	MPI 2021 (MPER 1) Estimated Value[a]	MPI 2022 (MPER 2) Estimated Value[a]	MPI 2024 (MPER 3) Estimated Value[a]
Outcome III (short term) 1. Manufacturers formalize and provide LLLC training 2. Lighting Design Lab provides LLLC training 3 NEEA's NXT Level training includes LLLC	**3B.** The percentage of lighting installation companies with at least one installer trained in LLLC[b]	32% (n=66)	71% (n=32)	47% (n=55)
	3D. The percentage of lighting installation companies with the capability to bid on a project that involves LLLC installation	66% (n=145)	71% (n=33)	89% (n=55)
	3E. The percentage of companies with at least one LLLC-trained installer in each state[c]	Not assessed in MPER 1	ID (n=20): 57% MT (n=8): 46% OR (n=23): 69% WA (n=24): 73%	ID (n=16): 41% MT (n=11): 55% OR (n=27): 59% WA (n=37): 52%
Outcome IV (short term) 1. Increase in supply-chain awareness among trade allies and lighting designers	**4A.** The percentage of lighting installation companies and lighting designer/specifier companies that are aware of LLLC	Installation companies: 78% (n=179) Designer/specifier companies: 68% (n=86)	Installation companies: 78% (n=33) Designer/specifier companies: 82% (n=31)	Installation companies: 94% (n=59) Designer/specifier companies: 82% (n=37)
Outcome V (short term) 1. Lighting designers and specifiers recommend LLLC solutions	**5A.** The percentage of companies with lighting designers/specifiers who have recommended LLLC to a decision-maker for at least one project	44% (n=75)	63% (n=27)	73% (n=29)
	5B. The percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35% (n=78)	61% (n=27)	67% (n=35)
Outcome VI (short term) Manufacturers increase the number of product types with embedded controls.	**6A.** Manufacturers say compared to the previous year, for at least one of these fixture types—low-bay, high-bay, recessed can, and retrofit kits—they have increased the number of products available with embedded controls	Not assessed in MPER 1	4 of 4 manufacturers	5 of 5 manufacturers
	6B. Sales reps say there are sufficient types and styles of fixtures with embedded controls to meet their customers' needs	Not assessed in MPER 1	6 of 7 manufacturer's representatives	4 of 4 manufacturer's representatives
	6C. The percentage of designers/specifiers who say there are sufficient types and styles of fixtures with embedded controls to meet their LLLC system design and specification needs	Not assessed in MPER 1	Not assessed in MPER 2	87% (n=31)

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Outcome IX (medium term) 1. LLLC is accepted as the easiest-to-install lighting controls solution	**9A.** The percentage of installation companies that report having installed at least one LLLC system (i.e., "experienced installation firms")	61% (n=159)	63% (n=32)	65% (n=52)
	9B. The percentage of experienced installation companies that say LLLC systems are easier to install than other NLC systems	43% (n=59)	74% (n=21)	83% (n=28)
	9C. The average number of LLLC projects installation companies have completed in the past 12 months	Not assessed in MPER 1	Not assessed in MPER 2	9.2 projects (n=46)
Outcome X (medium term) LLLC are priced competitively in comparison with non-connected lighting	**10A.** The number of aware and knowledgeable customer-side decision-makers willing to pay for a higher cost LLLC system	Not assessed in MPER 1	Not assessed in MPER 2	Same price: 4 $15 more: 3 $45 more: 3 (n=10)
Outcome XII (medium term) LLLC referenced in all Northwest codes	**12.** LLLC becomes an optional compliance path in all Northwest states	Not assessed in MPER 1	Not assessed in MPER 2	3 of 4 states[d]
Outcome XV (long term) LLLC solutions become standard practice	**15A.** The percentage of experienced installation firms that say LLLC is their first choice in controls where technically applicable	Not assessed in MPER 1	Not assessed in MPER 2	81% (n=30)
	15B. The percentage of designers/specifiers who have recommended LLLC to a decision-maker for at least one project who say LLLC is their first choice where technically feasible	Not assessed in MPER 1	Not assessed in MPER 2	73% (n=21)

[a] For each MPER conducted, respondents were asked to reflect on the completed, previous year when providing insights. So, for example, although this MPER is being published in 2025, data reflects trends from 2024. Each time findings are referenced and compared across years, these years reflect the timeframe for which respondents were providing data.

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[c] While the sample size at the total region level is sufficient for analysis, it is smaller at the state level. Thus, state-level differences are directional.

[d] One state (Oregon) uses the ASHRAE code, which does not provide optional compliance pathways.

MPI 3B: The percentage of installer companies reporting that their employees have received LLLC-related trainings has decreased

For MPI 3B, Cadmus assessed the percentage of lighting installation companies with at least one trained LLLC installer, which was defined as having received training in at least one of four key topics: the best type of building spaces for LLLC, the benefits and capabilities of LLLC relative to other types of control systems, how to install LLLC, and how to program LLLC.

Of the survey respondents, 47% of installers said that their company had at least one trained LLLC installer—a 24% decrease from the reported percentage of companies with trained installers in MPER 2. However, all but one of the installers who said no one at their company had received LLLC training also said that they have the capabilities to bid on LLLC projects. Cadmus observed this same situation in 2021, when MPER 1 showed a 34% gap between installation company bidding capabilities (66%) and companies with trained staff (32%). Table 6 shows the percentage of companies with trained installers from MPERs 1-3.

Table 6. Percentage of Companies reporting Trained Staff

Stratum	2021	2022	2024	2022–2024 Change
Companies with installers	32% (n=66)	71% (n=33)	47% (n=53)	-24%

Source: Installer and Designer/Specifier survey QC1: "Have staff at your company received training on Luminaire level lighting controls (LLLC)?"; QC4: "For each of the following, please indicate if any staff at your company, including yourself, have been trained on this subject. First, have any staff been trained on the best types of buildings and spaces for LLLC? Have any staff been trained on the benefits and capabilities of LLLC relative to other types of control systems? Have any staff been trained on how to install LLLC? Have any staff been trained on how to program LLLC?"

MPI 3D: Nearly all installation companies can install or bid on LLLC projects.

MPI 3D measures the percentage of lighting installation companies with the capability to bid on a project that involves LLLC. Cadmus considered respondents to be capable of bidding on an LLLC project if they could install an LLLC project.

As shown in Table 7, 89% of respondents reported that they were capable of installing or capable of both installing and programming LLLC systems, a substantial increase from the prior MPER. The share of companies with LLLC installation capabilities has increased each reporting year, showing that the market's experience with LLLC is growing.

Table 7. Installation Company Bidding Capability

Stratum	2021	2022	2024	2022–2024 Change
Companies with installers	66% (n=145)	71% (n=33)	89% (n=55)	+18%

Source: Installer and Designer/Specifier survey QC5: "Is your company able to install an LLLC system, install and program an LLLC system, or neither?"

MPI 3E: Around half of installers surveyed in each of the four states were LLLC-trained.

MPI 3E measures the distribution of lighting installation companies with at least one trained LLLC installer across the four states of the Northwest region. An installation company may operate in several states, especially when its office is located near state borders.

Table 8 shows results across states and associated sample sizes. Each of the four states is served by multiple LLLC installation companies. The share of installation companies with training was over half in Oregon, Montana, and Washington, but only around 40% in Idaho.

Table 8. Percentage of Installation Companies with Trained Staff, by State

State	2022	2024
Oregon	69% (n=23)	59% (n=27)
Montana	46% (n=8)	55% (n=11)
Washington	73% (n=24)	52% (n=37)
Idaho	57% (n=20)	41% (n=16)

Source: Installer and Designer/Specifier survey QC6: "In which of the following Northwest states does your company operate?"; QC5: "Is your company able to install an LLLC system, install and program an LLLC system, or neither?"
Note: Not assessed in MPER 1 (2021).

MPI 4A: Awareness of LLLC remained high.

MPI 4A monitors the percentage of installers and designers/specifiers who are aware of LLLC. Almost all (94%) installers said they were aware of LLLC in 2024, up from 78% in 2022. Awareness of LLLC among designers/specifiers remained constant between 2022 and 2024, at 82%. Table 9 shows the historical percentages of awareness for each group.

Table 9. Awareness of LLLC

Stratum	2021	2022	2024	2022–2024 Change
Installers	78% (n=179)	78% (n=33)	94% (n=59)	+16%
Designers/Specifiers	68% (n=86)	82% (n=31)	82% (n=37)	No Change

Source: Installer and Designer/Specifier survey QC5: "Are you aware of a type of networked lighting control system in which each fixture is programmable and has its own built-in sensor, allowing flexible grouping and granular fixture control? These are known as Luminaire-level Lighting Control systems, or LLLC."

MPI 5A and 5B: Designers/specifiers were more likely to recommend and include LLLC in their projects.

MPI 5A tracks the percentage of designers/specifiers who have recommended LLLC to a project decision-maker for at least one project. MPI 5B tracks the percentage of designers/specifiers who have written LLLC into project plans.

As shown in Table 10, nearly three-quarters of designers/specifiers were likely to have recommended LLLC in a project in 2024, an increase of 10 percentage points from 2022. This increase continues a trend from 2021, when under half said they had recommended LLLC.

Table 10. Designers/Specifiers Recommending LLLC

Stratum	2021	2022	2024	2022–2024 Change
Designers/Specifiers	44% (n=75)	63% (n=27)	73% (n=29)	+10%

Source: Installer and Designer/Specifier survey D3 "How many times would you estimate your company has included a recommendation for LLLC in a project?" Note: if the respondent indicated once or more, they were marked as a positive response for this analysis.

Respondents were similarly slightly more likely to have written LLLC into a project plan in 2024 than in 2022, shown in Table 11.

Table 11. Designers/Specifiers Writing LLLC into Project Plans

Stratum	2021	2022	2024	2022–2024 Change
Designers/Specifiers	35% (n=78)	61% (n=27)	67% (n=35)	+6%

Source: Installer and Designer/Specifier survey QD6: "Approximately how many times would you estimate your company has written LLLC into a project plan?" Note: if the respondent indicated once or more, they were marked as a positive response for this analysis.

MPI 6A: Manufacturers reported overall increasing availability of LLLC-capable fixtures.

All five lighting and sensor manufacturers reported that they manufactured fixtures in all four categories of interest and that most fixtures were LLLC-capable. Two representatives reported that recessed cans were the hardest lighting product to integrate with LLLC, and multiple said they were working on potential sensor solutions.[4] Most reported that market sales for LLLC-capable products were increasing. While the software manufacturer was not asked these questions specifically, they noted that the growing sensor ecosystem has matched the growth in LLLC. Outside of the interviews, Cadmus noted that one manufacturer had created a dedicated webpage with a product guide and step-by-step instructions to address LLLC requirements.

Table 12. Lighting Manufacturer Product Availability (MPI 6A)

Fixture Type	Produced?	LLLC Integrated?	Market Trend
Low Bay	5- Yes	5- Yes	5-Increasing
High Bay	5-Yes	5- Yes	4-Increasing (with 1 reporting less adoption than other fixture types); 1-said "low adoption"
Retrofit Kits	5-Yes	5- Yes	5-Increasing
Recessed Cans	5-Yes	3- Yes; 2 No	3-Increasing; 2-said "low adoption"

Source: Manufacturer Interviews question 3: "I'm going to list four types of lighting products. For each of them, I'll want to learn a little more about their compatibility with LLLC and how your offerings may have changed in the last two years. So first, do you manufacture low-bay fixtures? [If yes] About how many low-bay fixture types do you make that can be used in LLLC systems? Has that stayed the same, decreased, or increased over the last two years? [Repeat for High-bay fixtures, Recessed cans, and Retrofit kits]"

[4] Recessed cans are not a target application for LLLC and are included due to their prevalence in lighting projects.

MPI 6B: Manufacturer's representatives said that there were sufficient LLLC products available to meet their customers' needs.

All four manufacturer representatives mentioned having increased availability of low-bay and high-bay fixtures with embedded controls. Manufacturer representatives disagreed about the availability of recessed cans[5], with some reporting adequate options and others noting limited supply and low demand. Manufacturer representatives generally agreed that retrofit kits with embedded sensors were available, with one representative saying that these kits were the least available option. Manufacturer representatives shared that their sales trends showed growth in most categories, except for some recessed can options and retrofit kits, for which opinions were mixed.

