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## Luminaire Level Lighting Controls – Market Progress Evaluation Report #1

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## Acronyms

DLC	DesignLights Consortium
IECC	International Energy Conservation Code
LDL	Lighting Design Lab
LLLC	Luminaire-level lighting controls
MPER	Market Progress Evaluation Report
MPI	Market progress indicator
MT	Market transformation
NEB	Non-energy benefits
NEEA	Northwest Energy Efficiency Alliance
NLC	Networked lighting controls
QPL	Qualified product list
RTF	Regional Technical Forum

## Executive Summary

This study is the first market progress evaluation report (MPER) for NEEA’s Luminaire-Level Lighting Controls (LLLC) Initiative.

### *LLLC Initiative Background*

The NEEA LLLC Initiative is designed to overcome barriers in the commercial lighting market to the adoption of luminaire-level lighting controls (LLLC) so 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 its own built-in sensor and controller so the luminaires can communicate wirelessly and transmit data and be flexibly programmed and re-programmed in any grouping needed.

From 2016 to early 2019, NEEA pursued foundational program development activities to begin to overcome key barriers laid out in the LLLC Logic Model: lack of product readiness, first cost, lack of market awareness, and lack of skilled installers. These foundational activities, described in further detail in this report, include supporting the development of a detailed product specification, helping utilities develop incentive programs, conducting marketing and media outreach, training installers and designers/specifiers, and influencing code development to include LLLC as an optional code compliance path (with the long-term goal of LLLC being a code requirement). The LLLC Logic Model is presented in *Appendix A*.

The LLLC program gained approval in early 2019 to move into “market development.” This has consisted of continuing the foundational activities while increasing marketing activities as well as direct market engagement. The latter is currently focused on supporting manufacturers in championing LLLC and providing LLLC sales training to manufacturer representatives and other key supply-chain market actors.

### *MPER Objectives and Research Activities*

This first MPER for the LLLC initiative addressed six core research objectives:

- Review the NEEA program documents to assess their clarity, completeness, and alignment
- Conduct the first year of tracking market progress indicators (MPI)
- Research market awareness and adoption of non-LLLC NLC
- Assess the influence of NEEA-sponsored LLLC trainings on installer skills and installations
- Identify building types and circumstances best suited for LLLC versus other non-LLLC NLC
- Identify key factors influencing end-use customer decisions on whether to install LLLC

To address these objectives, Cadmus and its partner TRC, the Cadmus Team, conducted the research activities described in Table 1.

**Table 1. Research Activities for NEEA LLLC Initiative MPER 1**

Task	Target Group	Completes
Document Review	N/A	N/A
Stakeholder Interviews	Interviews with NEEA program staff, NEEA implementation contractor staff, and staff from NEEA’s funding utilities	9
Supply-chain Market Actor Interviews	Interviews with the DesignLights Consortium (DLC), controls manufacturers, manufacturer representatives, and distributors	15
Installer Survey	Surveys of Northwest commercial lighting and controls installation companies from various source lists	179
Designer/Specifier Survey	Surveys of Northwest commercial lighting designer/specifier companies from various source lists	86
Trainee Interviews	Interviews with participants in various Northwest utility-sponsored and NEEA-sponsored trainings as well as trainings by other entities (e.g., manufacturers)	19
End-use Customer Interviews	End-use customers that installed LLLC or completed a project with other types of controls	14

This first MPER evaluated six of the seven total MPIs associated with short-term program outcomes (one to two years) and evaluated one of four MPIs for medium-term outcomes. The remaining MPIs (including three for long-term outcomes (six to ten years)) will be tracked in future MPERs. The results in Table 2 show that a number of program outcomes have been realized and the remaining outcomes evaluated are well on their way. For the one MPI measured at 18% – 3D. *The percentage of lighting installation companies with at least one installer trained in LLLC* – it was notable that a high number of installation companies nevertheless said they have the capability to bid on a project involving LLLC installation.

**Table 2. 2021 Estimated Value for LLLC Market Progress Indicators (MPIs) Assessed in MPER 1**

Expected LLLC Program Outcome (Logic Model)	MPI	LLCC Program MPI	MPI 2021 Estimated Value
<b>Outcome I (short term)</b> 1. Utilities support LLLC through programs with incentives	<b>MPI 1</b>	<b>1A.</b> Utilities establish LLLC incentive programs	7 utilities plus BPA <sup>a</sup>
<b>Outcome II (short term)</b> 1. DLC maintains QPL 2. Specification continues to advance	<b>MPI 2</b>	<b>2A.</b> DLC regularly reviews the LLLC QPL	Achieved
		<b>2B.</b> DLC regularly reviews LLLC specification and updates	Achieved
<b>Outcome III (short term)</b> 1. Manufacturers formalize and provide LLLC training 2. LDL provides LLLC training 3 NEEA’s NXT Level training includes LLLC	<b>MPI 3</b>	<b>3A.</b> Manufacturers with LLLC products on the DLC QPL offer LLLC training to at least one type of supply-side market actor	Achieved
		<b>3B.</b> The percentage of lighting installation companies with at least one installer trained <sup>b</sup> in LLLC	18%
		<b>3D.</b> The percentage of lighting installation companies with the capability to bid on a project that involves LLLC installation	66%

Expected LLLC Program Outcome (Logic Model)	MPI	LLCC Program MPI	MPI 2021 Estimated Value
<b>Outcome IV (short term)</b> 1. Increase in supply chain awareness among trade allies and lighting designers	<b>MPI 4</b>	<b>4A.</b> The percentage of (1) lighting installation companies and (2) the companies with lighting designers/specifiers who are aware of LLLC	Installers: 78% designer/ specifiers: 68%
<b>Outcome V (short term)</b> 1. Lighting designers and specifiers recommend LLLC solutions	<b>MPI 5</b>	<b>5A.</b> The percentage of companies with lighting designers/specifiers who have recommended LLLC to a decision-maker for at least one project	44%
		<b>5B.</b> The percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35%
<b>Outcome VII (short term)</b> 1. LLLC is an optional path in Washington code, and LLLC is referenced in IECC 2018	<b>MPI 7</b>	<b>7A.</b> LLLC is an Optional Compliance Path in Washington code	Achieved
		<b>7B.</b> LLLC is referenced in IECC 2018	Achieved
<b>[Outcome VIII was removed from the program logic model]</b>			
<b>Outcome IX (medium term)</b> 1. LLLC is accepted as easiest-to-install lighting controls solution	<b>MPI 9</b>	<b>9A.</b> The percentage of installation companies that report having installed at least one LLLC system (“experienced installation firms”)	61%
		<b>9B.</b> The percentage of experienced installation companies that say LLLC systems are easier to install than non-LLLC NLC systems	43%
		<b>9C.</b> The average number of LLLC projects companies have completed in the past 12 months	3.4

<sup>a</sup>The region’s public utilities that purchase power from BPA can use BPA’s lighting calculator for their commercial lighting incentives. BPA expanded the calculator to include NLC (including LLLC).

<sup>b</sup>Defined as completing training on at least three of four topics asked about in the survey. See Section 3.3.

## Conclusions and Recommendations

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

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



**Table 3. Summary of Conclusions and Recommendations**

Topic	Conclusion	Recommendation
<a href="#">Progress in Market Awareness, Perception, and Adoption of LLLC</a>	<p><b>Conclusion 1:</b> NEEA’s efforts are contributing to greater awareness and market uptake of LLLC as well as other NLC as evidenced in the positive results for the MPis evaluated in this MPER (see Table 2 above).</p> <p><b>Conclusion 2:</b> Perceived complexity, high first cost, and lack of interoperability among LLLC brands continue to be barriers to increased uptake of LLLC.</p>	<p><b>Recommendation 1:</b> Identify and highlight manufacturers with programming interfaces that are easiest for installers and facility managers to use.</p> <p><b>Recommendation 2:</b> To help overcome the cost barrier, continue to complete cost studies, publicize and educate the market about NEEA’s existing savings studies showing that LLLC save substantially more energy than non-LLLC NLC, and conduct studies to quantify the dollar value of non-energy benefits (NEBs).</p>
<a href="#">Current Trainings and Potential New Topics and Approaches</a>	<p><b>Conclusion 3:</b> Existing trainings available in the market, including those sponsored by NEEA and those offered by other providers, are useful and effective, but most supply-chain market actors, even those who have received some training, need more.</p>	<p><b>Recommendation 3:</b> Continue to offer and facilitate training through other providers (e.g., manufacturers, professional associations, and utilities) tailored to various supply-chain market actors on the topics interview respondents said were most useful. These are how to install and program LLLC; how to sell LLLC effectively by clearly understanding and effectively communicating their benefits and best applications; and, for designers/specifiers, how to communicate LLLC-specific design details to other professionals.</p> <p><b>Recommendation 4:</b> Continue to collaborate with industry training partners to offer trainings that are even more tailored to specific supply-chain market actors, in particular designers and specifiers.</p>
<a href="#">Best Use Cases for LLLC versus Other Non-LLLC NLC Systems</a>	<p><b>Conclusion 4:</b> Large offices, institutions, and industrial buildings in states and municipalities where the energy code identifies LLLC as a compliance path and utilities offer incentives are factors favorable to LLLC adoption.</p> <p><b>Conclusion 5:</b> Supply-chain market actors’ opinions were highly variable regarding the best applications for LLLC within building types and space types, suggesting their understanding of the value proposition of LLLC is limited.</p>	<p><b>Recommendation 5:</b> Continue to incorporate content and collaborate with utilities to reach customers that align with market segments, project types, and other project characteristics amenable to LLLC.</p>
<a href="#">Key Factors Influencing End-Use Customer Decisions</a>	<p><b>Conclusion 6:</b> For some end-use customers, the granularity and flexibility of fixture control afforded by LLLC systems have value and are key considerations in selecting an LLLC lighting system.</p> <p><b>Conclusion 7:</b> Although manufacturer representatives and distributors see potential for LLLC’s data mining to be an attractive feature for end-use customers, this feature is not a priority for them.</p>	<p><b>Recommendation 6:</b> Conduct further end-use customer research to define how LLLC end users value the NEBs of LLLC systems, especially benefits related to data capture and analytics.</p>
<a href="#">Lessons Learned from Customer Experience</a>	<p><b>Conclusion 8:</b> Successful implementation of LLLC requires some decisions and actions from end-use customers that are not necessary for other lighting control systems and may not be recognized by supply-chain market actors.</p>	<p><b>Recommendation 7:</b> Develop resources to inform end-use customers installing LLLC for the first time about actions that can help ensure successful system installation and operation, along with tools to help them complete those actions.</p> <p><b>Recommendation 8:</b> Develop training modules for supply-chain market actors about the end-use customer experience when installing LLLC for the first time.</p>

## 1 Introduction

The NEEA Luminaire-Level Lighting Controls (LLLC) Initiative is designed to overcome barriers to the adoption of LLLC in the commercial lighting market so 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 its own built-in sensor and controller, enabling the luminaires to communicate wirelessly and transmit data and be flexibly programmed and re-programmed in any grouping needed. By comparison, in non-LLLC NLC, the sensor and controller are external to the fixtures. One sensor and controller—typically mounted in the ceiling—will control a group of fixtures, usually wirelessly.