Table 13. Manufacturer Representatives Product Availability (MPI 6B)

Fixture Type	Product Availability by Manufacturer	Sufficient LLLC Availability to Meet Needs?	Market Trend
Low Bay	4- Yes	4- Yes	3- Increasing; 1- Decreasing
High Bay	4- Yes	4- Yes	3- Increasing; 1- Decreasing
Retrofit Kits	4- Yes	3- Yes; 1- No	2- Increasing; 2- Stayed the same
Recessed Cans[5]	4- Yes	2- Yes; 2- No	3- Increasing; 1- Stayed the same

Source: Manufacturer Representative Interviews question 4: "I'm going to list four types of lighting products. For each of them, I'll want to learn a little more about your thoughts on the variety of products. So first, do the manufacturers you represent produce low-bay fixtures? [If yes] Do you feel the number of low-bay fixtures with embedded controls is sufficient to meet your customers' needs? Has that stayed the same, decreased, or increased over the last two years? [Repeat for High-bay fixtures, Recessed cans, and Retrofit kits]"

MPI 6C: Most designers/specifiers shared that the types and styles of LLLC fixtures available were sufficient for their needs.

MPI 6C tracks the percentage of designers/specifiers who say there are sufficient types and styles of fixtures with embedded controls to meet their LLLC system design and specification needs. The Cadmus team designated respondents who rated their satisfaction with the fixtures as a seven or higher on a scale from one to 10 as thinking that the types and styles of LLLC fixtures were sufficient.

Of responding designers/specifiers, 87% (n=31) indicated that the types and styles of LLLC fixtures were sufficient. Two respondents who found the types and styles of LLLC fixtures insufficient shared a bit more context. One wrote that "any architectural/decorative fixture you want in the job either [is not offered] or the price is exorbitant" and another cited limitations with "flexibility for relocating light fixtures as space uses change."

MPI 9A: A majority of installation companies continue to have experience with LLLC.

MPI 9A monitors the number of installation companies that have installed at least one LLLC system. As shown in Table 14, 65% of installation companies have installed at least one LLLC system, reflecting

[5] As noted above, recessed cans are not a target application for LLLC.

modest but consistent year-over-year growth from estimates in 2021 and 2022 of 61% and 63%, respectively.

Table 14. Installation Companies That Have Installed at Least One System

Stratum	2021	2022	2024	2022–2024 Change
Installers	61% (n=159)	63% (n=32)	65% (n=52)	+2%

Source: Installer and Designer/Specifier survey QC7: "To the best of your knowledge, has your company ever installed an LLLC system?" Note: Cadmus changed the question design between 2022 and 2024 due to respondent difficulties answering the prior question.

MPI 9B: Installers were more likely to say that LLLC was easier to install than other NLC.

MPI 9B monitors the percentage of experienced installation companies (those that have installed at least one LLLC and other NLC systems) that say LLLC systems are easier to install than other NLC systems. In 2024, a higher percentage of respondents than in 2022 said LLLC require less time and labor than other NLC, a continued positive trend from 2021 and 2022 (Table 15).

Table 15. Experienced Installers Who Say LLLC Requires Less Time and Labor to Install than Other NLC

Stratum	2021	2022	2024	2022–2024 Change
Installers	43% (n=59)	70% (n=21)	83% (n=28)	+13%

Source: Installer and Designer/Specifier survey QC10: "Based on your experience, which type of system is likely to require less time and labor to install and program – an LLLC system, or another type of networked controls system?"

MPI 9C: Overall, the average number of LLLC projects per installer was about nine per year.

MPI 9C measures the average number of LLLC projects that installation companies have completed in the last 12 months, by asking respondents to estimate the number of buildings they've completed retrofits for and estimating the number of fixtures involved[6]. On average, these respondents reported installing LLLC in an average of 9.2 buildings (n=46), with the majority of the projects that were completed (65%) consisting of 100 or fewer fixtures each. Among installers who completed projects, the number of buildings involved ranged from 1 to 75[7] and a quarter (24%) of these projects had a larger amount of fixtures (101-300). Only 10% of the projects reported utilized 301 fixtures or more.

MPI 10A: Decision-makers were varied in their willingness to pay more for LLLC lighting

MPI 10A measures decision-makers' willingness to pay an additional cost for a lighting system with advanced LLLC over one with only basic controls (i.e., on/off switch). Interviewers presented decision-makers with a hypothetical lighting upgrade project in which the LLLC controls could save up to 50% of

[6] Thinking of LLLC projects as happening 'by building' was easier for respondents and provided more replicable results than asking about "projects". We used number of buildings as a proxy for number of projects for this MPI.

[7] During data cleaning, one installer reported 235 buildings in the prior year, which was removed from analysis as an outlier. See *Appendix A. Detailed Methodology Data Cleaning* section for full details on the data cleaning approach.

energy per year over the basic controls strategy. Interviewers then asked decision-makers how likely they would be, on a scale of '1' to '10' (with '10' being most likely), to choose the advanced LLLC system over the system without any controls, if it were $45 more expensive per fixture, $30 more expensive per fixture, $15 more expensive per fixture, or the same price.[8] If a respondent gave an answer of '8' or higher for likelihood to choose the system at a $45 per fixture incremental cost, they were not asked about the lower priced options.

Table 16 shows a summary of answers by incremental cost. Six respondents would be willing to pay more for an LLLC system over a basic controls system, with three selecting $45 more per fixture and three selecting $15 more per fixture. A full set of results by respondent can be found in Appendix B. Expanded Results.

The three decision-makers who reported a high likelihood of choosing the advanced LLLC controls system at the highest price point all argued that the savings would "outweigh" or "justify the added cost." One respondent, who would be highly likely to choose the advanced system only if it were the same price, argued that any additional price would be a challenge, especially since they (along with several other respondents) relied on utility incentive programs to support the lighting retrofits they recently underwent.

Table 16. Decision-Makers' Willingness to Pay More for Advanced LLLC Systems

Incremental Cost for LLLC	Number of Respondents
$45 more expensive per fixture	3
$30 more expensive per fixture	0
$15 more expensive per fixture	3
Same price per fixture	4

The likelihood of choosing the advanced LLLC system was ranked on a 1–10 scale. Once a respondent gave a rating of '8' or higher, the respondent was considered sufficiently likely to pay for the advanced LLLC system at that price level and was not asked subsequent price levels. Respondents are ordered from most likely to choose an LLLC system to least likely.

Source: Decision-Maker Interview, D1–D4 "How likely would you be to choose the advanced LLLC system if was [price] per fixture?" (n = 10)

MPI 12: Three of four Northwest states specify LLLC as a code compliance pathway while the fourth allows, but does not specify, LLLC.

MPI 12 assesses whether LLLC is stated as a way to meet compliance with code in each Northwestern state. The Cadmus team reviewed the code documentation for each of the four states in NEEA's territory to understand if LLLC is an optional pathway for compliance. In three of these states, Idaho

[8] Cadmus selected these price levels by reviewing data from the 2022 LLLC Incremental Cost Study. Cadmus used the clever-smart hybrid full system incremental cost (IMC) of ~$55 (with a fixture-only IMC of ~$47) because this system type can cover a similar range of features of a full LLLC system but might be more likely to be selected by a non-knowledgeable customer. To make it easier to cover in a phone call, Cadmus rounded the IMC to $45.

(IECC 2018, 405.2), Montana (IECC 2021, 405.2), and Washington (IECC 2021, 405.2), LLLC is mentioned as a way that new construction projects can meet code. The exception is Oregon (ASHRAE 90.1-2022), where LLLC is not mentioned, but could be used to meet the required and optional control strategies listed in section 9.4.1.1 and tables 9.5.2.1-1 and 9.5.2.1-2.

MPI 15A and 15B: LLLC systems are the first choice for the majority of market actors.

MPIs 15A and 15B explore whether LLLC systems are the first choice for lighting controls systems in applicable project types among installers and designers/specifiers, respectively. The analysis was limited to installers who had installed at least one LLLC system and designers/specifiers who had recommended LLLC for least one project. As shown in Table 17, most experienced installers (81%) and designers/specifiers (73%) identified LLLC systems as a first choice for projects over other networked controls systems.

Table 17. LLLC Systems as a First Choice

Stratum	Percentage
Installers	81% (n=30)
Designers/Specifiers	73% (n=21)

Source: Installer and Designer/Specifier survey QC11 and QD4: "Based on your experience, which type of system is your first choice in controls when applicable to the project type – an LLLC system, or another type of networked controls system?"

RO #3: Lighting Controls Market Research

Cadmus added questions to the manufacturer representative and decision-maker interviews in order to explore the rationale of buyers and sellers who included LLLC in their initial project plans, but did not follow through with the purchase or sale. To support a more nuanced understanding of the value proposition explored through this research objective, Cadmus collated information sharing the perceived benefits and drawbacks of LLLC by manufacturing representatives and commercial building decision-makers.

Removal of LLLC from Project Plans

Cadmus asked several groups of market actors about cases in which LLLC were included in project plans but ultimately removed prior to installation.

Manufacturer representatives noted a variety of reasons why customers removed LLLC from project plans.

All four representatives confirmed that they had experienced cases in which they were working with a customer who initially included LLLC in their project plan but ended up installing something else. Manufacturer representatives cited several reasons for the removal of LLLC from project plans. Some noted that poor communication with the end-user regarding the increased cost of LLLC often impacted the decision, as these customers were deterred by the high up-front equipment costs and lack of certainty on labor savings. One representative said, "I've run into [scenarios] where there's not good

communication of the message of the labor savings, so that upfront material costs is a bit more of a shock." The representative then explained that this can lead the end user to not select LLLC, as they did not have a full picture of the long-term costs of their lighting system choices.

Another representative said that there was a push from local utilities in their geographic region to steer design teams toward LLLC. However, the representative noted that some contractors may include LLLC-capable fixtures in a project plan, but not adequately explain those capabilities and their related cost and energy savings with the customer or offer to program the fixtures' LLLC features, resulting in the customer opting for a more basic controls package rather than installing LLLC. In these cases where they are only seeing the upfront costs, the end user doesn't typically see enough financial benefit from the utility rebate and often opts out of embedded controls to stay within budget. Another representative observed that many customers are deterred from installing LLLC systems, because procuring all of the necessary products from the same manufacturer is not always feasible, and oftentimes LLLC products from different manufacturers do not work together properly.

Representatives cited several types of systems that customers typically installed after removing LLLC from their project plans. Two recalled that at least 50% of these projects end up with some type of NLC, especially if the customers understood some of the benefits of advanced controls. The other two representatives said that most customers resort to code minimum lighting controls. Multiple representatives noted that the final decision on controls often comes down to cost and ease of operation after installation; customers can sometimes be deterred when learning about the programming needs for more advanced controls.

Decision-makers had varied reasons for choosing non-LLLC controls

Cadmus asked decision-makers who had not installed LLLC fixtures or other NLC systems as part of their lighting upgrades why they chose different lighting options. Two respondents whose projects featured only limited controls and who did not have any familiarity with LLLC said that they had not considered such a system. One of these respondents whose lighting upgrade was entirely covered by a utility incentive program said that the "offer was for the basic upgrade."

Another respondent began their lighting upgrade several years ago, at which time they did not see LLLC as an option. As the technology became more prevalent, they embraced LLLC in applicable areas of their building, while using standard lighting fixtures in spaces such as laboratories that required constant lighting and couldn't practically utilize advanced controls.

For other NLC systems, two respondents said the building structure limited installation of wired fixtures, with one specifically citing drop ceilings as a barrier. One of these respondents mentioned that LLLC fixtures would avoid these issues.

LLLC Market Barriers

Manufacturers, manufacturer representatives, and commercial building decision-makers each discussed the barriers to further LLLC adoption.

Manufacturers and manufacturer representatives noted that education is a major barrier to LLLC adoption.

Cadmus asked manufacturers and manufacturer representatives about barriers that remain in the LLLC market. Four manufacturers stated that a lack of education, specifically among contractors and installers, has led to difficulties in the sales process. Three suggested increasing education to drive awareness among end users, such as building owners and facility managers. Two suggested that programming enhancements and education could make LLLC more user friendly for end users. One stated that knowledgeable technicians help to communicate LLLC's value and expand the technology. This manufacturer views LLLC as the logical next step for lighting controls, and thinks anything that expands availability, acceptance, and education is good for the industry.

Two manufacturer representatives also emphasized the need to educate contractors, architects, engineers, and end-use customers who might not be aware of the benefits of LLLC. One representative shared that most current LLLC-specific training occurs on a one-time basis, and that increasing the frequency of training sessions and standardizing the content could help raise the profile of LLLC. To supplement training and standardize educational resources for customers, another representative suggested that manufacturers should create platforms that are easy to access on a cell phone or websites that users can log in to for assistance with troubleshooting challenges that they encounter with their systems.

Manufacturers and manufacturer representatives observed a variety of gaps in the market for LLLC.

Beyond education, manufacturers noted that building integration, mechanics, interoperability, commissioning, and attention to code and costs could all be improved. Two manufacturers expressed excitement about the potential for HVAC integration driving the LLLC market towards implementing sensor control in all fixtures in the future, but stated that these capabilities are not widely available or implemented. Two manufacturers named connectivity and mechanical issues as candidates for improvement, with one mentioning that improved Bluetooth performance has increased the allowable distance between fixtures. While expanded Bluetooth has allowed better signal performance for outdoor and obstructed facilities, which has expanded LLLC possibilities, connectivity still has room for improvement. One manufacturer also noted that simplified commissioning and installation, particularly related to room zoning and system design, may make LLLC easier to sell. One mentioned that the incremental cost for LLLC was still high, especially for quality manufacturers. One noted that additional enforcement through building codes, stronger enforcement of controls use from utilities involving rebates as well as sensor monitoring would help ensure that LLLC are utilized and programmed as expected.