From 2016 to early 2019, NEEA focused on foundational program development activities. NEEA developed a Market Transformation (MT) Theory and LLLC Logic Model that laid out barriers to LLLC adoption, LLLC market opportunities, and a path to market transformation. Barriers consist of first cost, lack of skilled trade allies, product readiness, and lack of market understanding of the value proposition. Opportunities consist of rapid market adoption of solid-state lighting and on NEEA’s perception based on long-standing experience in the codes arena that LLLC can be successfully incorporated into codes.

During these years, NEEA pursued foundational program development activities to begin to address barriers and leverage opportunities. These included working with the DesignLights Consortium (DLC) to create a specification for LLLC features and operation, working with manufacturers to develop qualifying products, and conducting LLLC energy savings and incremental cost studies. More direct market interventions, which are ongoing, include influencing the incorporation of LLLC into building energy codes, supporting utilities to develop incentive programs for LLLC to mitigate first cost, and providing training to lighting professionals both through NEEA-funded efforts and through efforts co-sponsored with NEEA’s funding utilities 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. In addition to continuing the activities described above, the program team hired contractors for field implementation and marketing. Implementation has focused on establishing direct working relationships with manufacturers of LLLC and supporting them in championing LLLC and directly training product representatives, specifiers, and distributors in effective messaging and sales techniques for LLLC. Marketing activities to further raise awareness include increasing the placement of articles in industry publications, developing and publicizing case studies, holding webinars, and collaborating on informational and educational events with professional associations for installers, designers, specifiers, and end-use customers such as building operators.

The LLLC program is also collecting anonymized regional LLLC sales data from the manufacturers that agreed to share data with NEEA, and NEEA is collecting savings claimed through utility programs through its annual survey of its funders.

Based on the program outcomes described in the LLLC Logic Model, NEEA developed a number of market progress indicators (MPIs) for tracking program progress. This study is the first of several LLLC market progress evaluation reports (MPER) that will track the LLLC MPIs and provide continuing market research to help guide NEEA’s outreach and intervention activities.

As indicated in the program documents and the MPis, NEEA' initiative is focused on increasing market adoption of LLLC. However, NEEA also wants to understand what other networked lighting control (NLC) technologies (non-LLLC NLC) are present in the market, customer awareness and project activity around these competing products, and why customers might select non-LLLC NLC rather than LLLC. For this reason, in addition to MPis related to LLLC, in this first MPER Cadmus and its partner TRC (the "Cadmus Team"), had a corresponding research element related to other non-LLLC NLC.

## 2 Methodology

The MPER 1 has six core research objectives:

- Review the LLLC MT Program Theory, LLLC Logic Model, and MPIs to assess their clarity, completeness, and alignment
- Conduct the first year of tracking MPIs to prepare for year-over-year evaluation of program progress in overcoming market barriers, achieving planned program outcomes, and increasing LLLC adoption and report progress on several short- and medium-term outcomes
- Conduct additional research on non-NLC LLLC available in the market, market awareness of and project activity around these, and reasons customers might select non-LLLC versus LLLC
- Assess the influence of NEEA-sponsored LLLC trainings on installer skills and installations, and remaining training needs and topics of interest
- Identify which commercial and industrial building types and circumstances are best suited for LLLC versus other non-LLLC NLC systems, and why
- Identify key factors influencing end-use customer decisions on whether to install LLLC<sup>1</sup>

To inform MPER 1, the Cadmus Team conducted the following primary and secondary research tasks and designed each to address a specific subset of research questions related to the core research objectives. This section presents additional detail on the methods and purpose for each task listed in Table 4.

**Table 4. Research Activities for NEEA LLLC Initiative MPER 1**

Task	Target Group	Completes
Document Review	N/A	N/A
Stakeholder Interviews	Interviews with 3 NEEA program staff, 1 NEEA implementation contractor staff person, and 5 staff from NEEA’s funding utilities	9
Supply-chain Market Actor Interviews	Interviews with a DesignLights Consortium (DLC) representative, 6 controls manufacturers, 1 provider of software to manufacturers, 5 manufacturer representatives, and 2 distributors	15
Installer Survey	Surveys of Northwest commercial lighting and controls installation companies from various source lists <sup>a</sup>	179
Designer/Specifier Survey	Surveys of Northwest commercial lighting designer/specifier companies from various source lists <sup>a</sup>	86
Trainee Interviews	Interviews with trainees from Northwest utility-hosted and/or NXT-Level hosted trainings <sup>a</sup> . Trainees may have also attended other trainings (e.g., provided by manufacturers). Respondents included 7 installers, 8 designers/specifiers, and 4 distributors	19
End-use Customer Interviews	End-use customers that installed LLLC (12) and who installed other control types (2)	14

<sup>a</sup> See Section 2.3.3 for in-depth detail on the contact lists obtained and used for this study.

<sup>1</sup> Throughout this report, the term “end-use customer” refers generally to the organization that owns, manages, or occupies the space where the control system is installed and is primarily used to differentiate that organization’s perspective from that of supply-chain market actors. The term does not refer to specific individuals.

## 2.1 Document Review and Stakeholder In-Depth Interviews

Cadmus reviewed NEEA’s program documents to ensure that its strategy for overcoming market barriers was clear and reflected market research and that the identified program MPIs corresponded to the market transformation narrative, addressed all identified outcomes, and were measurable. In parallel with this effort, the Cadmus Team interviewed NEEA program staff, implementation contractor staff, and utility funder staff (collectively, stakeholders).

### 2.1.1 Objectives

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

- Evaluate the clarity, completeness, and alignment of the LLLC Logic Model and MT Program Theory
- Assess whether the LLLC Logic Model and MT Program Theory reflect key market barriers identified in market research and other resources
- Document program accomplishments, challenges, and improvement opportunities as described by the stakeholders
- Document LLLC and other NLC incentives offered by Northwest utilities

### 2.1.2 Approach

The Team conducted a thorough review of all program documentation, including the LLLC Logic Model, MT Program Theory, MPIs, description of LLLC features and capabilities, description of the target market, and other program documents. *Appendix B* lists all documents the Cadmus Team reviewed. To inform the review of program documents, the Team consulted recent NEEA market research, utility websites, and NEEA and utility funder staff interview responses.

The Team conducted the stakeholder interviews with program staff and utility representatives in parallel with the documentation review to inform its understanding of the alignment of documentation and actual program implementation and to provide insight on the status of the market, including any evidence of expected outcomes or NEEA influence. The Team completed four interviews with program staff: three with NEEA program staff and one with Cadeo, the program implementer. The Team conducted five interviews with utility representatives in NEEA’s territory.

## 2.2 Supply-Chain Market Actor In-Depth Interviews

The Cadmus Team interviewed a staff member from the DLC and representatives from lighting and controls manufacturers, a lighting software provider,<sup>2</sup> manufacturer representatives, and distributors.

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<sup>2</sup> This respondent did not directly manufacture control systems, but they provide software to lighting controls manufacturers to support Bluetooth mesh networks and so had valuable insights on the LLLC market.

## 2.2.1 Research Topics

The interview with the DLC representative allowed the Cadmus Team to address several topics:

- DLC’s process and protocols to maintain the LLLC specification and update the qualified product list (QPL), and how they balance manufacturer innovation with the need for consistent specifications
- Role of NEEA and utilities in developing the LLLC market
- Trends and shifts in the LLLC market and opportunities for the future

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

- Whether manufacturers are offering training, the contents of those trainings, and how the trainings are received by participants
- Comparison of the market presence of LLLC and non-LLLC NLC products
- Characteristics of LLLC and other NLC buildings and project characteristics and differences between the two
- What LLLC or other NLC product features are most interesting to prospective buyers and whether buyers value integration with other building systems
- Whether product changes introduced or accelerated for the COVID-19 pandemic are likely to endure (features such as occupant density sensors and individual temperature monitoring)

## 2.2.2 Sample

The Cadmus Team recruited respondents from a contact list NEEA developed. In some cases, respondents had direct engagement with NEEA’s LLLC program (three manufacturers and two manufacturer representatives). Table 5 shows the target and number of completed interviews with each market actor group.

**Table 5. Supply-Chain Market Actor Interview Sample**

Respondent Type	Target	Completed
DLC	1	1
Manufacturers/Software Provider	7	7
Manufacturer Representatives	4	5
Distributors	2	2

## 2.3 Installer and Designer/Specifier Survey

The Cadmus Team conducted a survey of installers and designers and specifiers (grouped together as the designer/specifier population for this report). The Team used this survey to collect data to assess several LLLC MPIs and to conduct corresponding research on non-LLLC NLC of interest to NEEA. The Cadmus Team worked with a phone survey vendor to field the surveys in July 2021, offering respondents a chance to win a \$500 gift card as an incentive to participate in the survey.

## 2.3.1 Research Topics

The primary objective of the survey was to assess the MPIs that address installer and designer/specifier knowledge, experience, and preferences related to LLLC. The survey also gathered information on these topics for non-LLLC NLC.<sup>3</sup>

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

- Types of training installers and designers/specifiers have received and training providers
- Trends in LLLC and non-LLLC NLC market share
- Types of organizations that have installed LLLC
- Supplier perceptions of LLLC benefits and drawbacks

## 2.3.2 MPI Framework and Survey Design

To provide a solid foundation for updating MPI measurements in future years, the Cadmus Team developed a measurement framework that documents the data source for each MPI and any key parameters or assumptions the Team would apply in the analysis. The framework informed the survey instrument, ensuring that all necessary parameters were mapped to specific interview or survey questions.

## 2.3.3 Sample Design

The Cadmus Team defined the population of installers as all commercial lighting installation firms that install lighting controls, serve the Northwest (Idaho, Montana, Oregon or Washington), and have at least one office or base of operations in the Northwest. The Team stratified this population as follows:

- **Identified Trainees:** Northwest commercial lighting and control installation firms<sup>4</sup> with staff who attended the following trainings identified from lists provided by NEEA and their funding utilities: a utility-hosted training<sup>5</sup> covering both LLLC and other NLC<sup>6</sup>, co-funded by NEEA and developed and delivered by the DLC or LDL; or a NXT Level 1 or 2 training including content on both LLLC and other NLC (at the time of the study NXT Level was funded by NEEA). (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )
- **Trade Allies – Training Attendance Unconfirmed:** Northwest commercial lighting and controls installation firms identified from lists provided by NEEA’s funding utilities of their affiliated trade allies but that were not on the lists of attendees of the two NEEA-sponsored trainings described in the bullet above.<sup>7</sup> (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )

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<sup>3</sup> The MPIs covered in the survey were 3B, 3D, 3E, 4A, 5A, 5B, 9A, 9B, and 9C. *Appendix A* contains full descriptions of these MPIs.

<sup>4</sup> Some trainees were designer/specifiers and were analyzed separately.

<sup>5</sup> NEEA was not able to obtain all the attendee lists.