Multiple manufacturer representatives pointed to the lack of industry standardization as a major gap in the LLLC market. One representative shared that the proprietary nature of some products makes integration difficult. Another emphasized that there are significantly fewer controls manufacturers than lighting manufacturers, which hinders interoperability with existing fixtures, as the brand of fixture already installed and not scheduled to be replace may not have an LLLC-compatible model from the

same manufacturer. One representative noted that it can be difficult to find a single manufacturer that can cover the full project because they may not manufacture enough product lines. Therefore, customers may face challenges finding and working with multiple manufacturers and default to legacy lighting control systems. This representative suggested that increased standardization would create an easier process for embedding sensors into different fixture types.

Conclusions and Recommendations

Based on the research conducted for this MPER, Cadmus offers the following conclusions about the market for LLLC along with recommendations to improve the LLLC program.

Review and Verify Program Activities

Conclusion 1: LLLC program activities have contributed to expected program outcomes.

Program staff noted that the number of LLLC stakeholders they engage with has dynamically increased. Staff stated that working with an expanded audience of stakeholders has further raised awareness of LLLC and opened opportunities to add technological capacities based on various manufacturing approaches. As a result of these activities, LLLC is written into more standards and has become a recommended practice and accepted control strategy. This shows that LLLC is meeting a business need to find additional opportunities for energy savings from lighting.

Track Market Progress

Conclusion 2: LLLC is well positioned to grow its market share in the commercial lighting market.

Building on MPER 1 and MPER 2, a large majority of installation companies and designer/specifiers are aware of LLLC and demonstrate a preference for this technology in their lighting projects. The share of installers (94%) and designers/specifiers (82%) aware of LLLC has grown to be nearly universal among those surveyed, maintaining its high level since MPER 2 (MPI 4A). The share of designers/specifiers who recommend LLLC to customers and included LLLC in project plans has also remained strong (MPI 5A, 73%; MPI 5B, 67%) and most designers/specifiers say that LLLC fixtures meet the needs of their customers (MPI 6C, 87%). Market actors' positive experiences with LLLC have also influenced their decision-making, with approximately three-quarters of installers and designers/specifiers who have included LLLC fixtures in their projects identifying LLLC as a first choice when technically feasible (MPIs 15A and 15B).

Recommendation 2: Focus future program activities on supporting managers, utilities, professional organizations, and trade organizations with trainings that help installers and designers/specifiers with converting LLLC opportunities to installations, with an emphasis on appropriate LLLC programming and operations.

Conclusion 3: While installation companies' ability to install LLLC remained strong, a decrease in reported formal training indicates further opportunity for engagement.

In MPER 3, a growing majority of installation companies said that they can install LLLC (MPI 3D, 89%), despite the share of market actors who reported receiving training on LLLC decreasing (MPI 3B, 71% in 2022 to 47% in 2024). Among the installers who reported that they did not receive training on LLLC, all but two said their company has the capability to install LLLC, indicating a possible reliance on informal training or the use of trained subcontractors to install LLLC.

Trained lighting installers continue to be distributed across the Northwest region, consistent with overall levels of training (MPI 3E, 41% to 59%). Over six of 10 installation companies stating that they have experience installing LLLC (MPI 9A, 65%). The ability to install LLLC has also improved in MPER 3, with a vast majority reporting that LLLC are easier to install than other advanced control systems (MPI 9B, 83%) and an average of 18.9 LLLC projects installed annually (MPI 9C).

Recommendation 3a: Encourage formal training providers to conduct additional outreach to lighting market actors in order to increase participation in LLLC training. Advise these training providers to emphasize that formal training can provide market actors with the skills necessary to fully utilize LLLC. Additionally, encourage training providers to host trainings that go beyond introductory and awareness building to cover more nuanced value propositions and how to fully utilize the many benefits of LLLC in different space types.

Recommendation 3b: Identify any potential training gaps in the LLLC market and, should a gap be identified, work with manufacturers, utilities, and professional organizations to either incorporate this topic into existing trainings or create a new training module.

Lighting Controls Market Research

Conclusion 4: While knowledgeable users found value in their LLLC systems, commercial building decision-makers' understanding of LLLC features and value proposition remains low.

Of the ten decision-makers interviewed about lighting upgrades they made in the last two years, only three were aware of LLLC, knew that their upgrade project featured LLLC fixtures, and were knowledgeable about LLLC's various benefits. Other interview respondents had installed upgrades with lighting fixtures that included many of the components of LLLC but did not know whether they were LLLC or basic fixtures with limited controls.

Of the LLLC-knowledgeable respondents, all were aware of the energy savings benefits of LLLC, but two primarily found the lighting quality to be the most valuable feature of the lighting system, citing the potential health and commercial benefits of more-natural lighting. The LLLC-knowledgeable respondents were also highly satisfied with the aesthetics of the fixtures, while the least satisfied respondents all had non-LLLC fixtures. The cost benefits from controls like occupancy sensing were the most commonly cited by respondents with more limited LLLC knowledge.

Manufacturer representatives reported that the higher up-front cost of LLLC fixtures over other options was a primary reason for customers removing them from projects, with many not seeing the value or long-term cost benefits of LLLC as outweighing the initial cost. Representatives attributed this lack of understanding to contractors and installers not discussing the capabilities or benefits of LLLC fixtures with customers. A lack of education on the benefits of LLLC among contractors and installers, as highlighted by several manufacturers, likely contributes to this information not reaching the customer to inform their lighting project decisions.

Recommendation 4: Work with formal training providers to develop opportunities for lighting installers and designers to highlight the benefits of LLLC during sales conversations, focusing on higher quality

light and the adaptability of LLLC fixtures as well as the benefits from energy efficiency. This will provide market actors with the ability to educate their customers on the full breadth of features and the value of LLLC systems to provide savings on a longer-term basis.

Conclusion 5: While the technological capabilities of LLLC fixtures have grown, market barriers remain.

Manufacturers noted that building integration, mechanics, interoperability, commissioning, and attention to code and costs could all be improved. In particular, two manufacturers expressed excitement about HVAC integration driving the LLLC market towards implementing sensor control in all fixtures in the future, but noted that the technology is not yet widely available or in use. Two manufacturers named connectivity and mechanical issues as candidates for improvement, with one mentioning that improved Bluetooth performance has increased the allowable distance between fixtures.

Multiple manufacturer representatives pointed to the lack of industry standardization as a major gap in the LLLC market. One representative shared that the proprietary nature of some products makes integration difficult. Another emphasized that there are significantly fewer controls manufacturers than lighting manufacturers, which hinders interoperability with existing fixtures, as the brand of fixture already installed and not scheduled to be replace may not have an LLLC-compatible model from the same manufacturer.

Appendix A. Detailed Methodology

The MPER 3 has three core research objectives:

- Review and verify program activities that the LLLC program completed since the previous MPER.
- Track identified MPIs that measure the reduction of identified market barriers and conduct year-over-year analyses to report progress on several program outcomes.
- Conduct market research to understand the rationale of buyers and sellers who include LLLC in their initial project plans, but do not follow through with the purchase or sale.

To inform MPER 3, the Cadmus team conducted several primary and secondary research tasks and designed each to address a specific subset of research questions related to the core research objectives. This section provides additional detail on the methods and purpose for each task listed in Table A-1.

Table A-1. Research Activities for NEEA LLLC MPER 3

Task	Research Objectives Addressed	Target Group/Documents (and Completion Targets)	Completions Achieved
Document review	1	Program quarterly progress reports, code documentation for Northwest states, and email review	N/A
Stakeholder interviews	2, 3	NEEA program staff and NEEA implementation contractor staff	5
Supply-chain market actor interviews	2, 3	Lighting and controls manufacturers and manufacturer representatives	10
Installer survey	2, 3	Northwest commercial lighting and controls installation companies	59
Designer/specifier survey	2, 3	Northwest commercial lighting designer/specifier companies	37
Decision-maker interviews	2, 3	Northwest building owners and managers who installed lighting controls	10

Document Review and Stakeholder In-Depth Interviews

Cadmus reviewed NEEA's program documents to verify that the program completed the designated activities since MPER 2. In parallel with this effort, Cadmus interviewed NEEA program staff and implementation contractor staff (collectively, stakeholders) to understand more about program progress and activities.

Objectives

Through the documentation review and stakeholder interviews, Cadmus addressed several objectives:

- Explore program goals and progress
- Understand state of NEEA outreach activity and perceived impact

- Explore utility support through programs and incentives
- Explore emerging regional and national trends that may impact the lighting market

Approach

Cadmus conducted a review of the recent program quarterly progress reports, code documentation for Northwest states, and several emails containing relevant information. Given that the research team completed a detailed review of program documentation in MPER 1 and MPER 2, the review for the MPER 3 focused only on select topics.

Cadmus conducted the stakeholder interviews with NEEA program staff in parallel with the documentation review to assess the alignment of program documentation and actual implementation. This provided insight on the status of the market, including any evidence of expected outcomes or NEEA influence. Cadmus completed four interviews with program staff—two with NEEA program staff and two with the program implementer.

Supply-Chain Market Actor In-Depth Interviews

Cadmus interviewed representatives from lighting and controls manufacturers and manufacturer representatives.

Research Topics

During the market actor interviews, Cadmus addressed several topics about key supply-chain functions and market demand:

- Comparison of the market presence of LLLC products, including whether a sufficient mix of product exists by fixture type
- Characteristics of LLLC buildings and lighting projects and differences between the two
- Which LLLC product features were most interesting to prospective buyers and whether buyers valued integration with other building systems
- LLLC marketing and promotional activities

Sample

Cadmus recruited respondents from a contact list that NEEA developed. Two of the manufacturer respondents—a controls manufacturer and a software manufacturer—did not directly manufacture LLLC fixtures. Cadmus did not count the software manufacturer in the MPI calculation. Table A-2 shows the target and number of completed interviews with each market actor group.

Table A-2. Supply-Chain Market Actor Interview Sample

Respondent Type	Target	Completed
Manufacturers	4	6
Manufacturer Representatives	4	4

Installer and Designer/Specifier Survey

Cadmus conducted a survey of installers and of designers and specifiers (grouped together as the designer/specifier population for this report). The research team used the survey to assess several LLLC MPIs and address research questions about these market actors and the companies they represented. Cadmus worked with a phone survey vendor to field the surveys from March to June 2025, offering respondents a $100 gift card and a chance to win a $300 gift card as incentives to participate in the survey.

Research Topics and Survey Design

The primary objective of the survey was to assess the MPIs related to these market actors and their companies, with a focus on their knowledge of, experience with, and preferences for LLLC.[9]

Through the survey, Cadmus also addressed several topics related to market status:

- Types of training and training providers for training installers and designers/specifiers have received
- Types of organizations that have installed LLLC
- Context on LLLC installations in exterior parking lots
- Supplier perceptions of LLLC benefits and drawbacks

The research team used the same survey the Cadmus team fielded in MPER 2. For one MPI (MPI 9C), Cadmus worked with NEEA to change the MPI question design between MPER 2 and MPER 3 because of difficulties respondents had with the question in the MPER 2 survey.

Sample Design

Cadmus defined the population of installers and designers/specifiers as belonging to all commercial lighting installation and/or design/specification firms that worked with lighting controls, served the Northwest (Idaho, Montana, Oregon or Washington), and had at least one office or base of operations in the Northwest. The research team stratified this population as follows:

- **Installers – Trade Allies:** Northwest commercial lighting and controls installers from lists of affiliated trade allies provided by NEEA alliance member utilities. Trade allies were likely to have attended trainings on controlled lighting installations provided through either the Lighting Design Lab (LDL) or NXT Level[10].
- **Installers – Non-Trade Allies:** All other Northwest commercial lighting and controls installers without a known affiliation with a NEEA partner.

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[9] The MPIs covered in the survey were 3B, 3D, 3E, 4A, 5A, 5B, 6c, 9A, 9B, 9C, 15A, and 15B.

[10] NXT Level is a commercial lighting controls training program designed to enhance the capabilities of commercial lighting design and installation companies in the Northwest.

- **Designers/Specifiers**: Professionals providing lighting design or specification services, specifically around commercial lighting and controls, to clients in the Northwest, including architecture firms, mechanical and engineering firms, independent designers, energy service companies, and others.

To determine the size of the populations and sample sizes for each market actor, Cadmus purchased installer and designer/specifier contact information from third-party vendors Data Axle and Exact Data and supplemented these with the trade ally contact lists provided by NEEA.