<sup>6</sup> Some trainings were longer and more comprehensive, others were shorter and more topic-specific.

<sup>7</sup> NEEA was not able to obtain trade ally lists from all their funding utilities.

- **Non-Trade Allies – Training Attendance Unconfirmed:** All other Northwest commercial lighting and controls installation firms that were not on the lists of attendees of the two NEEA-sponsored trainings described in the bullet above and were not affiliated as trade allies with a NEEA funding utility. (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )
- Because the three groups above did not comprise complete and independent strata, and because installers may have participated in multiple trainings, we did not report survey results by these strata.

The Team defined the designer/specifier population as including all firms that provide lighting design or specification services to clients in the Northwest and have at least one office or base of operations in the Northwest, including architecture firms, mechanical and engineering firms, independent designers, energy service companies, and others. The Team specifically excluded distributors since they are a separate type of market actor.

The Team stratified the designer/specifier population into the following:

- **Identified Trainees:** Northwest commercial lighting designer/specifier companies with staff who attended either a utility-hosted training covering both LLLC and other NLC, co-funded by NEEA and developed and delivered by the DLC or LDL; or a NXT Level 1 or 2 training including content on both LLLC and other NLC (at the time of the study NXT Level was funded by NEEA). (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )
- **Training Attendance Unconfirmed:** All other Northwest commercial lighting designer/specifier firms that were not on the lists of attendees of the two trainings described in the previous bullet. (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )

Similar to installers, as the two groups above did not comprise complete and independent strata, and because designers/specifiers may have participated in multiple trainings, we did not report survey results by these strata.

To determine the size of the populations and strata, the Team purchased data from a third-party vendor then supplemented these data with contact lists for firms affiliated as trade allies with a NEEA funding utility and for individuals who had attended the utility-hosted<sup>8</sup> or NXT Level-hosted LLLC trainings sponsored by NEEA.

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<sup>8</sup> NEEA was not able to obtain all the attendee lists.



The Team developed a detailed set of rigorous data-cleaning protocols to merge these various datasets and account for duplicate contacts in an organized, replicable manner.<sup>9</sup> The protocols accomplished several objectives:

- Removed firms known to be outside the target populations of installers and designers/specifiers
- Defined and identified the unique firms present in the data
- Selected a single point of contact for each unique firm
- Assigned firms to sampling strata
- Created sample frames for each stratum

The Cadmus Team adjusted the population estimate following the survey, incorporating information from the survey implementation firm on companies that were duplicates or that were outside the target populations. Based on the adjusted population and final sample sizes, the Team applied strata weights to estimate results at the population level. Table 6 shows the population and number of completed surveys in the final sample, by stratum.

**Table 6. Installer and Designer/Specifier Populations and Survey Samples**

Stratum	Population	Sample Size	Expected Precision at 90% Confidence <sup>a</sup>
<b>Installers <sup>c</sup></b>	<b>2,136</b>	<b>179</b>	<b>≤ ±7%</b>
Trainees	105	27	≤ ±16.8%
Trade allies – Training Attendance Unconfirmed	496	70	≤ ±15.4%
Non-Trainee Non-Trade Allies – Training Attendance Unconfirmed	1,535	82	≤ ±10.7%
<b>Designer/Specifier <sup>c</sup></b>	<b>1,353</b>	<b>86</b>	<b>≤ ±8%</b>
Trainees	12	3	≤ ±44.8% <sup>b</sup>
Training Attendance Unconfirmed	1,341	83	≤ ±10%

<sup>a</sup> Confidence and precision are calculated at the question level. Therefore, in this table, Cadmus has reported the highest precision for each stratum.

<sup>b</sup> Due to the low sample size for trainees, precision at 90% confidence is very variable for some questions where respondents answered drastically differently. When respondents aligned well on their responses, precision dropped as low as 2.6%.

<sup>c</sup> Above this table, in this section 2.3.3 *Sample Design*, are definitions of the strata for installation companies and designer/specifier companies.

## 2.4 Trainee In-Depth Interviews

To recap, trainees are defined as firms with staff who attended either a utility-hosted training that included content on both LLLC and other NLC (co-funded by NEEA and developed and delivered by the DLC or LDL) or a NXT Level-hosted training focused on LLLC content (funded by NEEA and developed and delivered by the LLLC program). (Staff from these firms may have attended other trainings not funded by NEEA [e.g., provided by manufacturers, industry associations, etc.] )

<sup>9</sup> The Cadmus Team provided this complete set of protocols to NEEA in a separate document.

Trainees who were interviewed overlapped with the trainee stratum included in the survey sample, but the Team filtered these respondents out of the survey contact list so no trainees were sampled twice.

## 2.4.1 Research Topics

The Cadmus Team used the interviews to gain insight on several topics:

- Motivation for attending training
- Most useful training content and additional training needs
- Trainee insights on the benefits of LLLC

## 2.4.2 Trainee Observations of LLLC Market Trends and Barriers Sample

The Cadmus Team recruited trainee respondents for the in-depth interviews from a list of participants collated by NEEA. Respondents included 13 participants in the utility-hosted training that included content on both LLLC and other NLC (co-funded by NEEA and developed and delivered by the DLC or LDL) and six participants in the NXT Level-hosted training focused on LLLC content (funded by NEEA and developed and delivered by the LLLC program). Although the Cadmus Team selected respondents from among attendees of these two specific NEEA-sponsored trainings, respondents were asked about training in general to capture insights from trainings not funded by NEEA (such as provided by manufacturers) and because the Team considered it unlikely that many respondents would be able to differentiate accurately among multiple trainings they may have attended months or years earlier.

Table 7 provides the trainee population and completed interviews. The Team conducted interviews by phone in May and June 2021 and provided respondents a \$50 gift card as a thank you for participating.

**Table 7. Trainee Population and Completed Interviews**

Group	Population	Target Completes	Actual Completes
Trainees from utility-hosted trainings (covering both LLLC and other NLC; co-funded by NEEA and developed and delivered by the DLC or LDL)	199 <sup>a</sup>	20	13
Trainees from NXT Level-hosted trainings focused on LLLC; funded by NEEA and developed and delivered by the LLLC program)	20		6

<sup>a</sup> This number does not represent all attendees of these trainings because NEEA was not able to obtain all the attendee lists.

## 2.5 End-Use Customer In-Depth Interviews

The Cadmus Team interviewed representatives from end-use customer organizations that had completed a lighting project within the past three years, focusing on organizations that completed LLLC projects. The Team conducted these interviews by phone in June and July 2021 and provided respondents with a \$100 gift card as a thank you for participating.

### 2.5.1 Research Topics

The Team used these interviews to explore topics related to end-use customer decision-making regarding lighting controls purchase and installation:

- Respondent awareness of and past experience with lighting controls generally, and with LLLC and non-LLLC NLC specifically, including perceptions of attributes and features

- How the decision-making process was structured, including how customers became aware of the controls they selected, influential actors, and details of specific equipment proposals (at what point they were made and how they were vetted)
- Relative importance of decision-making factors for installing LLLC and non-LLLC NLC (such as cost, maintenance, future-proofing, flexibility, aesthetics, or others)
- Real and perceived barriers or challenges related to LLLC or non-LLLC NLC along with possible solutions
- End-use customer experience and satisfaction with LLLC and non-LLLC NLC
- Space and building characteristics such as industry segment, space uses, vintage, own versus lease, single versus multiple building ownership, and retrofit versus new construction

## 2.5.2 Sample

The Team recruited respondents from contact information provided by NEEA’s funding utilities. Table 8 shows the number of interviews the Team completed.

**Table 8. End-use Customer Completed Interviews**

Group	Completes
Projects with LLLC	12
Projects with other types of controls	2

### 3 Detailed Findings

This section presents the detailed findings from the Cadmus Team’s research, organized by task. Results are synthesized across tasks in the *Conclusions* section that follows. Several tasks informed the MPI estimates, and individual MPI results are presented throughout these findings. A summary of the values for all the MPIs included in the scope of this MPER is presented in *Appendix C*.

#### 3.1 Document Review and Stakeholder Interviews

As the first step in this evaluation, the Team reviewed the program documentation and LLLC Logic Model to assess the clarity, completeness, and alignment of all documents guiding the program activities. In parallel with the documentation review, the Team interviewed NEEA program staff, implementation contractor staff, and staff from NEEA’s funding utilities.

These interviews contributed to the measurement of MPIs 1, 7A, and 7B, as shown in Table 9. Detailed findings from the interviews relevant to the MPIs and other research topics assess are discussed following the table.

**Table 9. Details of MPIs 1A, 7A, and 7B**

LLLC Program MPI	2021 Estimate	Corresponding Research for Non-LLLC NLC	2021 Estimate
<b>1A.</b> Utilities establish LLLC incentive programs	7 utilities plus BPA	Utilities establish non-LLLC NLC incentive programs	7 utilities plus BPA
<b>7A.</b> LLLC is an Optional Compliance Path in Washington code	Achieved	N/A	N/A
<b>7B.</b> LLLC is referenced in IECC 2018	Achieved	N/A	N/A

<sup>a</sup>The region’s public utilities that purchase power from BPA can use the BPA lighting calculator for their commercial lighting incentives. BPA expanded the calculator to include NLC (including LLLC).

##### 3.1.1 Document Review

Overall, NEEA’s LLLC program documentation is well-designed and successfully conveys the program strategy to overcome market barriers and drive adoption of LLLC. The MT Program Theory and supporting documentation are thorough and provide substantial detail on key market barriers, target audiences, program activities, and expected outputs and outcomes. Additionally, many of the program activities target important leverage points in the LLLC market, where intervention with a single actor can have significant positive repercussions on multiple other actors in the market. These activities and leverage points include trade ally training, and engagement with local and state governments (code development), manufacturers, distributors, manufacturers’ representatives, utilities, and other organizations (such as the DLC).

The LLLC Logic Model accurately reflects the market transformation theory and supporting documentation, showing a clear pathway from each program activity to the expected outputs and outcomes and tying these back to market barriers. The Cadmus Team provided minor recommendations to NEEA on MPI language and data tracking in a separate memorandum.

### 3.1.2 Evidence of Market Outcomes

Documents and interviews indicate that NEEA has been engaged in numerous LLLC initiative activities for several years, and stakeholders reported that they are observing market changes.

#### **DLC LLLC QPL and Specification**

NEEA staff reported working with the DLC to influence product specifications and build awareness of the value proposition for LLLC, consistent with the activities listed in the LLLC Logic Model. NEEA and implementation contractor staff reported that the number of LLLC systems being manufactured and the willingness of manufacturers to develop and promote these systems has increased since program inception with NEEA's support (activity link D from the LLLC Logic Model). There are now over 20 LLLC products on the market, compared to only three or four when the DLC first established the NLC QPL in 2016. NEEA and utility staff reported that supply-chain market actors are no longer reporting limited product availability.