Cadmus developed a detailed set of rigorous data-cleaning protocols to merge these sample sets and account for duplicate contacts in an organized, replicable manner. The protocols accomplished several objectives:

- Removed firms known to be outside the target populations of installers and designers/specifiers
- Identified the unique firms by state present in the data based on company names, addresses, and phone numbers
- Selected a single point of contact for each unique firm[11]
- Assigned individuals to sampling strata using North American Industry Classification Systems (NAICS) code to determine best fit
- Created sample frames for each stratum

Survey screening included several questions intended to determine the respondent's knowledge level and categorize the respondent's company as part of the installer or designer/specifier population. Because designers/specifiers are less common than installers (see population estimates in Table A-3), a respondent that qualified as both was classified as a designer/specifier and presented with questions for that population. Thus, the respondent's initial stratum classification based on NAICS code was not necessarily their stratum for the survey.

To increase participation and reach a broader audience, Cadmus conducted direct outreach at two in-person events, one in Seattle and one in Portland, during fielding.

Based on the adjusted population calculated in MPER 1 (the "Population" column)[12] and final sample sizes in MPER 3, Cadmus applied strata weights to estimate results at the population level. Table A-3 shows the population and number of completed surveys in the final sample by stratum.

Cadmus did not reach the target sample sizes for all strata during fielding. The research team had a high degree of non-responders across the sample frame, resulting in a 1% response rate across the sample.

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[11] If the single point of contact did not respond to the survey request, Cadmus used secondary and tertiary points of contact.

[12] Cadmus calculated the adjusted population values shown in Table A-3 during the work for MPER 1. This involved a comprehensive assessment of the population of installers and designers/specifiers in the Northwest, estimating the total number of market actors in each stratum.

Cadmus has experienced a drop-off in response rate among its other projects targeting contractors in the past two years.

Table A-3. Installer and Designer/Specifier Populations and Survey Samples

Stratum	Population	Target Completions	Achieved Completions	Expected Precision at 90% Confidence [a]
Installers [b]	2,136	68	59	≤ ±18.9%
Designer/Specifier [b]	1,353	68	37	≤ ±20.1%

[a] Confidence and precision are calculated at the question level. Therefore, in this table, Cadmus has reported the highest precision for each stratum. Due to the low sample size, precision at 90% confidence is very variable for some questions that respondents answered drastically differently. When respondents aligned well on their responses, precision was within ±2.6%.

[b] The *Sample Design* section above includes definitions of the strata for market actors at installation and designer/specifier companies. Each respondent (and company) counted as either an installer or designer/specifier based on the respondent's answers to the survey question. If a respondent had experience in both design/specification and installation, they were asked the designer/specifier set of questions.

Across the survey, most questions were designed to assess information about the respondents' company (i.e., question C4. "For each of the following, please indicate if any staff at your company, including yourself, have been trained on this subject."). Cadmus crafted the survey questions in this manner due to the structure of the MPIs, with most referring to installation or design/specification "companies." Some metrics that were difficult to assess at a company level, such as awareness of LLLC or perceptions of LLLC product suitability, were assessed in questions about the individual's own experience. In these instances, Cadmus assumed that an individual's experience was representative of the company for the purpose of MPI tracking. This assumption required the sample frame to contain a primary contact for each firm-state combination, which was built into the data cleaning procedures.

Data Cleaning

Cadmus used industry best-practice data cleaning processes when reviewing the Installer and Designer/Specifier survey data, checking each response against expected outcomes. Additionally, each MPI had its own rules for which responses qualified and how they were counted. For MPI 9C (average number of LLLC projects), Cadmus used John Tukey's (1977) method for removing outliers known as "Tukey fences." These are bounds set on a dataset to identify data points that fall far outside the interquartile range. Tukey proposed the bounds outlined in Equation 1 for fences to determine outliers.

Equation 1. Tukey's Fences

$$-Q_1 - k(Q_3 - Q_1), Q_3 + k(Q_3 - Q_1)$$

where k=1.5 indicates an outlier and k=3 indicates data that are "substantial outliers"

Cadmus selected the Tukey fence value of k=3 to take a more conservative approach with the data-cleaning process because of the small sample size of this question (n=46). Using the Tukey fence value of k=3 resulted in one data point being removed from the analysis.

Building Owner and Manager Interviews

Cadmus conducted interviews with building owners and managers from organizations that had completed a lighting project within the past two years and received a utility incentive. The research team used this survey to collect data to assess one LLLC MPI and to conduct corresponding research on other areas of interest to NEEA. Cadmus fielded the interviews in March through June 2025, offering respondents a $100 gift card as an incentive to participate in the survey.

Research Topics

Cadmus used the survey to explore topics related to customer decision-making with regard to lighting controls purchase and installation:

- Respondent awareness of and past experience with lighting controls generally, and LLLC specifically, including perceptions of attributes and features
- The structure of the decision-making process, including how customers became aware of the controls they selected, influential actors, and details of specific equipment proposals (when proposals were made and how equipment was vetted)
- Relative importance of decision-making factors for installing LLLC and why LLLC was removed from the project plan if the customer opted not to install LLLC
- Real and perceived barriers or challenges related to LLLC
- Customer experience and satisfaction with the lighting system
- For those who *did not* purchase LLLC or other NLC, what equipment was installed and why that specific equipment was chosen
- Space and building characteristics, such as industry segment, space uses, vintage, own versus lease, single versus multiple building, and retrofit versus new construction

Sample Design

Cadmus used NEEA partner utility data as the sample frame from which to recruit respondents. Cadmus conducted outreach to all respondents on the list, with the intent to collect a mix of respondents from across NEEA's territory and different building segments. Cadmus completed a total of 10 interviews.

Appendix B. Expanded Results

This section contains expanded results from the main body of the report.

MPI 10A: Decision-Maker Willingness to Pay

Table B-1 contains the full results from the decision-maker willingness to pay question battery, including respondents' answers for each incremental cost level.

Table B-1. Decision-Maker Willingness to Pay Response Details

Decision-Maker	$45 more expensive per fixture	$30 more expensive per fixture	$15 more expensive per fixture	Same price per fixture
Respondent 1	10	–	–	–
Respondent 2	9	–	–	–
Respondent 3	8	–	–	–
Respondent 4	6	7	9	–
Respondent 5	5	7	10	–
Respondent 6	4	4	10	–
Respondent 7	5	5	6	10
Respondent 8	5	5	5	10
Respondent 9	5	5	5	10
Respondent 10	5	5	5	10

The likelihood of choosing the advanced LLLC system was ranked on a 1–10 scale. Once a respondent gave a rating of '8' or higher, the respondent was considered sufficiently likely to pay for the advanced LLLC system at that price level and was not asked subsequent price levels. Respondents are ordered from most likely to choose an LLLC system to least likely.
Source: Decision-Maker Interview, D1–D4 "How likely would you be to choose the advanced LLLC system if was [price] per fixture?" (n = 10)

Decision-maker General Lighting Project Feedback

Through the decision-maker interviews, Cadmus asked decision-makers several questions about their lighting upgrade projects.

Many decision-makers encountered challenges with installations, though all were overcome.

When asked if decision-makers had encountered any challenges during their lighting installation projects, seven of 10 said they had. As shown in the table below, challenges included unexpected complexity of the wiring or placement of the lighting fixtures, supply chain issues, and skepticism about incentive programs. Installation challenges were mentioned the most, (by five respondents); these included wiring issues (two respondents), high placement of fixtures (two respondents), and complicated ceiling structure (one respondent). One respondent who had challenges with wiring appreciated that LLLC fixtures "reduce[d] the need for getting involved with existing wiring."

Table B-2. Challenges Encountered during Lighting System Project

Challenges encountered	Count of mentions
Wiring/installation complexity	5
Supply issues	2
Program skepticism	1
None	3

Source: Decision-maker interview question B5 "Were there any challenges encountered during the project?" (n=10) Multiple answers accepted

After resolving these challenges, most respondents (seven of 10) rated their satisfaction with their new lighting system operation as a 5 out of 5 and the rest (three of 10) gave a rating of 4.

Decision-makers' lighting systems had varied advanced controls.

Cadmus asked decision-makers which advanced features beyond on-off switches they were aware of in their new lighting systems and received a range of answers, as shown in the table below Eight of the 10 respondents reported having advanced controls. The most common control feature was occupancy or motion sensing, which was available for all eight respondents who had advanced controls. Six decision-makers said that their light fixtures were networked to one another, and five reported their lighting systems had sensors in every fixture and were capable of daylight harvesting.

Table B-3. Advanced Controls of Decision-Makers' Lighting Systems

Decision-Maker	Installed LLLC?[a]	Controls Beyond On/Off Switch?	Occupancy Sensing	Networked to each other	Sensor in every fixture	Daylight harvesting	Energy use monitoring	Automatic response to utility TOU rates	Integrated with other building systems
Resp. 1	Likely	x	x	x	x	x	x		
Resp. 2	x	x	x		x				
Resp. 3	x	x	x	x	x			x	
Resp. 4									
Resp. 5		x	x	x		x			
Resp. 6	x	x	x		x	x			
Resp. 7	Likely	x	x	x		x	x		
Resp. 8		x	x	x					
Resp. 9	Likely	x	x	x	x	x	x		
Resp. 10									
Total	**6**	**8**	**8**	**6**	**5**	**5**	**3**	**1**	**0**

Source: Decision-Maker Interview, A8 "Did your lighting project include controls beyond on and off switches?" and A9 "I'm going to read a list of some capabilities that lighting fixtures with controls might have. Foe each one, please let me know if your new lighting system has this feature, doesn't have it, or if you're not sure." (n=10)

[a] "Likely" indicates that the respondent was not sure if they installed LLLC but based on their answers, Cadmus felt they had installed an LLLC system.

Interview respondents had a limited understanding of LLLC systems, whether their lighting upgrade included LLLC, and the scope of their systems' features. Only three respondents had a clear

understanding of LLLC and knew that at least some of their lighting upgrade included LLLC fixtures. These included decision-makers for lighting upgrade projects in convenience stores, a research lab, and a conference center.

Decision-makers found value from lighting systems that they installed.

Interviewees discussed which aspects and features of their lighting systems they did and did not find valuable. As shown in the table below, the most commonly valued aspect of the new lighting systems was energy efficiency and the power and monetary savings that come with it, which was mentioned by four respondents. No respondents mentioned energy efficiency as *not valuable*. Of the lighting system control features that the interviewees mentioned as *valuable*, occupancy sensing was the most common.

Of the three respondents with knowledge of LLLC, two mentioned light quality with their new system as *valuable*, with one respondent attributing improved sales in their convenience store to the LLLC installed and the other respondent saying the light quality improved the health of employees working under the lighting. The other respondent said that high-end trim, daylight harvesting, and the savings that come from those features were the most valuable aspect of their new LLLC lighting system.

Table B-4. Value of Lighting System Features

Features of Lighting System		Valuable	Not Valuable
General Lighting	Energy efficiency	4	–
	Quality of lighting	3	–
Controls	Occupancy sensing	3	2
	Dimming	2	1
	Daylight harvesting	2	–
	High-end trim	1	–
	Scheduling	–	1
	None	2	4

Source: Decision-maker interview question C2 "What features of your lighting control system have you found to be valuable? What made these features valuable to you? Conversely, what features have you not found to be valuable?" (n=10) Multiple answers accepted

Cadmus asked interviewees if they had input about how the lighting fixtures that they installed would look and how satisfied they were with their appearance. Of the 10 interviewees, six said that they did have some choice about the fixtures' appearance. Of the three LLLC-knowledgeable respondents, only one said that aesthetics were important; the other two were more focused on the function and compatibility of their new LLLC fixtures.

All respondents were satisfied with the aesthetics of their new lighting fixtures. Seven of 10, including all three LLLC-knowledgeable respondents, rated themselves as *very satisfied* and the three others, all of whom were basic upgrade respondents, were *somewhat satisfied*.

Market Actor Feedback on LLLC System Benefits

Across manufacturers and manufacturer representatives, the most frequently named benefits included energy savings, lower installation fees, and customer ease of use. Specifically, manufacturers' top cited benefits included the daylight harvesting and high-end trimming capabilities that result in energy savings, longer lighting lifespans, and lower energy bills. Two manufacturers highlighted ease of use for customers, as well as savings in equipment cost, time, and design for contractors. Three manufacturer representatives also pointed to ease of installation and operation as major benefits of LLLC, particularly from the perspectives of contractors and end users. Two manufacturer representatives noted cost savings as a significant driver of LLLC projects, including lower installation costs and availability of subsidies through utility rebates. Two manufacturers also explicitly named available rebates as a benefit of LLLC.