#### **Incorporating LLLC in Building Codes**

NEEA staff reported working with the International Energy Conservation Code (IECC) to add LLLC as an optional compliance path for controls in the 2016 code, which was then carried forward to 2018 (activity link E in the LLLC Logic Model). Staff also reported that NEEA influenced the incorporation of LLLC as an optional compliance path into Washington's code in 2016. Idaho and Montana have now adopted the 2018 IECC. Additionally, NEEA worked with manufacturers to influence their LLLC product plans and ensure that products continue to evolve and have features that are important to the market (activity link D in the LLLC Logic Model). Based on these findings, Cadmus determined that LLLC MPI 7A, which indicates that the LLLC is an Optional Compliance Path in the Washington code, and LLLC MPI 7B, which indicates that LLLC is in IECC 2018, have been achieved.

#### **Utility Program Development**

Seven utilities plus BPA offer incentives for LLLC as well as other types of NLC (described in greater detail in section *3.1.4 Utility Incentives* below).

Of the five utilities the Cadmus Team interviewed, four are offering LLLC and other NLC incentives, and one of those four is planning to launch an additional incentive for LLLC and other NLC in new construction projects. Multiple utility staff respondents said the Controls Work Group, which NEEA created and facilitates to allow utilities to interact with NEEA staff and other utilities, was especially helpful in determining how to design their own offerings around LLLC and other NLC. One utility said it would be beneficial to include utility program implementers in this group, since these implementers have more direct engagement with customers.

Some utility staff respondents also credited NEEA's research on LLLC savings as being an important factor in their ability to offer incentives for LLLC. NEEA-funded research has enabled the inclusion of LLLC-specific savings in the Regional Technical Forum (RTF) nonresidential lighting protocol, which is required for some utilities to be able to claim the higher savings for any LLLC system or other NLC systems that meet stricter requirements (i.e., function closer to an LLLC system). However, another

utility reported it will need research that proves the savings potential of LLLC specific to its own service territory before it can justify adding LLLC incentives to its portfolio.

NEEA has completed several studies of the energy savings potential of NLC systems, including LLLC. In 2020, NEEA completed a study of energy savings in 194 buildings with NLC systems installed, including many LLLC systems.<sup>10</sup> The study found that LLLC achieved significantly higher energy savings than non-LLLC NLC systems, though it also recommended conducting additional research to confirm this result.

### **Supply-Chain Market Actor Awareness-Building and Training**

NEEA hired a program implementation contractor in July 2019. NEEA staff said this implementer has been effective in introducing technical education and training to the market and increasing awareness of LLLC through marketing, outreach to professional associations, and media outreach (activity link C in the LLLC Logic Model). In addition, NEEA created marketing and educational materials, available online through the BetterBricks website, for utilities to use. Staff also noted that, though there is still a need to build upon current efforts, they have seen a good response in the market from their increased awareness-building activities (customer- and contractor-focused earned media, webinars, and the development of marketing materials) and said they plan to invest more in marketing efforts in 2021 and 2022. The implementer has engaged with six manufacturers and established collaborative action plans with four of them to date (three relatively large manufacturers and one smaller manufacturer). These collaborative action plans are intended to build market awareness and educate market actors about LLLC.

NEEA and its funding utilities have also been providing training throughout the region for several years. The first of these trainings were hosted by utilities and included content on both LLLC and other NLC. They are co-funded by NEEA and developed and delivered by the DLC or LDL. Through its NXT Level program, NEEA offers two levels of training, both of which dedicate some time to LLLC. During the interviews, all five utility staff respondents said these trainings were beneficial in increasing awareness of LLLC in their service territory (activity link B and output link 19 in the LLLC Logic Model). In addition, as mentioned earlier in this report, a NXT Level-hosted training focuses on LLLC content, and it is funded by NEEA and developed and delivered by the LLLC program.

NEEA staff said their early focus has been on increasing awareness of LLLC throughout the entire supply chain and increasing the availability of LLLC products. Moving forward, staff plan to increase their support of partner marketing and education efforts (industry organizations, manufacturers, and utilities, among others) that target end-use customers and influencers such as specifiers with messaging to increase awareness of LLLC and their benefits. NEEA plans to continue education and marketing efforts but with a greater focus on content that directly addresses LLLC barriers. NEEA also plans to increase its

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<sup>10</sup> Energy Solutions. September 24, 2020. *Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC*. Prepared for Northwest Energy Efficiency Alliance and DesignLights Consortium. <https://neea.org/resources/energy-savings-from-networked-lighting-control-systems-with-and-without-luminaire-level-lighting-controls>

engagement with utilities to help further raise the visibility of LLLC to utility customers through trade ally and utility program engagement (output links 19, 25, 27, and 28 in the LLLC Logic Model).

### 3.1.3 Training

The utilities had mostly positive feedback regarding NEEA-sponsored trainings, but a few offered suggestions for improvement. Several noted that the educational resources on LLLC provided through the NEEA-sponsored trainings have helped installers and other supply-chain market actors become more comfortable with the LLLC technology itself, but these respondents thought more is needed to build sales skills and the ability to explain the benefits to customers. One utility staff respondent noted in particular that trade allies are not discussing the long-term flexibility benefit of LLLC with their customers. (NEEA does already offer a more sales-focused class, “Communicating the Value Proposition of NLC and LLLC” through the LDL, but utility respondents did not mention this.) Another utility respondent said installers are not providing sufficient long-term customer support on LLLC. This respondent cited an example of a business customer who called their utility for help after their energy manager left (and the company no longer had anyone who knew how to operate their LLLC system).

In addition, although a few utility staff respondents occasionally referred to the NEEA-sponsored trainings as “installer” trainings, others reported that a diverse group of professionals attend, including other types of supply-chain market actors, end-use customers, and utility program implementation/management staff. NEEA staff interviewed also described the trainings as including diverse attendees. The Cadmus Team views this as an appropriate and positive circumstance since all of these actors need to be educated on LLLC in order to advance market transformation. One utility staff respondent specifically requested a training for utility program managers (although NEEA does already offer this through the LDL).

Several utility staff respondents also said contractors (interpreted by the Team as including installers and other lighting professionals) still need more assistance to feel comfortable proposing LLLC systems to customers for several reasons. Utility staff said contractors are not familiar enough with the benefits for customers, are not confident they can successfully install and program the system to meet customers’ needs, and are uncertain what problems might occur once the system is installed.

### 3.1.4 Utility Incentives

An anticipated outcome of NEEA’s outreach and support to utilities and BPA regarding LLLC is a greater proliferation of Northwest utilities offering incentives for LLLC. The Cadmus Team referenced online research and records compiled by NEEA to document active utility incentives for LLLC and NLC. The following organizations have incorporated LLLC offerings into their programs: Idaho Power, Pacific Power, Puget Sound Energy, Seattle City Light, Avista Utilities, Snohomish County Public Utility District, Tacoma Power, and the public utilities that purchase power from BPA. The public utilities use BPA’s lighting calculator which now includes NLC (including LLLC).

Table 10 provides additional detail on each active incentive program. Energy Trust of Oregon’s pilot program for LLLC incentives for existing building projects is on hold, but Energy Trust does offer incentives for LLLC for both existing buildings and new construction through its custom program.

NorthWestern Energy also incentivizes LLLC through its custom program. Reports are available by clicking on the name of the organization.

**Table 10. Active Incentive Programs for LLLC and Other NLC by Organization<sup>a</sup>**

Organization <sup>b</sup>	Unit Eligibility	Rebate Amount	Project Eligibility
<a href="#">Bonneville Power Administration (lighting Calculator used by public utilities)</a>	NLC, including LLLC	Dollar-per-kilowatt-hour calculated through BPA’s Lighting Calculator); additional \$40 to \$60 per fixture for non-specialty (i.e., general indoor/outdoor) fixtures; \$60 to \$100 per hi-bay fixtures installed with NLC, depending on wattage reduction	Nonresidential retrofit projects
<a href="#">Idaho Power</a>	NLC, including LLLC	\$15 to \$30 per sensor, or \$25 to \$35 for LED fixtures with multiple control strategies	Nonresidential retrofit projects
<a href="#">Pacific Power</a>	NLC, including LLLC	\$0.07 to \$0.20 per kilowatt-hour saved; \$30 per fixture (to vendor)	Nonresidential retrofit projects; LLLC must have at least one control strategy enabled; other NLC must have at least two control strategies enabled.
	NLC, including LLLC	\$0.40 to \$1.00 per watt controlled	Nonresidential new construction
<a href="#">Puget Sound Energy</a>	NLC, including LLLC	\$0.35 per kilowatt-hour saved (all NLC); LLLC receive an additional \$75 bonus per fixture	Nonresidential retrofit projects; new construction; LLLC fixture bonus is limited to daylighted spaces
<a href="#">Seattle City Light</a>	NLC, including LLLC	\$0.15 per kilowatt-hour saved, and NLC (both LLLC and non-LLLC) projects get an additional \$50 bonus per fixture	Nonresidential retrofit projects; multiple strategies must be enabled
<a href="#">Avista Utilities</a>	LLLC fixtures must be DLC-qualified	\$30 per occupancy sensor; \$50 per LLLC fixture	Nonresidential interior lighting retrofit projects; non-LLLC NLC must not have had occupancy sensor previously; LLLC must replace fixtures that did not have a control
<a href="#">Snohomish County Public Utility District</a>	NLC, including LLLC	Incentives based on the type of control installed <sup>c</sup>	Nonresidential retrofit projects; requires a description of the proposed controls strategy
<a href="#">Tacoma Power</a>  Incentives based on BPA’s Lighting Calculator	NLC, including LLLC	Dollar-per-kilowatt-hour calculated through BPA’s Lighting Calculator; additional \$40 to \$60 per fixture for non-specialty (i.e., general indoor/outdoor) fixtures; \$60 to \$100 per hi-bay fixtures installed with NLC, depending on wattage reduction	Nonresidential retrofit projects

<sup>a</sup> Energy Trust does offer incentives for LLLC for both existing buildings and new construction through its custom program. NorthWestern Energy also incentivizes LLLC through its custom program.

<sup>b</sup>The report is available by clicking on the name of the organization.

<sup>c</sup> The Team did not find additional information about Snohomish County Public Utility District’s incentive on its website.



Some utility staff respondents reported that offering higher incentives for LLLC than non-LLC NLC was not feasible for their energy efficiency portfolio in the near term. Of the four interviewed utilities that offer incentive programs for NLC (including both LLLC and other NLC), three offer the same incentive amount for both types of systems. Staff with two of these utilities said they want to offer larger incentives for LLLC than other NLC but were not sure whether the RTF's unit energy savings library (updated in January 2021) would support the additional payments.

The fifth interviewed utility respondent does not offer any incentives targeting LLLC or other NLC and has no near-term plans to do so. This respondent said the utility's customer base includes many smaller facilities that have not shown much interest in lighting upgrades, even for simple LED retrofits or replacements. This highlights a potential challenge regarding the applicability of LLLC to all utility territories, especially where fewer customers are the type that appear more likely to install LLLC based on projects completed thus far (specifically, customers in sectors such as healthcare, education, or warehousing that occupy large buildings and are doing major renovations or major new construction).