Manufacturer representatives spoke about aesthetic benefits and ways of addressing perceived barriers of LLLC. Two representatives emphasized the importance of aesthetics to architects and designers and how LLLC can assist these stakeholders through embedding sensors into fixtures and thereby reducing the need for exposed infrastructure such as sensors and wiring. Two manufacturers stated that addressing perceived complications, such as irregular lighting levels (which manufacturers call the "popcorn effect") due to a lack of industry standards for daylight capabilities, can also improve customer understanding and ease acceptance of LLLC. One manufacturer noted that their tiered lighting control plans include both LLLC and NLC capacities to address these customer concerns and needs.

Market actors named a variety of other benefits of LLLC, such as energy savings, the ability to meet energy codes more effectively, interoperability, reconfiguration capabilities, flexibility, future-proofing, performance improvement, data collection capacity, and wireless/Bluetooth features.

Appendix C. NEEA LLLC MPER 3 – Market Actor Survey

This survey is the third iteration of a market actor survey for NEEA's Luminaire Level Lighting Controls Market Progress Evaluation Report. The goal of this survey is to understand the state of LLLC in the Northwest by addressing the below Market Progress Indicators.

Research Objectives	Question Number
RO#2 – **Track Identified Market Progress Indicators**: Track identified MPIs that measure the reduction of identified market barriers and conduct year-over-year analyses when indicated to report progress on several program outcomes predicted by the program's logic model.	See table below
RO#3 – **Conduct Market Research**: Conduct market research to describe the rationale of buyers and sellers of LLLC that include it in their initial project plans, but do not follow through with the purchase or sale.	F1-F8

MPI	Question Number
MPI 3B. YOY increase in the percentage of lighting installation companies with at least one installer trained in LLLC.	C1-C4
MPI 3D. YOY increase in the percentage of lighting installation companies with the capability to bid on a project that involves LLLC installation	C5
MPI 3E. YOY, companies with at least one LLLC-trained installer become more evenly distributed across the region	B10-B12
MPI 5A: YOY increase in the percentage of companies with lighting designers/specifiers who have recommended LLLC to a project decision-maker for at least one project	D3
MPI 5B: YOY increase in the percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	D6
MPI 6C: The percentage of designers/specifiers who say there are sufficient types and styles of fixtures with embedded controls to meet their LLLC system design and specification needs	D7-D8
MPI 9A. YOY increase in the percentage of installation companies that report having installed at least one LLLC system ("experienced installation firms")	C7
MPI 9B. YOY increase in the percentage of these experienced installation companies that say LLLC systems are easier to install than non-LLLC systems	C10
MPI 9C. YOY increase in the average number of LLLC projects that companies have completed in the past 12 months	C8
MPI 15A: Percentage of "experienced" installation firms who say LLLC is their first choice in controls where technically applicable	C11
MPI 15B: Percentage of designers/specifiers who have recommended LLLC to a decision-maker for at least one project who say LLLC is their first choice where technically feasible	D4
Not tied to an MPI: Provides context on LLLC installations in exterior parking lots	C12-C15
Not tied to an MPI: Provides context to Designer/Specifier capabilities	D1-D4
Not tied to an MPI: Provides context to Designer/Specifier recommendation of LLLC	D5
Not tied to an MPI: Provides general market insights that help explain trends in other questions	E1-E5

Email Invite

To: **[EMAIL]**
From: **[YOUR MAIL]**
Subject: Market research study on commercial lighting market in the Northwest

Hello **[NAME]**,

We are conducting a research study with commercial lighting professionals on behalf of the Northwest Energy Efficiency Alliance (NEEA) to better understand the commercial lighting systems being installed in the Northwest. It will take about 15 minutes and **we will provide you with a $100 electronic gift card** as a thank you for your time and also enter you into a sweepstakes for one $300 VISA gift card (drawing across all respondents).

If you are knowledgeable about your company's commercial lighting work, you can click the link below to take the survey or copy the URL into your browser. If you don't think you're the right person, we would appreciate it if you could forward this email to the correct contact from your company.

[LINK: Click here to take the survey]

[SURVEY URL]

This study is being conducted by Leede Research and The Cadmus Group, two market research firms hired by NEEA to conduct these surveys. If you have any questions about the survey, please reach out to Mai Thao from Leede at 612-314-4403 or mthao@leederesearch.com. If you have questions about the broader study, please reach out to Mark Janett from The Cadmus Group at 617-673-7194 or mark.janett@cadmusgroup.com.

Thank you for your time and help with this,

[NAME
SIGNATURE]

PS. If you have questions about the study itself or would like to share any concerns, you are welcome to contact the lead researcher at the local non-profit coordinating this study instead; Zdanna King, Market Evaluation and Research Scientist at the Northwest Energy Efficiency Alliance (zking@neea.org).

A. Introduction

A1. Hello! May I please speak with **[CONTACT NAME]**?

A2. My name is **[NAME]** from Leede Research. We are conducting research on commercial lighting systems being installed in the Northwest on behalf of the Northwest Energy Efficiency Alliance (or NEEA). Are you the best person to speak to about the commercial lighting services your company provides?

1. ***IF YES, CORRECT PERSON – MOVE INTO SURVEY***
2. ***IF NOT THE RIGHT PERSON, ASK FOR INDIVIDUAL MOST KNOWLEDGABLE ABOUT COMPANY'S COMMERCIAL LIGHTING SERVICES.***
3. ***IF COMPANY DOES NOT OFFER LIGHTING-RELATED SERVICES USE DISPOSITION CODE 08 TO TERMINATE***

A3. Do you have about 10 minutes to speak with me today? We will provide you with a $100 gift card and enter you in a sweepstakes for a $300 VISA gift card, if you are eligible and complete this survey.

1. ***[IF NOT A GOOD TIME – SCHEDULE A CALL-BACK FOR A MORE CONVENIENT TIME FOR Let's RESPONDENT]***

A4. ***[IF NEEDED, STATE "THIS SURVEY IS FOR RESEARCH PURPOSES ONLY. THIS IS NOT A MARKETING CALL AND WE ARE NOT TRYING TO SELL YOU ANYTHING.. YOUR PERSPECTIVE HELPS*** **UTILITIES AND NON-PROFITS UNDERSTAND** ***ENERGY USE, TRENDS, AND TECHNOLOGY IN THE NORTHWEST."]***

1.

2. **[IF ASKED FOR A CONTACT TO VERIFY THE SURVEY AUTHENTICITY, OFFER** ***ZDANNA KING AT*** *ZKING@NEEA.ORG; A SCIENTIST WORKING AT THE NON-PROFIT THAT IS COORDINATING THE STUDY.]*

B. Screeners

B1. Thank you. First, does your **[COMPANY NAME]** do commercial interior lighting installation?

1. *(Yes)*
2. *(No)*

98. (Don't know)

99. (Refused)

B2. **[IF B1 = 1]** Does your company also install lighting **control** systems?

1. *(Yes)* ***[ASSIGN INSTALLER = TRUE] [SKIP TO B6]***
2. *(No)*

98. (Don't know)

99. (Refused)

B3. Does your company offer lighting design services, such as designing the lighting layout, appearance, and function of a space for major renovations or new construction projects?

1. *(Yes)*
2. *(No)*

98. (Don't know)

99. (Refused)

B4. Does your company provide commercial lighting specification, meaning you select and document the performance requirements and costs of system components, including controls for major renovations or new construction projects?

1. (Yes)

2. (No)

98. (Don't know)

99. (Refused)

[**IF B3=1 OR B4=1 ASSIGN D/S = TRUE AND SKIP TO B6]**

B5. **[IF INSTALLER ≠ TRUE AND D/S ≠ TRUE]** What business is your current company in?

*1. **[ALLOW TEXT ENTRY] [SET AS NOT QUALIFIED AND SKIP TO H1]***

98. (Don't know) ***[SET AS NOT QUALIFIED AND* SKIP TO H1]**

99. (Refused) ***[SET AS NOT QUALIFIED AND* SKIP TO H1]**

B6. In which of the following Northwest states does your company operate? **[ALLOW MULTIPLE RESPONSE]**

1. Idaho

2. Montana

3. Oregon

4. Washington

*5. None of the above **[EXCLUSIVE; SET AS NOT QUALIFIED AND SKIP TO H1]***

99. (Refused) **[EXCLUSIVE; *SET AS NOT QUALIFIED AND* SKIP TO H1]**

B7. **[IF MORE THAN ONE OPTION SELECTED IN B6]** In which state would you say your company primarily operates? **[SINGLE SELECT]**

*1. **[LIST OPTIONS SELECTED IN B6]***

B8. Are you aware of networked lighting control systems, in which one sensor– typically mounted in the ceiling – controls a group of programmable fixtures, usually wirelessly?

1. (Yes)

(1) How familiar are you with networked lighting control systems? Would you say you are:

(a) Very familiar

(b) Somewhat familiar

(c) A little familiar

2. (No)

98. (Don't know)

99. (Refused)

B9. Are you aware of a type of networked lighting control system in which each fixture is programmable and has its own built-in sensor, allowing flexible grouping and granular fixture control? These are known as Luminaire-Level Lighting Control systems, or LLLC.

1. *(Yes)*
   (1) *How familiar are you with LLLC systems? Would you say you are:*
      (a) *Very familiar*
      (b) *Somewhat familiar*
      (c) *A little familiar*
2. *(No)*

98. (Don't know)
99. (Refused)

[IF B9≠1, *SET AS NOT QUALIFIED AND* **SKIP TO H1]**

B10. Does your company partner with utilities in the Pacific Northwest? This could be through a rebate program, or any other way.

2. (Yes)
3. (No)

98. (Don't know)
99. (Refused)

B11. **[IF INSTALLER = TRUE]** Is your company a franchise?

1. *Yes*
2. *No*

98. (Don't know)
99. (Refused)

B12. Does your company have multiple office locations?

1. *Yes*
2. *No* ***[SKIP TO END OF SECTION LOGIC]***

98. (Don't know) **[SKIP TO END OF SECTION LOGIC]**
99. (Refused) **[SKIP TO END OF SECTION LOGIC]**

B13. **[IF B12=1]** Are you more knowledgeable about the company's capabilities just at your specific location, or generally across all locations?

1. *(specific location)*
2. *(all locations)*
3. *(Other* ***[SPECIFY: _____])***
4. *(Don't know)* ***[SKIP TO C]***
5. *(Refused)* ***[SKIP TO C]***

B14. **[IF B12=1]** Ok. For the rest of these questions, please answer from

1. ***[IF B13=1]*** *the perspective of your specific location*
2. ***[IF B13=2]*** *the perspective of your company as a whole across all locations*
3. ***[IF B13=3]*** *that perspective*

B15. [IF D/S=TRUE, SKIP TO SECTION D]

B16. [IF INSTALLER = TRUE AND D/S≠TRUE, CONTINUE TO SECTION C]

C. Installer Only Questions

These next questions are about your company's experience with Luminaire Level Lighting Controls - where each fixture is programmable, has its own built-in sensor, and is networked to other fixtures.

C1. Have staff at your company received training on luminaire level lighting controls (LLLC)?

1. *(Yes)*
2. *(No)* ***[SKIP TO C5]***

98. (Don't know) **[SKIP TO C5]**

99. (Refused) **[SKIP TO C5]**

C2. What organization offered the training? **[MULTIPLE RESPONSE ALLOWED].**

1. *(Lighting Design Lab [LDL])*
2. *(NXT Level)*
3. *(Utility sponsored)*
4. *(BetterBricks)*
5. *(Professional or industry association)*
   (1) *Which association?* ***[ALLOW TEXT RESPONSE]***
6. *(Manufacturer)*
7. *(Manufacturer representative)*
8. *(Distributor)*
9. *(Other)* ***[ALLOW TEXT RESPONSE]***

98. (Don't know)

99. (Refused)

C3. Are you familiar with the contents of these trainings?

1. *(Yes)*
2. *(No)* ***[SKIP TO C5]***

98. (Don't know) **[SKIP TO C5]**

99. (Refused) **[SKIP TO C5]**

C4. For each of the following, please indicate if any staff at your company, including yourself, have been trained on this subject.

1. *First, have any staff been trained on the best types of buildings and spaces for LLLC?*
   (1) (Yes)
   (2) (No)
   (3) (Don't know)
2. *Have any staff been trained on the benefits and capabilities of LLLC relative to other types of control systems?*
   (1) (Yes)
   (2) (No)
   (3) (Don't know)
3. *Have any staff been trained on how to install LLLC?*
   (1) (Yes)
   (2) (No)
   (3) (Don't know)
4. *Have any staff been trained on how to program LLLC?*
   (1) (Yes)
   (2) (No)
   (3) (Don't know)

C5. Is your company able to install an LLLC system, install and program an LLLC system, or neither?

1. *(Able to Install)*
2. *(Able to Install and program)*
3. *(Neither)*

98. (Don't know)
99. (Refused)

C6. Would you say that your company is capable of diagnosing and troubleshooting post-installation issues with an LLLC system?

1. *(Yes)*
2. *(No)*

98. (Don't know)
99. (Refused)

C7. To the best of your knowledge, has your company ever installed an LLLC system?

1. *(Yes)*
2. *(No)*

98. (Don't know)
99. (Refused)

C8. **[IF C7=1]** In the past 12 months, about how many buildings has your company installed LLLC systems in? Your best estimate is fine.

1. ***[ENTER NUMERIC VALUE]***

98. (Don't know)
99. (Refused)

C9. **[IF C8>0]** Across those **[VALUE FROM C8]** buildings, what would you say was the average number of fixtures per project? Would you say it was…

1. (100 or fewer)
2. (101 to 300)
3. (301 to 600)
4. (601 to 1000)
5. (More than 1000)
98. (Don't know)
99. (Refused)

C10. **[IF C8>0]** Based on your experience, which type of system is likely to require less time and labor to install and program – an LLLC system, or another type of networked controls system?

1. (LLLC system)
2. (Another type of networked controls system)
98. (Don't know)
99. (Refused)

C11. **[IF C8>0]** Based on your experience, which type of system is your first choice in controls when applicable to the project type – an LLLC system, or another type of networked controls system?

1. (LLLC system)
2. (Another type of networked controls system)
98. (Don't know)
99. (Refused)

C12. Now I have a few questions about outdoor parking lot lighting. Have you completed any lighting retrofits for outdoor parking lots? If so, about how many parking lots?

1. (Yes)
(1) Specify number of parking lots: ***[NUMERICAL TEXT BOX]***
2. (No)
98. (Don't know)
99. (Refused)

C13. **[ASK IF C12=1]** Do you recommend and/or install LLLC in outdoor parking lots?

1. (Have recommended and installed)
2. (Have recommended but not installed)
3. (Have not recommended or installed)
98. (Don't know)
99. (Refused)

C14. **[ASK IF C13=1 OR 2]** In what ways do you think LLLC is a **good fit** for outdoor parking lots?

1. ***[OPEN ENDED]***

C15. **[ASK IF C13=1 OR 2]** In what ways do you think LLLC is a **poor fit** for outdoor parking lots?

1. ***[OPEN ENDED]***

D. Designers and Specifiers Only Questions

[ASK SECTION IF D/S=TRUE, ELSE SKIP TO SECTION E]

D1. Would you say your company is capable of designing an LLLC system?

1. *(Yes)*
2. *(No)*

98. (Don't know)

99. (Refused)

D2. Would you say your company is capable of specifying an LLLC system?

1. *(Yes)*
2. *(No)*

98. (Don't know)

99. (Refused)

D3. In the past 12 months, about how many times would you say your company has included a recommendation for LLLC in a project? Please only count unique projects (i.e., if you submit multiple plans for a single project, those would all count as 1 project).

1. ***[NUMERIC ENTRY FOR VALUE]***
2. *(Not applicable)*

98. (Don't know)

99. (Refused)

D4. **[IF D3>0]** Based on your experience, which type of system is your first choice in controls when applicable to the project type – an LLLC system, or another type of networked controls system?

1. *(LLLC system)*
2. *(Another type of networked controls system)*

98. (Don't know)

99. (Refused)

D5. In the past 12 months, about how many times would you say your company has recommended networked control systems other than LLLC in a project? Again, your best estimate is fine.

1. ***[NUMERIC ENTRY FOR VALUE]***
2. *(Not applicable)*

98. (Don't know)

99. (Refused)

D6. In the past 12 months, about how many times would you say your company has written LLLC into a project plan? Please only count unique projects where LLLC makes it into the final design (i.e., if you submit multiple plans for a single project, those would all count as 1 project).

1. ***[NUMERIC ENTRY FOR VALUE]***
2. *(Not applicable)*

98. (Don't know)
99. (Refused)

D7. On a scale of 1 to 10, How satisfied are you with the types and styles of fixtures with embedded controls in meeting your LLLC system design and specification needs, where 1 is not at all satisfied and 10 is very satisfied?

1. ***[NUMERIC ENTRY FOR VALUE]***

D8. **[IF D7<7]** What additional types or styles of fixtures are needed to meet your LLLC system design or specification needs?

1. ***[OPEN END]***

98. (Don't know)
99. (Refused)

E. Market Insights

E1. How does your company hear about new developments in commercial lighting? [MULTIPLE RESPONSES ALLOWED]

1. *(Word of mouth)*
2. *(Manufacturers' representatives)*
3. *(Distributors)*
4. *(Professional organizations) [SPECIFY]*
5. *(Conferences) [SPECIFY]*
6. *(Social Media) [SPECIFY]*
7. *(Other) [SPECIFY]*
8. *(Don't know)*
9. *(Refused)*

E2. Would you say sales of LLLC in the Northwest are increasing, staying about the same, or decreasing?

1. *(Increasing)*
2. *(Staying about the same)*
3. *(Decreasing)*
4. *Don't know)*
5. *(Refused)*

E3. **[IF C7>0 OR D3>0 OR D6>0]** Thinking about your customers, what types of businesses or industries have you worked with that have installed LLLC? Please list as many as you know of. **[MULTIPLE RESPONSES ALLOWED]**

1. *(Commercial office)*
2. *(School)*
3. *(Local Government)*
4. *(Industrial)*
5. *(Military base)*
6. *(Warehouses)*
7. *(Retail)*
8. *(Hospitals)*
9. *(Other)* ***[ALLOW TEXT ENTRY]***

98. (Don't know)
99. (Refused)

E4. What are the drawbacks of LLLC over other networked controls systems, if any. Please list up to three. [MULTIPLE RESPONSES ALLOWED]

1. *(Cost)*
2. *(Difficult to program)*
3. *(Long order time)*
4. *(Other)* ***[ALLOW TEXT ENTRY]***
5. *(None)*

98. (Don't know)
99. (Refused)

E5. **[IF INSTALLER=TRUE]** Using a scale of *very confident*, *somewhat confident*, *not very confident*, or *not at all confident*, how confident are you in your company's ability to sell LLLC to customers?

1. *(Not at all confident)*
2. *(Not very confident)*
3. *(Somewhat confident)*
4. *(Very confident)*

98. (Don't know)
99. (Refused)

F. Rationale of Buyers and Sellers

F1. Have you worked with a customer who included LLLC in their initial project plans, but did not follow through with the purchase or sale of LLLC?

1. *Yes*
2. *No* ***[SKIP TO NEXT SECTION]***
3. *Don't know* ***[SKIP TO NEXT SECTION]***

F2. **[IF F1=1]** What specific LLLC options or solutions do you present to the customer in your initial plans? Please list all that apply.

1. ***[OPEN END]***

F3. What key features or advantages of LLLC were emphasized in your initial presentation? Select all that apply. [MULTIPLE RESPONSES ALLOWED]
1. *Cost savings over time*
2. *Energy efficiency*
3. *Compatibility with project goals*
4. *Technological innovation*
5. *Other (please specify)* ***[ALLOW TEXT RESPONSE]***

F4. What LLLC options or solutions did the customer plan to install at the beginning of the project?
1. ***[OPEN END]***

F5. What were the customer's main reasons for planning to install LLLC initially? Select all that apply. [MULTIPLE RESPONSES ALLOWED]
1. *Energy cost savings*
2. *Improved system performance*
3. *Regulatory compliance*
4. *Improved occupant experience*
5. *Other (please specify)* ***[ALLOW TEXT RESPONSE]***

F6. What did the customer ultimately decide to install in their project?
1. *The initially proposed LLLC solution*
2. *A modified version of the LLLC solution*
3. *A different technology/system (please specify)* ***[ALLOW TEXT RESPONSE]***
4. *None*

F7. Why did the customer decide not to proceed with the LLLC solution as initially planned? Select all that apply. [MULTIPLE RESPONSES ALLOWED]
1. *Too expensive*
2. *Too difficult to install*
3. *Vendor or supplier issues*
4. *Project scope changed*
5. *Other (please specify)* ***[ALLOW TEXT RESPONSE]***

F8. What feedback, if any, has the customer provided about their final choice compared to the initially proposed LLLC?
1. ***[OPEN END]***

G. Incentive & Closing

G1. Those are all my questions today! Would you like to receive the $100 gift card and be entered into the drawing to win a $300 VISA gift card?

1. *(Yes)*
2. *(No)*

99. (Refused)

G2. **[IF G1=1]** Great! Can I get the name and email address I should send the $100 gift card to and the $300 gift card if you are selected? **[FILL OUT EACH FIELD]**

1. *Name:* ***[ALLOW TEXT ENTRY]***
2. *Email Address:* ***[ALLOW TEXT ENTRY]***

99. (Refused)

G3. We would also like to email you with a link to the terms and conditions of the gift card drawing. May I have the best email to send the link to? We will not use your email for any other purpose.

1. ***[ALLOW TEXT ENTRY FOR EMAIL]***

99. Refused

G4. Would you be interested in being sent a link to the final write-up of these survey results later in 2025? We will not use your email for any other purpose.

1. *(Yes)* ***[ALLOW TEXT ENTRY FOR EMAIL]***
2. *(No)*

99. Refused

[IF G1=1 and G2=/=99] Thank you so much for your time today, we really appreciate it. If you win, you should receive the gift card within 6 to 8 weeks. I hope you have a wonderful rest of your day!

[IF G1=/=1] Thank you so much for your time today, we really appreciate it. I hope you have a wonderful rest of your day!

H. Non-Qualified Incentive & Closing

H1. Unfortunately, you do not qualify for the survey, but we'd still like to offer you a chance to win the $300 VISA gift card. Would you like to be entered into that drawing?

1. *(Yes)*
2. *(No)*

99. (Refused)

H2. **[IF H1=1]** Great! Can I get the name and email address I should send the $300 gift card if you are selected? We will not use your information for any other purpose. **[FILL OUT EACH FIELD]**

1. *Name:* ***[ALLOW TEXT ENTRY]***
2. *Address Line 1/Street:* ***[ALLOW TEXT ENTRY]***
3. *Address Line 2/Suite Number/etc:* ***[ALLOW TEXT ENTRY]***
4. *City:* ***[ALLOW TEXT ENTRY]***
5. *State:* ***[ALLOW TEXT ENTRY]***
6. *Zip:* ***[ALLOW TEXT ENTRY]***

99. (Refused)

H3. We would also like to email you with a link to the terms and conditions of the gift card drawing. May I have the best email to send the link to? We will not use your email for any other purpose.

1. ***[ALLOW TEXT ENTRY FOR EMAIL]***

99. Refused

Thank you so much for your time today, we really appreciate it. If you win, you should receive the gift card within 6 to 8 weeks. I hope you have a wonderful rest of your day!

Appendix D. NEEA LLLC MPER 3 – Decision-Maker Interview Guide

Interviewee Name:	
Interviewee Organization:	
Interviewee Title:	
Date of Interview:	
Interviewer Name:	

Research Objectives	Corresponding Question Numbers
RO#2 – **Track Identified Market Progress Indicators**: Track identified MPIs that measure the reduction of identified market barriers and conduct year-over-year analyses when indicated to report progress on several program outcomes predicted by the program's logic model.	D1-D4
RO#3 – **Conduct Market Research**: Conduct market research to describe the rationale of buyers and sellers of LLLC that include it in their initial project plans, but do not follow through with the purchase or sale.	See table below

Research Objectives	Research Questions	Corresponding Question Numbers
3	What are the space and building characteristics of the project?	Screener and A1-A6
3	What equipment was installed and why?	A7-A11, B3-B4
3	How are they using some specific features of the lighting they installed?	A9
3	How was the decision-making process structured?	B1
3	How important were different decision factors?	B2
3	What challenges did they encounter during the project?	B5
3	What was the respondent's experience with their new lighting system?	C1-C2
3	How did respondents learn about lighting features?	C2.1
2	MPI 10: Qualitative willingness-to-pay assessment of LLLC over no controls	D1-D4

Audience: Decision-makers or high-level informers that recently purchased (upgraded/retrofit/new construction) a lighting system for a commercial space.

Purpose: Address the above research objectives.

These in-depth interviews will be conducted by Cadmus staff. Interviews will be scheduled in advance of the call via email. The interview will take about 20 minutes. This information will be included in the email invitation.

Target: 10 interviews spread across NEEA's territory.

Initial Email from Cadmus

To: **[EMAIL]**
From: **[YOUR MAIL]**
Subject: Invitation for Interview on Lighting Upgrade

Hello **[FIRST NAME]**,

We are conducting interviews with building owners or managers who recently completed lighting projects to learn more about the market and inform programs that support businesses in the Northwest. It will take about 20 minutes and **we will provide you with a $100 electronic gift card** as a thank you for your time. If you have completed a lighting upgrade, retrofit, or new construction project in the past few years, we would love to speak with you.

We got your contact information through a utility program you participated in recently, where you received an incentive for installing efficient lighting. The purpose of these interviews is to hear about your recent experience selecting lighting for your building, including what factors went into your decision and what types of lighting controls (if any) you chose to purchase.