All four utility respondents who offer LLLC and other NLC incentives have seen some level of market uptake with an increasing number of projects, but they report that NLC savings still comprise a small portion of total commercial lighting savings, in the range of 5% or less. One utility said incentive applications have increased from three in 2019 to potentially 50 in 2021, while another utility reported that annual participation has increased from only five projects in 2019 to an estimated 10 projects in 2021. The other two utility respondents did not provide specific project numbers.

Utility respondents differed about the types of end-use customers, types of projects, or types of spaces best suited for either LLLC or non-LLC NLC. When answering questions about NLC in general, one utility said customers are more likely to install NLC when "the building is owned entirely by a single entity." Another utility saw the greatest potential for growth in reaching out to property managers, which it plans to do directly rather than going through trade allies. A third utility thought convention centers and other major venues provided a strong opportunity for NLC because they frequently adjust their usage and lighting needs.

Utilities' perspectives regarding the types of spaces best suited for LLLC differed as well. For example, one utility said schools are a poor fit for LLLC "because the lighting needs are static," while two other utilities thought LLLC would be a good fit for schools and universities due to the diversity of room types and usages. Two utilities viewed LLLC as a poor fit for retail, both stating that having some lights off during business hours may deter customers. One utility has seen successful LLLC implementation in hospitals, city centers, government buildings, and offices. The remaining two utilities reported little success with LLLC uptake among their customers, with one having had only a couple of projects over the past few years and the other reporting no projects. Neither had a clear perspective on which types of customers and spaces would be best suited for LLLC. One said any commercial or industrial facility would be eligible for incentives (but did not specify what market segment would be most likely to participate), while the other did not know.

### 3.2 Supply-Chain Market Actor Interviews

The Cadmus Team conducted interviews with the DLC, LLLC manufacturers, Northwest manufacturer representatives, and Northwest distributors. These interviews contributed to the measurement of MPIs 2A, 2B, and 3A and to the corresponding research on non-LLLC NLC, as shown in Table 11. The following sections provide more information on the MPIs, non-LLLC NLC research, and other research topics identified for this task.

**Table 11. Details of MPIs 2A, 2B, and 3A**

LLLC Program MPI	2021 Estimate	Corresponding Research for Non-LLLC NLC	2021 Estimate
<b>2A.</b> DLC regularly reviews the LLLC QPL	Achieved	DLC regularly reviews non-LLLC NLC QPL	Yes
<b>2B.</b> DLC regularly reviews LLLC specification and updates	Achieved	DLC regularly reviews non-LLLC NLC specification and updates	Yes
<b>3A.</b> Manufacturers with LLLC products on the DLC QPL offer LLLC training to at least one type of supply-side market actor	Achieved	Manufacturers with non-LLLC NLC also offer training for these products	Yes

#### 3.2.1 DLC Interview

##### *DLC Management of the QPL*

LLLC MPI 2A and MPI 2B track whether the DLC regularly reviews the LLLC QPL and the LLLC specification, respectively. Information provided by the DLC representative confirms that these MPIs have been fulfilled to date. According to the DLC representative, when the QPL was launched, DLC updated the technical requirements every year. More recently, major updates are less frequent (once every few years), but DLC does review the full QPL every year (including LLLC) and develops minor interim updates between those major updates, on an as-needed basis, to address changing market circumstances and new technologies.

##### *Roles of NEEA and Utilities*

The DLC representative said that NEEA has had and continues to have a major influence on the market for LLLC and also on DLC’s own NLC initiative. The respondent said NEEA was one of the original architects of DLC’s NLC program and has provided ongoing market and technical research on LLLC. The representative also said NEEA’s efforts have been important in engaging utilities, especially in driving more enhanced incentive offers for LLLC through utility programs, especially prescriptive rebate programs. This is a benefit because prescriptive programs, which pre-qualify certain eligible measures, are less complicated for customers than custom programs that typically require pre-installation energy modelling and post-installation verification of savings.

DLC worked closely with NEEA to develop its definition of LLLC capability. Currently, DLC’s definition differs from NEEA’s internal definition. NEEA’s definition limits LLLC to wireless systems, while DLC’s definition does not have the same limitation. As of June 2020, three of 33 LLLC systems on the DLC QPL were wired-only products, and another seven included some wired and some wireless components. NEEA and DLC are collaborating on how they might align their definitions.

In addition, the representative cautioned that, though NEEA promotes LLLC over NLC, there may be applications where LLLC is not the ideal approach. For example, daylight control is most useful in buildings with smaller or more narrow footprints, where daylight is likely to reach all parts of the interior. But in buildings with larger footprints, it may not make sense to have daylighting sensors on every fixture. According to the DLC representative, the distinction between LLLC and other NLC systems is also important from a design perspective. In some scenarios, designers and clients may not want so many sensors to be visible on the fixtures, and there are limitations to integrating sensors in some fixture types.

In terms of future opportunities, the DLC respondent suggested that NEEA target specific market segments for LLLC adoption, such as warehouses, where LLLC is particularly well-suited. The DLC representative also suggested that, because NEEA often intervenes early in the product development cycle, it can engage in improving related lighting control technologies. For example, if NEEA were to expand its initiative to include outdoor lighting, NEEA could support occupancy sensor improvements so that the sensor range extends as wide as the light footprint of larger outdoor fixtures.

### 3.2.2 Manufacturer, Manufacturer Representative, and Distributor Interviews

The Cadmus Team interviewed five luminaire manufacturers, one manufacturer of sensors and controls, and one company that provides lighting software to controls manufacturers<sup>11</sup> (referred to in this study as part of the manufacturer group of respondents). Four of the five luminaire manufacturers offer controls product lines that are primarily or entirely LLLC as well as other, non-LLLC NLC product lines. One manufacturer offers LLLC only as an option for certain products within a broader NLC line.

The Team also interviewed five Northwest manufacturer representatives and two distributors. All manufacturer representatives and distributors represent or sell both LLLC and other NLC products.

Three manufacturer interviewees and two manufacturer representative interviewees are engaged with NEEA.

#### *Manufacturer Training*

All seven of the manufacturers interviewed offer training on their lighting controls products, including LLLC. Respondents reported offering training to a variety of supply-chain market actor types, such as manufacturers' representatives, distributors, and contractors. One respondent said the company offers training specific to local or regional requirements: the company developed training for the Northwest region about two years ago in response to the updated Washington energy code. Another four said they introduced the training when the product lines were introduced, but none specified how long ago that occurred.

Manufacturers typically target training to their primary sales channels. For four luminaire manufacturers, those are representatives and distributors. A fifth luminaire manufacturer, as well as the

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<sup>11</sup> This respondent did not directly manufacture control systems, but they provide software to lighting controls manufacturers to support Bluetooth mesh networks and so had valuable insights on the LLLC market.

controls manufacturer and the software provider, target training to manufacturer representatives and distributors but also train installers, energy service companies, and facility managers. Some manufacturers also offer training to a broader audience. The controls manufacturer and the software provider in particular said they customize their training to meet the needs of their audience. One manufacturer that was partnering with NEEA reported working with NEEA to expand their training, initially offered only to large turnkey installers, to manufacturer representatives and distributors.

All manufacturers orient their training to their own product lines (which include both LLLC and non-LLLC NLC), and the structure, format, and specific content vary among manufacturers. Training topics frequently include installation, system specifications and capabilities, programming, and commissioning. Though it was not clear whether all manufacturers address all of these topics, all do offer multiple levels of training, ranging from more basic to more advanced. Two manufacturers offer training on sales strategies, and one (the luminaire manufacturer that does not have a dedicated LLLC product line) specifically addresses the pros and cons of LLLC versus other types of NLC systems. Depending on the topic and the manufacturer, training ranges from short webinars or videos for more introductory topics to multi-day, in-person training about detailed installation and commissioning. These responses indicate that the market has achieved MPI 3A, which tracks whether manufacturers with LLLC products on the DLC QPL offer LLLC training to at least one type of supply chain market actor (such as installers, manufacturer representatives, distributors, or specifiers).

All five manufacturer representatives and both distributors had participated in some form of training on NLC (respondents did not indicate if the training was specific to LLLC or other NLC) offered by manufacturers, utilities, or a professional training source. When asked what information was most useful in the training, respondents most frequently mentioned seeing actual case studies for different types of NLC systems (including LLLC) as well as real-world usage data and analysis (including the pre- and post-installation submetering data provided by NEEA from an Energy Trust pilot site). A few respondents also mentioned additional, very specific topics (mostly related to LLLC), which included wanting more programming details, such as that not all sensors need to be activated in all fixtures and being aware of issues like using different programming for fixtures in an open space to provide visibly even lighting.

Manufacturer representatives and distributors identified several LLLC-specific topics on which they would like additional training or educational resources:

- Hands-on installation
- Energy and building code requirements related to LLLC and other NLC
- Issues related to IT security and mitigation strategies
- Using sensors for functions beyond lighting controls
- Communicating the benefits of LLLC over a zonal approach to end-use customers (especially for a building that already has very granular zoning)
- Giving customers confidence that internal facility management staff will be able to operate the system on their own

- Communicating the added value of LLLC to other industry professionals (such as designers and those managing project financing)
- LLLC technology trends (what products are being developed)
- Real-world examples or case studies

## *Best Applications for LLLC*

Most respondents across all three supply-chain market actor types (manufacturers, manufacturer representatives, and distributors) considered LLLC superior to other NLC in nearly all circumstances because its greater flexibility makes it easier to meet end-use customer needs and because LLLC is easier to install than other types of NLC.

### **Manufacturer Perspective**

Manufacturers identified some circumstances they think are particularly well-suited to LLLC and some they think are not. One manufacturer specifically mentioned that LLLC is well-suited to high-bay installations, private and open offices, and classrooms because the LLLC will achieve a high return on investment in these applications. However, this manufacturer said that if the end-use customer is already reconfiguring the lighting layout (i.e., moving the location of fixtures), the customer may not benefit from the flexible programming LLLC offers. Another respondent said open offices are not a good choice for LLLC because this type of space may not need much lighting variability. A third manufacturer said LLLC are well-suited to large organizations with multiple integrated building management systems where there is a demand for and capability to process the building system data that LLLC can provide. One manufacturer said that, in general, troffers are more likely to be LLLC than are other types of fixtures such as downlights, for which “it is harder to have an LLLC solution.”

No manufacturers identified any applications that they considered to be better suited to non-LLLC NLC than to LLLC. However, they did indicate that customers often prefer non-LLLC NLC systems over LLLC systems because of cost. Several manufacturers noted that return on investment is a key factor in customer decision-making, so any added cost for LLLC poses a challenge compared to other NLC systems as well as to non-NLC systems. Another manufacturer, whose role at the company is direct-to-customer sales, summed up the market this way:

*“The legacy market is still designed around a zone-based approach, so if we know we’re up against a project where the system is already designed that way [and we’re] competing against standard [non-LLLC] NLC, [we do not propose LLLC because we would lose on cost]... But we’re typically competing against no controls, or basic analog sensors, and even in commercial spaces we’re still competing against basic switching. We like to convert analog lighting to NLC, and then LLLC is the cherry on top.”*

One manufacturer, who considered himself “skilled in articulating the benefits of LLLC,” recognized that some customers and installers are drawn to non-LLLC NLC just because it is easier to understand (being closer to the way “things have always been done”). Taken together, these respondents’ thoughts encompass the complexity and nuance of factors and circumstances that bear on lighting control decisions.