If you are interested in speaking to us, please let me know when we could briefly call to discuss if your experiences match what we are looking for. This phone call will take about 5 minutes. I will ask you a few questions about your recent lighting project(s) and if your experience aligns with our study's needs, we will then schedule the full interview.

Please let me know if we can schedule an interview with you soon. Thank you for your time and help with this.

[NAME
SIGNATURE]

PS. Please email or phone me to schedule an interview. However, if you have questions about the study itself or would like to share any concerns, you are welcome to contact the lead researcher at the local non-profit coordinating this study instead; Zdanna King, Market Evaluation and Research Scientist at the Northwest Energy Efficiency Alliance (zking@neea.org).

Reminder Email

Hello [First Name],

Just following up on my prior email with an invite to participate in our commercial lighting study. As a reminder, this study will take about 20 minutes and **we will provide you with a $100 electronic gift card** as a thank you for your time. If you have completed a lighting upgrade, retrofit, or new construction project in the past few years, we would love to speak with you.

If you are interested and would like to schedule a time to speak, please feel free to reply to this email with times that work for you. We are looking to interview 10 more people for the project, so we'd appreciate your time to help us reach our goal.

Thanks,

[NAME]

Second Reminder Email

Hello **[FIRST NAME]**,

Following up again on my invitation to participate in a brief interview on your lighting upgrade experience. We really appreciate your time to help us complete our study on commercial lighting. As a thank you for participating, you will receive a $100 electronic gift card. Please let me know if you're interested.

We're conducting this study to evaluate the current state of the market for lighting control systems and understand customers' experience with them. We're working with The Northwest Energy Efficiency Alliance (NEEA), a group of electric utilities and energy-efficiency organizations that works to increase the adoption of energy-efficient products, services and practices.

We're interested to hear about your recent experience selecting lighting for your building, including what factors went into your decision and what types of lighting controls (if any) you chose to purchase. NEEA will use this information to consider changes to their lighting program.
Thanks,
[NAME]

Phone Script

Hello **[FIRST NAME]**,

We are conducting interviews with building owners or managers who recently completed lighting projects to learn more about the market and inform programs that support businesses in the Northwest. It will take about 20 minutes and **we will provide you with a $100 electronic gift card** as a thank you for your time. If you have completed a lighting upgrade, retrofit, or new construction project in the past few years, we would love to speak with you.

We got your contact information through a utility program you participated in recently, where you received an incentive for installing efficient lighting. The purpose of these interviews is to hear about your recent experience selecting lighting for your building, including what factors went into your decision and what types of lighting controls (if any) you chose to purchase.

- If they answer move to screening questions and follow up with an email

If you are interested in speaking to us, please let me know when we could briefly call to discuss if your experiences match what we are looking for. This phone call will take about 5 minutes. I will ask you a

few questions about your recent lighting project(s) and if your experience aligns with our study's needs, we will then schedule the full interview.

Thanks,
[NAME] from Cadmus Group

Screening Questions

These screening questions will be asked to potential respondents over the phone to ensure they qualify for the interview.

1. In the past 2 years, have you been a part of a decision to purchase, upgrade, or replace lighting in a commercial building?

[IF YES, CONTINUE. IF NO, THANK AND END INTERVIEW.]

2. In what state is/are this/these commercial building(s) located? [IF ANY in ID, MT, OR, or WA QUALIFIED FOR INTERVIEW. IF NO, THANK AND END INTERVIEW.]
3. Were you personally involved in informing or making decisions about any of these lighting projects? [IF YES, CONTINUE TO INTERVIEW]
    a. [IF NO] If not, are you familiar with how lighting choices were made in these projects?
        i. [IF YES, CONTINUE TO INTERVIEW]
        ii. [IF NO] Can you recommend someone else at your company who is? [THANK AND END INTERVIEW]
4. [IF QUALIFIED BUT NOT CONDUCTING INTERVIEW NOW] Thank you! When is a good time to schedule the interview? We're looking for a half hour block within the next two weeks.

A. Introduction and Interviewee Details

Thank you for taking the time to speak with me. For this study, we are conducting interviews with building owners or managers who recently completed lighting projects in buildings they own or manage.

We would like to hear about your recent experience selecting lighting for your building, including what factors went into your decision and what types of lighting controls (if any) you chose to purchase. NEEA will use this information to consider changes to their lighting program. This interview will take about 20 minutes and all interview responses will be anonymized. As a thank you for your time, we will provide you with a $100 electronic gift card.

[FILL OUT QUESTIONS IN SECTION A WITH INFORMATION FROM SCREENER. ONLY ASK QUESTIONS NOT COVERED IN SCREENER OR CONFIRM INFORMATION AS NEEDED]

Earlier, you shared that a building you own or manage recently completed a lighting project. I have a few additional questions about that project. If you completed multiple projects over the past 2 years, please select the most recent project.

A1. Around when was this building constructed?

A2. What is the building used for in general? (e.g., school, hospital, small office building, warehouse, etc.)

A3. About how much square footage is this building?

A4. In what state is this building located?

A5. Do you consider this to be a rural, urban, or suburban property?

And now I'd like to hear a little more about the lighting project itself.

A6. About how much of the building was involved in the lighting project? (sq footage)

A7. Why did that area need to have its lighting updated?

A8. Did your lighting project include controls beyond manual on and off switches?

1. *[IF YES] Were your lighting fixtures networked to each other?*
2. *[IF YES] Was there one sensor in every fixture or one sensor for several different fixtures? [INTERVIEWER NOTE: This question is important to determine if the controls were LLLC or other NLC. If respondent says yes to "one sensor in every fixture", then they likely installed LLLC.]*
3. *What can the controls do?*

A9. I'm going to read a list of some capabilities that lighting fixtures with controls might have. For each one, please let me know if your new lighting has this feature, doesn't have it, or if you're not sure.

1. *Energy use monitoring [HAS this feature, DOES NOT have this feature, or Don't know]*
   (1) [If lighting has feature] How, if at all, have you used this feature?
2. *Respond automatically to utility programs to lessen energy use at peak times [HAS this feature, DOES NOT have this feature, or Don't know]*
   (1) [If lighting has feature] How, if at all, have you used this feature?
3. *Integration with other building systems (for example, coordinates with HVAC system or uses asset tracking to let you know where inventory is, etc.) [HAS this feature, DOES NOT have this feature, or Don't know]*
   (1) [If lighting has feature] How, if at all, have you used this feature?

A10. Do you remember the brand of the lighting fixtures you installed?

1. *[IF YES] What was it?*

A11. Did you make choices about what the lighting fixtures would look like?

1. *Were you satisfied with their aesthetic? [Very satisfied, somewhat satisfied, not very satisfied, not at all satisfied]*

B. Decision-Making Factors

Next, I'd like to hear more about how your company decided to purchase this lighting system.

B1. Who was involved in the decision?

1. *What role or influence did each of them have?*
2. *Who was the final decision-maker?*

B2. What factors did you consider while you were exploring a lighting system to purchase?

1. *[IF MULTIPLE FACTORS] Was one factor more important than the others? Why?*

B3. [IF LLLC NOT INSTALLED BASED ON ANSWER TO A8] You noted that you did not install luminaire level lighting controls – these are controls where there are sensors in each fixture instead of one sensor the controls several fixtures.

1. *Do you recall being offered this type of fixture as an option?*
2. *[IF YES] What factors were important in your decision to not install luminaire level lighting controls? (Probe for reasons why LLLC not chosen: cost, not aware, installer familiarity, availability, etc.)*

B4. Were there any other lighting options for this project presented by the installer that you decided against?

1. *[IF YES] What about these options made you decide not to choose them?*

B5. Were there any challenges encountered during the project?

1. *If so, how did you overcome them?*

C. System Experience

C1. Overall, how has the system been operating on a scale from 1 to 5, where 1 means very poorly and 5 means very well?

1. *Why did you give that particular rating?*

C2. What features of your lighting control system have you found to be **valuable**? What made these features valuable to you?

1. *How did you learn about how to use these features?*
2. *Conversely, what features have you **not found to be valuable**?*

D. Willingness to Pay

Now I have a few hypothetical questions. Please pretend like you are making a decision to upgrade your lighting system and need to choose between two options – one without any controls (i.e., only an on/off switch) or a system with advanced luminaire level lighting controls that can **save up to 50% more energy** per year through **features such as daylight harvesting, high-end trim, and occupancy sensing**, among others. Please pretend that the building where you are planning the lighting upgrade has the following characteristics:

- **40,000 square feet** of lit, commercial office space
- The total project requires about **360 fixtures**, with each fixture covering about **100 square feet**
- The lighting upgrade will only be inside (i.e., no outdoor lighting)

[REPEAT SCENARIO IF NEEDED TO RESPONDENT DURING QUESTIONS IN THIS BLOCK]

D1. How likely would you be to choose the advanced LLLC system if it was $**45 more expensive** per fixture (i.e., **50% more per fixture**) than the system without any controls? [RECORD ON SCALE FROM 0-10, 0=DEFINITELY NOT, 10=DEFINITELY, 98=DON'T KNOW]

1. *Why did you give that rating?*

D2. [ASK IF D1<7] How likely would you be to choose the advanced LLLC system if it was $**30 more expensive** per fixture (i.e., **33% more per fixture**) than the system without any controls? [RECORD ON SCALE FROM 0-10, 0=DEFINITELY NOT, 10=DEFINITELY, 98=DON'T KNOW]

1. *Why did you give that rating?*

D3. [ASK IF D2<7] How likely would you be to choose the advanced LLLC system if it **was $15 more expensive** per fixture (i.e., **17% more per fixture**) than the system without any controls? [RECORD ON SCALE FROM 0-10, 0=DEFINITELY NOT, 10=DEFINITELY, 98=DON'T KNOW]

1. *Why did you give that rating?*

D4. [ASK IF D3<7] How likely would you be to choose the advanced LLLC system if it was **the same price** per fixture as the system without any controls? [RECORD ON SCALE FROM 0-10, 0=DEFINITELY NOT, 10=DEFINITELY, 98=DON'T KNOW]

1. *Why did you give that rating?*

E. Closing and incentive contact information

Thank you for participating in this interview.

E1. Finally, we need to collect some contact information to send you the gift card for completing this interview. All information collected will only be used for processing the gift cards.

1. *Name:*
2. *Email:*

Again, thank you so much for your time and input; we really appreciate it. Feel free to contact me if you think of anything else or have any questions. Have a nice day.

Appendix E. NEEA LLLC MPER 3 – Guide for Manufacturers and Manufacturers' Representatives Interviews

Interviewee:

Company:

Date:

The purpose of the LLLC market supply chain market actor interviews is to track identified market progress indicators (MPIs) and collect information to inform the project's research objectives. These interviews will also probe the rationale of buyers and sellers of LLLC who include LLLC in initial project plans but do not follow through with the purchase or sale. Cadmus plans to conduct four interviews with manufacturers and four interviews with manufacturer representatives following the targets outlined in the table below.

Market Actor	Target Completes	Sample Description	Notes
LLLC Manufacturers	4	To be determined based on suitability among interviewees from MPER 2	If the contractor exhausts the list of interviewees, they will work with NEEA to review additional options.
LLLC Manufacturer Representatives	4	To be determined based on suitability among interviewees from MPER 2	If the contractor exhausts the list of interviewees, they will work with NEEA to review additional options. Some secondary research and/or referrals may be fruitful, but contacts need to be cleared with NEEA program staff.
Total	**8**		

Research Objective
Research Objective No. 1: Review and verify that the program has conducted the strategic activities described in their quarterly strike zone documents and outlined in their logic model since the previous MPER.
Research Objective No. 2: Track identified market progress indicators (MPIs) focused on measuring the reduction of identified market barriers and conduct year-over-year analyses when indicated, in order to report progress on several program outcomes predicted by the program's logic model.
Research Objective No. 3: Conduct market research to describe the rationale of buyers and sellers of LLLC that include it in their initial project plans, but do not follow through with the purchase or sale.

This interview guide is broken into different sections to cover various topics:

- The **preamble**, which is common to both types of interviewees, provides context for the interviewee and establishes rapport with the interviewer.
- The **background**, which is common to both types of interviewees, collects basic information from the interviewee and confirms their level of experience and knowledge related to LLLC.

- Several topics are covered separately for each key market actor type:
  - The **market actor engagement** section collects information on the interviewee's awareness and engagement with the LLLC market. This includes products/services offered, awareness of NEEA's efforts in the market, and the value proposition of LLLC in the market.
  - The **market landscape** section collects information on the types of projects the interviewee is installing for LLLC systems, typical customers or market segments that are purchasing LLLC systems, market trends, projects where LLLC were included in initial project plans but customers later chose not to include LLLC, as well as additional information on the breakdown of LLLC compared to NLC and more broadly with all luminaires.
  - The **LLLC capabilities** section asks about features that are desirable for the market, market barriers to adoption of LLLC, and if customers are integrating LLLC sensor outputs with HVAC or other building systems.
  - The **closing** section ends the interview and gives the interviewee an opportunity to ask questions.