### **Manufacturer Representative/Distributor Perspective**

Manufacturer representatives and distributors mentioned several specific applications that were better suited to LLLC over other NLC. These included applications in large spaces that require a large number of fixtures (such as warehouses or big-box retailers); in buildings operated by organizations that have the capacity and building systems to make use of the data analytics capabilities of LLLC; and in smaller spaces used by different individuals or that change use or users frequently, such as office break-out rooms with a single fixture, open office or cubicle space, or classrooms.

One respondent included corridors as an example of this type of application (but another respondent grouped hallways with storage closets and mechanical rooms as places used too infrequently to achieve enough energy savings to justify LLLC).

One respondent said hospitals were an example of buildings well-suited to LLLC because they are large enough to make use of the data. Hospitals also operate continuously, which maximizes the energy savings benefit from LLLC. In addition, the fine-grain control of lighting levels and quality available from LLLC are helpful to create a positive environment for staff who work long shifts.

Manufacturer representatives and distributors suggested non-LLLC NLC was preferable to LLLC primarily where the space would not benefit from the added functionality of LLLC and, therefore, the added cost was not justifiable. Two respondents said small businesses were unlikely to use the data captured or the programming flexibility and, therefore, this market segment does not need LLLC. Another respondent said that in a broad sense most applications do not require LLLC functionality, at least not yet. This person considered the data analytics capabilities of LLLC to be its primary benefit but that there are not yet enough system integration opportunities to obtain useful data. Finally, one respondent said that, at present, LLLC is not a feasible option for restaurants or other spaces that use decorative lighting, because LLLC have too few decorative fixture options.

### *Customer Priorities*

When asked what customers are looking for in lighting and lighting controls systems, manufacturer representatives and distributors most frequently mentioned a high return on investment (i.e., a short payback period), optimal energy efficiency, and intuitive, easy-to-use systems. Respondents described easy-to-use systems as being reliable and understandable (“the occupants know what will happen when they push the button”), not requiring an outside contractor to adjust programming, and allowing users to automate to save energy but still use manual controls when necessary.

Two respondents said some end-use customers are very interested in data capture (i.e., asset tracking) and typically also want features such as the ability to tie into their existing building systems, visibility into system performance, and adaptability (the ability to integrate with new systems or to add capabilities in the future). One of these respondents separated end-use customers into two groups: those who want to “keep it simple” with an easy-to-use system and those who want “deep-dive data” with a hyper focus on integration, data visibility, centralized controls, and analytics.

### *Communicating the LLLC Value Proposition*

When asked how they communicate the value and benefit of LLLC and other NLC systems to customers, manufacturer representatives and distributors did not distinguish between the two technologies. Most respondents focused on the extra features available through NLC systems *in general* (i.e., not distinguishing between LLLC and other NLC) relative to non-NLC systems, but each built the sales pitch somewhat differently.

Two respondents emphasized the granularity of control, ability to customize lighting to individual user preferences, and ability to adapt easily to new users and new circumstances. One of these respondents combines this message with an emphasis on ease of use, a system that “you don’t have to think about” and that “just does what it’s supposed to.” A third respondent, who deals primarily with LLLC, said he presents NLC, of which LLLC is a subset, to high tech manufacturers as the latest technology that impresses customers. Another focuses on how the system provides insights (such as asset tracking through data capture), gives greater control, and supports optimization—of energy usage as well as operations. Two other respondents had simpler messaging. One focused entirely on energy savings. The other, who said he generally does not see the benefit of a fully networked controls system, specifically said he had recommended LLLC a few times as a way to meet code.

### *Role of Utility Incentives*

Both manufacturers and manufacturer representatives said utility incentives are key to encouraging LLLC adoption, but both groups also reported the need for greater awareness of the incentives. One representative suggested targeting incentives to installers to encourage them to sell LLLC and noted that installers may “value engineer” the controls specification by removing the LLLC system to lower the overall price of their bid to win a job.

### *Barriers*

Asked what the remaining barriers are to LLLC and other NLC adoption, nearly all manufacturer respondents said cost, especially the cost premium for LLLC compared to other NLC, but also any NLC systems compared to non-NLC. Other barriers specifically to LLLC adoption include lack of familiarity by end-use customer and installer (two mentions), complexity of LLLC systems (one mention), and lack of interoperability due to the inability to combine luminaires and control components from different manufacturers (one mention). Asked about strategies to overcome these barriers, some manufacturers suggested greater utility support and rebates to resolve the cost premium. Others suggested greater education and awareness of the overall value proposition of LLLC and non-energy benefits, not just the energy savings. One manufacturer said incorporating LLLC in more energy codes. Another said standardizing LLLC components for increased interoperability.

Manufacturer representatives were most likely to reference these as primary barriers: the lack of familiarity with LLLC systems by supply-chain market actors and end-use customers and the inadequate communication of the benefits of LLLC and other NLC systems by supply-chain market actors. Several manufacturer representatives also mentioned customers’ concerns about IT security. Overall, they were less likely to mention cost as a primary customer barrier, but one said that both the system component



costs and the installation and ongoing costs (such as subscription fees for control system platforms) are significant barriers.

### *Opportunities for Product Improvement*

Manufacturers mentioned several opportunities to improve LLLC products, most of which related to making the systems easier to install, operate, or integrate with other building systems. Manufacturer representatives and distributors also said manufacturers should focus on making systems easier for end-use customers to use. They specifically suggested that manufacturers develop more control applications for personal computers and mobile phones.

Several manufacturers mentioned the need to improve interoperability among different manufacturers' systems, which was also suggested by one manufacturer representative. Respondents expected that improving interoperability would increase competition and bring costs down as well as make installation easier (compared to having to learn how to install multiple proprietary systems).

Other opportunities for improvement include IT security for end-use customers, product support for installers and end-use customers, and sensor capabilities (such as enabling finer-grain occupancy sensing or heat detection).

### *3.3 Installer and Designer/Specifier Survey*

The Cadmus Team surveyed installers and designers/specifiers to assess several LLLC MPIs and conduct associated research of interest to the team for non-LLLC NLC. The Team proposed significant revisions to MPI 3E so it would be more measurable. Because this MPI was updated during the survey analysis, the Team was not able to collect necessary data to assess it. Table 12 presents the estimated 2021 values for the MPIs and associated research elements for non-LLLC NLC, which are discussed in more detail following the table.



**Table 12. First-Year Values for MPIs Assessed through Installer and Designer/Specifier Survey**

LLLC Program MPI	2021 Estimate	Corresponding Research for Non-LLLC NLC	2021 Estimate
<b>3B.</b> Percentage of lighting installation companies with at least one installer trained in LLLC	18%	Percentage of lighting installation companies with at least one installer trained in non-LLLC NLC	16%
<b>3D.</b> Percentage of lighting installation companies with capability to bid on project that involves LLLC installation	66%	Percentage of lighting installation companies with capability to bid on project that involves non-LLLC NLC installation	66%
<b>3E.</b> Percentage of companies with at least one LLLC-trained installer in each state	Data not available in this MPER <sup>a</sup>	Percentage of companies with at least one LLLC-trained installer in each state	Data not available in this MPER <sup>a</sup>
<b>4A.</b> Percentage of lighting installation companies and percentage of companies with lighting designers/specifiers who are aware of LLLC	Installers: 78%; designer/specifiers: 68%	Percentage of lighting installation companies and percentage of companies with lighting designers/specifiers who are aware of non-LLLC NLC	Installers: 77%; designer/specifiers: 57%
<b>5A.</b> Percentage of companies with lighting designers/specifiers who have recommended LLLC to a decision-maker for at least one project	44%	Percentage of companies with lighting designers/specifiers who have recommended non-LLLC NLC to a decision-maker for at least one project	37%
<b>5B.</b> Percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35%	Percentage of companies with designers/specifiers who say they have written non-LLLC NLC into at least one project plan	29%
<b>9A.</b> Percentage of installation companies that report having installed at least one LLLC system (“experienced installation firms”)	61%	Percentage of region’s installation companies that have installed and programmed at least one non-LLLC NLC	59%
<b>9B.</b> Percentage of experienced installation companies that say LLLC systems are easier to install than non-LLLC NLC systems	43%	Percentage of these experienced installation companies that say non-LLLC NLC systems are easier to install than LLLC	57%
<b>9C.</b> Average number of LLLC projects installation companies have completed in the past 12 months	3.4	Number of non-LLLC NLC projects that installation companies have completed in past 12 months	8.2

<sup>a</sup> The Cadmus Team did not collect sufficient data to evaluate this MPI, since the MPI was revised during the survey analysis. *Appendix D* includes other survey data related to the geographic distribution of LLLC-trained installers.

The next sections present detailed results for the MPIs and the corresponding research for non-LLLC NLC and additional topics addressed by the survey. For the MPI results for installers, the Team assessed the statistical significance using a t-test at the 5% significance levels.

**MPI 3B – Trained Installers**

The roles of installers vary, so the training they completed to support their role likely varied as well. For this reason, to assess MPI 3B the survey asked respondents about four different areas of training, and we calculated two different percentages based on their responses:

- 18% of installation companies had at least one staff person who had who had received training in **three out of four** of the following areas: 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.

- Another 14% of installation companies had at least one staff person who had received training in **one or two** out of the four topics in the prior bullet.

There were corresponding survey questions for non-LLLC NLC, but for these systems, the Team only asked about installation and programming because the survey’s focus was on LLLC. We calculated two different percentages based on their responses:

- 16% of installation companies had at least one staff person who had received training in both non-LLLC NLC installation and non-LLLC NLC programming.
- 14% of installation companies had at least one staff person who had received training in either installation or programming.

Table 13 shows the percentage of companies with staff trained in LLLC and non-LLLC NLC.

**Table 13. Percentage of Companies with Trained Staff**

Stratum	n	LLLC Training			N	Non-LLLC NLC Training		
		Three of Four Areas	One or Two of Four Areas	No Training		Both Areas	One of Two Areas	Neither Area
Installers	66	18%	14%	68%	68	16%	14%	71%

Source: Installer survey, QC4 (installers). “For each of the following, please indicate if any staff at your company, including yourself, have been trained on this subject: the best types of buildings and spaces for LLLC, the benefits and capabilities of LLLC relative to other types of control systems, how to install LLLC, to program LLLC, install other types of networked controls, program other types of networked controls?”

**MPI 3D – Bidding Capability**

MPI 3D monitors the percentage of lighting installation companies with the capability to bid on a project that involves either LLLC or non-LLLC NLC. The Cadmus Team considered respondents to be capable of bidding on an LLLC project if they were capable of either installing an LLLC system or both installing and programming one. The Team asked the same questions but about non-LLLC NLC.

As shown in Table 14, installation companies were about as equally likely to report they had these skills for LLLC projects as for non-LLLC NLC projects. For both technologies, respondents were more likely to say they were capable of installing and programming the system than saying they were capable only of installing it.

**Table 14. Installation Company Bidding Capability for LLLC and non-LLLC NLC Projects**

n	LLLC			n	Non-LLLC NLC		
	Can Program and Install	Can Install Only	Total		Can Program and Install	Can Install Only	Total
145	48%	17%	66%	153	50%	16%	66%

Source: Installer and Designer/Specifier survey, QC5 “Without hiring subcontractors, would you say that your company is currently capable of installing an LLLC system, installing and programming an LLLC system, or neither?” and QC6 “Without hiring subcontractors, would you say that your company is currently capable of installing a non-LLLC networked controls system, installing and programming a non-LLLC networked controls system, or neither?”

**MPI 4A – Awareness of LLLC/non-LLLC NLC**

MPI 4A monitors the percentage of installation and design/specification companies that have staff who are aware of LLLC. Corresponding research questions were asked about non-LLC NLC. To evaluate MPI 4A, the Team crafted survey questions about awareness that incorporated the definition of the technology:

- QB6: 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 for flexible grouping and granular fixture control? These are known as luminaire-level lighting control systems, or LLLC.
- QB7: Are you aware of another type of networked control system, in which one sensor—typically mounted in the ceiling—controls a group of programmable fixtures, usually wirelessly?

The majority of installation companies were aware of both LLLC and non-LLLC NLC, at 78% and 77%, respectively. Designers/specifiers were less aware, with 68% being familiar with LLLC and 57% familiar with non-LLLC NLC. Table 15 shows the percentages of awareness for both of these groups.

**Table 15. Awareness of LLLC and non-LLLC NLC**

Stratum	n (LLLC and non-LLLC NLC)	Aware of LLLC	Aware of Non-LLLC NLC
Installers	179	78%	77%
Designer/Specifiers	86	68%	57%

Source: Installer and Designer/Specifier survey, QB6 “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.” & QB7 “B7. Are you aware of another type of networked lighting control system, in which one sensor—typically mounted in the ceiling – controls a group of programmable fixtures, usually wirelessly?”

**MPIs 5A and 5B – Designer/Specifier Projects**

MPI 5A tracks the percentage of designers/specifiers who have recommended LLLC to a project decision-maker for at least one project. Corresponding questions were asked about non-LLLC NLC. MPI 5B tracks the percentage of designers/specifiers who have written LLLC or non-LLLC NLC into project plans. Corresponding questions were asked about non-LLLC NLC.

As shown in Table 16, designers/specifiers were more likely to have recommended LLLC than non-LLLC NLC; 44% said they had recommended LLLC and 37% said they had recommended non-LLLC NLC.

**Table 16. Designers/Specifiers Recommending LLLC or non-LLLC NLC**

n	LLLC	n	Non-LLLC NLC
75	44%	77	37%

Source: Installer and Designer/Specifier survey, QD7 “D7. How many times would you estimate your company has recommended networked control systems other than LLLC in a project? Again, your best estimate is fine.”

As with MPI 5A for LLLC and the corresponding findings for non-LLLC NLC, respondents were more likely to have written LLLC into a project plan than non-LLLC NLC (35% and 29%, respectively, as shown in Table 17).

**Table 17. Designers/Specifiers Writing LLLC/non-LLLC NLC into Project Plans**

n	LLLC	n	Non-LLLC NLC
78	35%	75	29%

Source: Installer and Designer/Specifier survey, QD9 “D9. Approximately how many times would you estimate your company has written networked control systems other than LLLC into a project plan?”

**MPI 9A – Installed at Least One System**

MPI 9A monitors the number of installation companies that have installed at least one LLLC system. Corresponding questions were asked about non-LLLC NLC systems.

As shown in Table 18, 61% of installation companies have installed at least one LLLC system, and 59% have installed at least one non-LLLC NLC system.

**Table 18. Installation Companies That Have Installed at Least One System**

n	LLLC	n	Non-LLLC NLC
159	61%	149	59%

Source: Installer and Designer/Specifier survey, QC7 “How many LLLC systems has your company installed, not including work done by subcontractors? Your best estimate is fine.” And C9 “How many non-LLLC networked controls systems has your company installed, not including work done by subcontractors?”

**MPI 9B – Easiest to Install**

MPI 9B monitors the percentage of experienced installation companies (those that have installed at least one LLLC and non-LLLC NLC system) that say LLLC systems are easier to install than non-LLLC NLC systems. Corresponding questions were asked about the percentage of installation companies that say the opposite—that is, non-LLLC NLC systems are easier to install than LLLC. The Cadmus Team evaluated the “easiest to install” system as the one that required less time and labor to install.

A higher percentage of respondents said non-LLLC NLC requires less time and labor than LLLC, as shown in Table 19.

**Table 19. Experienced Installers Who Say LLLC Requires Less Time and Labor to Install than non-LLLC NLC**

n	LLLC Less Time/Labor	n	Non-LLLC NLC Less Time/Labor
59	43%	59	57%

Source: Installer and Designer/Specifier survey, QC12. “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 – Average Number of Projects**

MPI 9C monitors the average number of LLLC projects an installation company has completed over the past 12-month period. Corresponding questions were asked to assess the average number of non-LLLC NLC projects in the same period. Overall, as shown in Table 20, lighting installation companies have installed 3.4 LLLC systems and 8.2 non-LLLC NLC projects over the past 12 months.

**Table 20. Installer Average Number of LLLC or non-LLLC NLC Projects in the Past 12 Months**

n	LLLC Average Projects	n	Non-LLLC NLC Average Projects
152	3.4	154	8.2

Source: Installer and Designer/Specifier survey, QC8 “And about how many of these LLLC systems has your company installed in the last 12 months?” and QC10 “And about how many of these non-LLLC networked controls systems has your company installed in the last 12 months?”

Additional results from the surveys on a variety of topics related to LLLC market status and installer and designer/specifier perceptions are included in *Appendix D*.

**3.4 Trainee Interviews**

The Cadmus Team completed 19 interviews with lighting professionals who completed a utility-hosted LLLC training developed and delivered by either DLC or LDL (13 respondents) or completed a NXT Level-hosted LLLC training developed and delivered by the LLLC Program (six respondents). The 19 respondents included seven installers, eight designers/specifiers, and four distributors.

Most respondents said they had participated in other training about LLLC or other types of NLC in addition to the training from which they were recruited to this study. Respondents mentioned several training providers, including NEEA (NXT Level 1 and 2), a utility, manufacturers, associations (one installer and one designer/specifier mentioned the Illuminating Engineering Society (IES), and one installer said the Lighting Controls Association), LightFair (a lighting industry symposium mentioned by two installer respondents), and others. Installers were the most likely to pursue multiple trainings; all seven said they had done so. On the other hand, five of the eight designer/specifiers and one distributor had not attended any training other than the utility-hosted or NXT Level-hosted LLLC trainings described in the first paragraph above. Table 21 shows the number of respondents in each market actor group who attended multiple trainings and total trainings received from different providers.

**Table 21. Respondent Training Levels**

Supply-Chain Market Actor Type	n	Attended Multiple Trainings	Total Trainings by Supply-Chain Market Actor Type				
			NEEA NXT Level	Utility-Hosted <sup>a</sup>	Manufacturer	Association/LightFair	Other
Installer	7	7	4	7	2	4	0
Distributor	4	3	2	4	2	0	2
Designer/Specifier	8	3	2	7	2	1	1

<sup>a</sup> These trainings were hosted by utilities and developed and delivered by either DLC or LDL.

### 3.4.1 Motivation for Attending Training

Almost all trainees said they took the training to stay ahead of lighting market trends and that they see NLC (LLLC and other NLC) as an increasingly popular option. These respondents noted the importance of keeping up with controls technology so they can be competitive in the market and effectively educate their customers. Trainees mentioned other motivations as well, such as networking with other professionals (three mentions), wanting to understand the code implications of NLC (two mentions), wanting to understand available rebates (two mentions), and wanting to receive continuing education credits (one mention).

### 3.4.2 Value of Training Content

When interviewers asked what training topics were considered most useful for NLC generally and LLLC specifically, the interviewers directed respondents to think about all their trainings, including but not limited to those sponsored by NEEA. Respondents mentioned a wide variety of topics as being most useful, with no one topic mentioned by a majority of respondents.

For LLLC, respondents most often said information on how to install systems (six responses), how to program and commission (five responses), and sales techniques (five responses). Topics tended to overlap in respondent comments. For example, one respondent appreciated learning different programming strategies to better explain them to customers. Another appreciated hands-on training about setting up and programming a system to understand how to talk about “features and benefits as a solution to the customer.” Respondents also mentioned learning how to program daylight harvesting and other strategies, different options for grouping, how to dim lights individually, pairing and commissioning, and generally how to “set up the features on the system and make it work.” For two respondents, learning about the limitations of what LLLC can do was important. One respondent said it was valuable to learn more about non-energy benefits because talking about additional energy savings alone was unlikely to upsell a customer to LLLC from non-LLLC NLC.

The topics respondents mentioned as most valuable for NLC in general tended to overlap with LLLC, but there were some differences. Most notably, only three respondents mentioned installation. Two trainees (one project designer and one specifier, an electrical engineer) said the most useful information they learned about NLC was how to communicate system requirements to other professionals. One of these trainees explained: “I had not realized there was so much confusion in the construction arena on how to commission the controls. I don’t often have the time to talk to the contractor when he [or she] is

in the field and programming, so I try to make this as easy as possible for them and the training helped me outline this.”

Several respondents appreciated learning about the features and functions of different NLC products, both generally and specific to a manufacturer. Two respondents mentioned learning the differences among switching options, including different sensors and timer options. Two valued learning how wireless communication systems worked, two valued learning about new products and specifically how those products offered advantages over existing products, and two valued hands-on training.

### 3.4.3 Additional Training Needs

Programming was the most often requested topic for future trainings for NLC generally (mentioned by five respondents) but especially for LLLC (mentioned by eight respondents). Specifically, respondents want to learn how to program the system efficiently, the right strategies for different spaces, and how to maximize energy savings. Six respondents also requested updates on new LLLC products, while two requested updates on other NLC products. A few respondents also mentioned additional training on system selection for specific applications. For example, one respondent who was comfortable programming LLLC for warehouses and production facilities was less confident in an office space and unclear what lighting strategies might be needed in different kinds of space in an office building.

When asked what their ideal training would be for LLLC, the most common response (10 respondents) involved getting real-world experience—either designing a system and experimenting with various options or breaking down a case study in detail. Respondents also commonly mentioned a hands-on format for this ideal training. For other NLC, respondents mentioned fewer ideas in general, but the most common was to focus on comparing technologies, especially LLLC and non-LLLC NLC (three respondents). For example, one respondent requested “a comparative analysis of no controls, some controls, other NLC, and LLLC, and being able to confidently say ‘Here is why you should do this one’ (even if it is three times the cost).”