Table 3 maps the collection of MPIs and other information stated in the work plan to the interview questions. **Due to the limited time available for interviews of this nature (which are typically a maximum of 30 minutes to ensure that the interviewee does not experience fatigue), we prioritized the information that we are able to gather.** We prefer to have about 15 to 20 open-ended questions for an interview of this length.

Table 3. MPI or Research Topics Addressed by Interviews

MPI or Research Topic	Information Captured	Question # [a]
NA	General candidate and company information	Background section Mfgs: 1, 2 Reps: 1, 2
RO #2 - MPI 6A measurement	Increased availability in products available with embedded controls, compared to the previous year, for at least one of the following fixture types: low-bay, high-bay, recessed can, retrofit kits	Mfgs: 3
RO #2 - MPI 6B measurement	Sales representatives say there are sufficient types and styles of fixtures with embedded controls to meet their customers' needs	Reps: 4
Provides context to RO #3	LLLC value proposition and remaining market gaps	Mfgs: 6, 9, 13 Reps: 7, 10, 14, 15
Provides context to RO #3	Commercial and industrial building types and circumstances best suited for LLLC systems and why	Mfgs: 7 Reps: 8
Provides context to RO #2	Trends in total sales and in market mix between LLLC and NLC	Mfgs: 11 Reps: 11
Provides context to RO #2	Trends in integration with other buildings systems	Mfgs: 8 Reps: 9

MPI or Research Topic	Information Captured	Question # [a]
Provides context to RO #2	LLLC marketing and promotion, both by companies and at conferences	Mfgs: 4, 5, 12 Reps: 5, 6, 13

[a] Mfgs = Manufacturers, Reps = Manufacturer representatives

Cadmus will initially ask the interviewees what area of the market supply chain they participate in (if it is not known) and then select that question path. The questions below may be slightly modified, re-ordered, or skipped depending on the interviewee's experience and the time available.

Topics for All Interviewee Types

Preparation

Interviewer will review company website prior to interview to familiarize themselves with the general scope of products/services offered by the company.

Company website link: _____

If respondent was interviewed in MPER 2, pull in relevant responses from last year and check to see if they are still accurate. Cadmus will note if the respondent was interviewed in MPER 2 and report on the number of repeat respondents when delivering results to NEEA.

Preamble

5. Thank you for taking the time to speak with us today. Have you heard of the Northwest Energy Efficiency Alliance before? [Record "yes", "no" or "unsure"] We are conducting this interview on behalf of the Northwest Energy Efficiency Alliance or "NEEA", to help them better understand the market for commercial lighting controls. NEEA is a non-profit organization in the Northwest that works to speed up the market adoption of energy-saving technologies, such as networked lighting controls. NEEA is funded by many of the largest utilities in Idaho, Montana, Oregon, and Washington, as well as by the Bonneville Power Administration.

- The information you provide will be used to develop strategies and recommendations related to lighting controls program offerings. Your participation in this interview will remain anonymous and any answers you provide will be pooled with responses from the other participants.

We will provide you with a $100 gift card for participating in this interview, which should take about 30 minutes. Do you have any questions before we get started?

Background

1. What is your job title?
2. How long have you been in this role?

Before we start the questions, let me provide some background definitions.

- Luminaire level lighting controls, or LLLC, are a type of networked lighting control system. In an LLLC system, each individual light fixture has its own built-in sensor and controller, and those

sensors can communicate wirelessly and transmit data. The sensors can be programmed in any grouping needed, all the way down to the individual fixture level.

- By comparison, in non-LLLC networked lighting control systems, the sensor and controller are external to the fixtures. One sensor and one controller—typically mounted in the ceiling—will control a group of fixtures, usually wirelessly. We'll call these "other NLC" during today's interview.

Manufacturers

IF INTERVIEWED IN A PREVIOUS YEAR, PULL IN PREVIOUS RESPONSES FOR REFERENCE.

Market Actor Engagement in LLLC Market

1. Does your company manufacture sensors, controllers or fixtures that can be used in LLLC lighting systems? [Yes, No, Unsure]
2. I'll have some more specific questions in a moment, but could you describe how what you manufacture might be used to create an LLLC lighting system? Remember, LLLC are advanced lighting controls, where a sensor and a control are embedded in each fixture and communicate with each other wirelessly.
3. [Answer required from interviewee] I'm going to list four types of lighting products. For each of them, I'll want to learn a little more about their compatibility with LLLC and how your offerings may have changed in the last two years. So first, do you manufacture low-bay fixtures? [If yes] About how many low-bay fixture types do you make that can be used in LLLC systems? Has that stayed the same, decreased, or increased over the last two years? [Repeat for High-bay fixtures, Recessed cans, and Retrofit kits]
   a. Low-bay fixtures
   b. High-bay fixtures
   c. Recessed cans
   d. Retrofit kits
4. Does your company do any marketing or promotion of LLLC systems to potential customers? These could be any type of customer – distributors, contractors, end-users, etc.
5. What does it share about LLLC systems with potential customers?
6. Why might a customer choose an LLLC system over other connected lighting control options?

Market Landscape

7. Let's get more specific. Think about LLLC projects that you're aware of. What are the typical characteristics of those projects? That is, in what situations do LLLC seem like the best fit? *(Prompt for and check off all that are applicable:*
   a. ☐ *Large vs* ☐ *small floor area*
   b. ☐ *Type or vintage of building:*
   c. ☐ *Owner-occupied versus* ☐ *leased/rented building*
   d. ☐ *New construction vs.* ☐ *renovation vs.* ☐ *retrofit*
   e. ☐ *Ownership and/or management of multiple buildings vs.* ☐ *single buildings*
   f. ☐ *Participation in utility incentive programs or building certification:*
   g. ☐ *Access to internet and/or building personnel IT capabilities:*
   h. ☐ *Particular organizational needs or opportunities, such as asset tracking:*
   i. ☐ *Other features that are chosen, etc. if needed:*
8. How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?
9. What appears to be the most requested or desirable feature or capability of LLLC products based on sales and product requests? Why?
10. Is there anything manufacturers may need to help them sell LLLC systems more effectively to customers?
11. Thinking just about your company, how would you describe the trend in LLLC sales over the last two years? Have your LLLC sales increased, stayed about the same, or decreased?
    a. What about other networked lighting controls that you manufacture, where there's one sensor for multiple fixtures? (probe for increased, stayed the same, or decreased)
12. Have you or other employees from your organization attended any lighting conferences or trade shows in the last year?
    a. [If yes] Which ones? _____
    b. [If yes to #12] Have you noticed LLLC systems being shared about at these conferences or trade shows?
    c. [If yes to #12] Can you provide some examples of what you've seen or heard about LLLC systems at these conferences or trade shows?
    d. [If yes to #12] Would you say LLLC systems are more prevalent, less prevalent, or have about the same prevalence at these shows or conferences, compared to the last few years?
    e. [If more or less in #12 d, Skip if about the same] Why might LLLC be [more/less] prevalent now than it was a few years ago?

LLLC Capabilities

13. In general, across all of the brands of LLLC products on the market, what opportunities do you see for improvement? *(Probe: Ease of system installation? Ease of programming? Training? Technical support? Interoperability of different system brands? Customer experience?)*

Closing

Thank you for participating in this interview.

14. Finally, we need to collect some contact information to send you the $100 gift card for completing this interview. All information collected will only be used for processing the gift cards.
    a. Name:
    b. Email:

Those were all of my questions. Do you have anything else you'd like to add?

Thank you again for your time. If you have any follow-up thoughts or questions on this research project please feel free to contact me at Joshua.Carey@cadmusgroup.com

Manufacturer Reps

IF INTERVIEWED IN A PREVIOUS YEAR, PULL IN PREVIOUS RESPONSES FOR REFERENCE.

Market Actor Engagement in LLLC Market

1. How many manufacturers does your company represent that offer networked lighting control product lines? Of these, how many are classified as LLLC?
2. What role does your company have in the sales process for LLLC?
3. Please describe a typical sales purchase.
    a. During a lighting purchase, does your company usually work directly with an end-use client or a lighting/building professional? Or a mix of these?
    b. During a sales purchase, does your company usually work with decision-makers on whether to include certain products for a particular project, or influence their decision in any way? If so, please describe.
4. [Answer required from interviewee] I'm going to list four types of lighting products. For each of them, I'll want to learn a little more about your thoughts on the variety of products. So first, do the manufacturers you represent produce low-bay fixtures? [If yes] Do you feel the number of low-bay fixtures with embedded controls is sufficient to meet your customers' needs? Has that stayed the same, decreased, or increased over the last two years? [Repeat for High-bay fixtures, Recessed cans, and Retrofit kits]
    a. Low-bay fixtures
    b. High-bay fixtures
    c. Recessed cans

d. Retrofit kits

5. Does your company do any marketing or promotion of LLLC systems to potential customers? These could be any type of customer – distributors, contractors, end-users, etc.
6. What does it share about LLLC systems with potential customers?
7. Why might a customer choose an LLLC system over other connected lighting control options?

Market Landscape

8. Now I'd like You to think about the LLLC projects you're aware of. What are the typical characteristics of those projects? That is, in what situations do LLLC seem like the best fit? *(Prompt for and check off all that are applicable:*
   a. *☐ Large vs ☐ small floor area*
   b. *☐ Type or vintage of building:*
   c. *☐ Owner-occupied versus ☐ leased/rented building*
   d. *☐ New construction vs. ☐ renovation vs. ☐ retrofit*
   e. *☐ Ownership and/or management of multiple buildings vs. ☐ single buildings*
   f. *☐ Participation in utility incentive programs or building certification:*
   g. *☐ Access to internet and/or building personnel IT capabilities:*
   h. *☐ Particular organizational needs or opportunities, such as asset tracking:*
   i. *☐ Other features that are chosen, if needed:*
9. How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?
10. What appears to be the most requested or desirable feature or capability of LLLC products based on sales and product requests? Why?
11. How would you describe the overall trend in LLLC sales and order activity? Is it increasing, staying about the same, or decreasing?
12. In the past year, have you observed an increasing number of product types in the market that are equipped with embedded sensors and controls?
    a. *If yes:* Have the manufacturers you represent increased the number of products available with embedded sensors and controls?
    b. *If yes to either/both previous questions:* In which applications or product types have these embedded features gained popularity? What factors, resources, or entities are responsible for this trend?
13. Have you or other employees from your organization attended any lighting conferences or trade shows in the last year?
    a. [If yes] Which ones? _____
    b. [If yes to #12] Have you noticed LLLC systems being shared about at these conferences or trade shows?

c. [If yes to #12] Can you provide some examples of what you've seen or heard about LLLC systems at these conferences or trade shows?

d. [If yes to #12] Would you say LLLC systems are more prevalent, less prevalent, or have about the same prevalence at these shows or conferences, compared to the last few years?

e. [If more or less in #12 d, Skip if about the same] Why might LLLC be [more/less] prevalent now than it was a few years ago?

LLLC Capabilities

14. What are the remaining barriers to further market adoption of LLLC? *(Probe for LLLC: For customers or players on the supply-chain side) (If barriers to LLLC)* What suggestions do you have for overcoming these barriers?
15. In general across all of the brands of LLLC products on the market, what opportunities do you see for improvement? *(Probe: Ease of system installation? Ease of programming? Training? Technical support? Interoperability of different system brands? Customer experience?)*

Closing

Thank you for participating in this interview.

16. Finally, we need to collect some contact information to send you the $100 gift card for completing this interview. All information collected will only be used for processing the gift cards.
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Those were all of my questions. Do you have anything else you'd like to add?

Thank you again for your time. If you have any follow-up thoughts or questions on this research project please feel free to contact me at Joshua.Carey@cadmusgroup.com

Follow Up Questions

1. I'm going to list four types of lighting products. For each of them, I'll want to learn a little more about your thoughts on the variety of products. So first, do the manufacturers you represent produce [FIXTURE TYPE]?
    a. [If yes] Do you feel that there are sufficient types and styles of [FIXTURE TYPE] with embedded controls to meet your customers' needs? Has the number of types and style of [FIXTURE TYPE] stayed the same, decreased, or increased over the last two years? [Repeat for High-bay fixtures, Recessed cans, and Retrofit kits]

2. Low-bay fixtures
3. High-bay fixtures
4. Recessed cans
5. Retrofit kits

I. In the original interview, you mentioned that you … [reference answer to Q3, where man rep describes their involvement in the sales process]. Can you think of any cases where you were working with a customer and they included LLLC initially in their project plan but ended up installing something else? [If yes, ask follow-ups]

- Why did the customer(s) initially want LLLC installed/why was it included in the project plan?
- What have customers ended up installing instead?
- Why did the customer(s) decide to not install LLLC? Was there one primary reason?
- What percentage of those cases go to NLC versus non-networked controls?