### 3.4.4 LLLC Value Proposition

Of 19 respondents, 16 said customers primarily want a lighting controls system to be easy for them to use and understand and to perform without requiring their intervention. One trainee (an architectural consultant) explained “[most owners] aren’t fully engaged so they are leaning on us to specify the system, and if it’s too complicated they will just disconnect it.” Several respondents also said a high return on investment (i.e., a short payback period) is important to customers. A few respondents said customers were motivated by specific features and functions such as dimming, flexibility to meet different occupant needs, capturing occupancy data, and special ease-of-use features such as voice controls (one mention each).

The Cadmus Team also asked what respondents considered to be the primary benefit of LLLC and of non-LLLC NLC, from the customer perspective. Table 22 shows the various benefits respondents mentioned. Respondents most commonly mentioned LLLC systems that are customizable (to meet every end-use customer’s needs), followed by being flexible or “future-proof” (can be easily reprogrammed as needs change). The primary benefits of non-LLLC NLC were simplicity (easily understandable without the

customer needing to learn anything) and energy savings. (Note that the Team perceived that some respondents may have mentioned energy savings for non-LLC NLC but not LLC because the question asked for the “primary” benefit, and respondents viewed other LLC benefits as more important than energy savings.)

**Table 22. Trainee Opinions on Primary End-Use Customer Benefits by System Type**

Benefit	LLC	Non-LLC NLC
Customizable	8	1
Flexible/“future-proof”	7	-
Low cost/easy installation	5	-
Energy savings	4	6
Ease of use (does what you want, do not need to think)	2	1
Basic control benefits	1	5
Asset tracking	1	-
Simple system (less complex, <i>not</i> customizable)	-	7
Less expensive	-	1

### *Best Applications*

In the trainee interviews, the Cadmus Team asked respondents whether LLC or non-LLC NLC was a better fit for each of several building types, spaces, project types, and other characteristics of a potential lighting project (collectively, “project circumstances”). Table 23 shows the frequency with which respondents said either LLC or non-LLC NLC (or a different system) for each circumstance.



**Table 23. Trainee Opinions on Best-Fit Systems for Different Project Circumstances**

Circumstance		Best-Fit System Type			
		LLC	Other NLC	Either	Hybrid
Market Sector	Office	10	1	2	-
	Retail	2	1	-	1
	School	4	1	-	2
	Gym <sup>a</sup>	-	1	-	-
	Warehouse	4	3	-	-
	Manufacturing Floor <sup>a</sup>	1	-	-	-
	Auditorium <sup>a</sup>	1	-	-	-
	Hospital	1	1	-	-
Type or Size of Space	Open Floor Plan	7	2	-	1 <sup>b</sup>
	Closed Floor Plan	2	-	-	
	Higher Square Footage	2	-	-	-
	Lower Square Footage	-	2	-	-
Project Type	New Construction	5	1	-	-
	Retrofit	7	1	1	-
Owned/Leased <sup>c</sup>	Owned Building	3	-	-	-
	Leased/Rented Building	2	2	-	-
Age of Building	Newer	3	-	-	-
	Older	1	-	-	-

<sup>a</sup> The Team did not ask about gyms, manufacturing floors, or auditoriums, but respondents volunteered opinions on these spaces.

<sup>b</sup> This respondent prefers a hybrid of LLC and no controls.

<sup>c</sup> Six respondents said the best system type for owned versus leased buildings depends on other circumstances, such as which party pays the electric bill and the application.

Though most respondents did not address all project circumstances the Team asked about, their responses did show some clear trends. For almost all circumstances asked about in the interview, more respondents said LLC was the best fit compared to any other system, but there were a few exceptions. One respondent volunteered gyms as a good fit for non-LLC NLC, and two said lower square footage space was better suited to non-LLC NLC. For leased/rented buildings, respondents were evenly split.

The clearest trend in favor of LLC for any individual circumstance was for offices; 10 of 13 respondents considered LLC the best fit for an office building. However, when asked about types of space, fewer respondents were willing to identify LLC as the best system for open or closed floor plans (two types of space common in offices). This was particularly true for closed floor plans, for which only two respondents selected LLC.

Respondents included some qualifiers in their responses. One respondent, a director of lighting design, said a hybrid of LLC and no controls would be the best fit for a building that had both open and closed floor plans. She said, "... in a small closet and storage, I want a wall switch, but in a classroom, I want LLC. I am in the retrofit solution business, so I have to find the best solution for each space... I choose LLC for most but can also see choosing a hybrid." One of the respondents who indicated LLC was typically best for warehouses clarified by saying LLC was better only for multi-use warehouses. For the

school market sector, respondents identified LLLC most often, but two respondents noted that a hybrid use of both LLLC and other NLC was the most applicable. One of these respondents, an architectural consultant, had recently designed a school that used LLLC in the classrooms and other NLC elsewhere.

For both new construction and retrofit, LLLC was overwhelmingly the technology of choice. But one respondent offered a caveat: “[First] cost is mitigated with new construction and LLLC has more flexibility, so it is easier. But the problem is you have to get married to one manufacturer because they won’t talk to each other otherwise.”

For owned versus leased or rented buildings, trainees said LLLC was the best fit for owned but were evenly divided between LLLC and other NLC for leased or rented buildings. Several respondents said that, whether the building is leased or not, the owner will be involved in the project and that owners who do not pay the utility bills are most interested in low upfront cost.

### *Opportunities for Product Improvement*

Respondents noted a few different opportunities to improve LLLC—the top two were interoperability (four mentions) and programming (three mentions). Other technical improvements mentioned were a desire for dual technology occupancy sensors (e.g., passive infrared and ultrasonic technologies), more reliable connectivity across the network of LLLC fixtures, dimmable line voltage tubes, more fixture types, and improved information technology security (one mention each).

For non-LLLC NLC, respondents mentioned various potential improvements including lowering the cost, simplifying system design and installation, and enabling interoperability (two mentions each). Respondents also mentioned improving the daylight sensing functionality and designing more non-LLLC NLC products to be wireless (one mention each).

For NLC in general, several respondents suggested manufacturers should provide more guidance for installers. One respondent, the president of a lighting design and installation company, explained the need as follows:

*“I think [manufacturers] need to consider key stakeholders and what they need to be successful... what does the engineer need to know to do their job [and who is providing that information?]. Then you get the contractors (general, electric, voltage) .... What does each stakeholder need to know—if this was thought out and put in each data sheet that brand would be preferred.”*

Other suggestions for NLC included improving reliability, making systems more application-based, and making more systems capable of interfacing with other building systems.

### *3.5 End-Use Customer Interviews*

The Cadmus Team interviewed 14 decision-makers involved in lighting and lighting controls projects. The contacts were provided by NEEA’s funding utilities. Respondents represented a variety of job titles or roles:

- Eight facilities managers, building engineers, or maintenance managers
- Two business owners

- Two sustainability or energy managers
- One construction project manager
- One client-side coordinator

Twelve respondents answered interview questions by thinking of a specific recent project, while two provided broader feedback on their experiences from multiple projects. Three of the 12 who described specific recent projects also provided insights on other lighting projects.

Respondents also represented several building types:

- Five warehouse, production, or other industrial use facilities
- Four higher education or research facilities
- Three office buildings
- Two K-12 schools

Table 24 illustrates the lighting project type (lighting-only retrofit, major renovation, or new construction) by the building type the interviewees represented. Note that two interviewees discussed multiple projects, so values in this table reflect all of the project types they discussed.

**Table 24. Lighting Project Type by Building Type**

Interviewee Building Type	Lighting-Only Retrofit	Major Renovation	New Construction	Multiple Projects
Warehouse, production, industrial (n=5)	5	-	-	-
Higher education or research facility (n=4)	3	2	1	1
Office (n=3)	2	1	-	-
K-12 School (n=2)	1	-	1	1

### 3.5.1 System Applications

Of the 14 respondents, 12 had installed fully networked LLLC systems, though six did not implement the LLLC system in their entire building. The other two respondents had installed non-networked systems with individual sensors and control logic built into each fixture. One respondent with a networked LLLC system did not change the occupancy sensor or daylighting settings at all because the software is compatible only with a specific, outdated version of the Android operating system; instead, fixtures had been left in their default settings.

Five other respondents said the networked LLLC controls were not implemented in specific areas that had special lighting needs or existing fixtures types with no LLLC equivalents. Respondents mentioned special lighting needs for areas where lights are required to be on all the time as a safety precaution and for areas used for detailed manufacturing work where occupancy sensors might fail to detect any motion and so turn the lights off.

Table 25 provides additional detail on lighting control approach by building type. Note that the two projects that did not implement fully networked LLLC systems were both warehouses, for which both

interviewees indicated that the built-in sensors and controls at each fixture were sufficient for their use cases and networked systems added a level of customization that was not needed in their facilities.

**Table 25. Lighting Control Approach by Building Type**

Building Type	Networked LLLC			Non-Networked, Sensors on Each Fixture
	Total Networked LLLC Installed	Select Areas without LLLC	Networked Programming Not Implemented	
Warehouse, production, industrial	3	1	-	2
Higher education or research facility	4	1	1	-
Office	3	2	-	-
K-12 School	2	1	-	-
<b>All Respondents</b>	<b>12</b>	<b>5</b>	<b>1</b>	<b>2</b>

### 3.5.2 Influences on Decision-Making

When asked what types of outside service providers supported their projects, the two most common responses were installers (including contractors and energy service companies) and distributors, with five mentions each. It is important to note that these responses likely reflect that the sample of projects consists of mostly retrofits (Table 24). Respondents also mentioned utility staff and manufacturers or manufacturer representatives (four mentions each), architects or design engineers (three mentions), and construction managers (one mention).

End-use customers consulted various resources for information on lighting controls when planning their project, with utility staff mentioned most frequently (five mentions, in addition to the mentions of utility staff as service providers). Respondents also reiterated the influence of distributors (three mentions), manufacturer representatives (two mentions), and installers (one mention). Two respondents were influenced by visiting a nearby lighting controls retrofit project before planning their own. Two respondents used internet research, and one used vendor resources as additional sources of information on lighting control systems.

End-use customers were motivated to install LLLC for several reasons, including increased flexibility in defining control zones, control responses and adaptability over time, ease of use for both occupants and building operators and/or individual occupant control, utility incentives, and energy savings. Table 26 illustrates the wide range of motivations mentioned by respondents.

**Table 26. Lighting Controls Motivations and Considerations**

Motivation/Consideration	Installed LLLC (n=12)	Installed Other Controls (n=2)
Control flexibility/adaptability to user needs	8	
Ease of use/occupant control	7	
Utility incentives	5	1
Improved light quality	4	1
Ease of maintenance/troubleshooting	4	
Return on investment/ energy cost savings	3	2
Project budget	3	
Interface with building automation / energy management system	2	
Manufacturer/product support	2	
Past experiences with controls projects or manufacturers	2	1
Product/system consistency across multiple projects	1	
Addressing control and scheduling requirements	1	
Updating older systems	1	
Accessibility (centralized access to lighting controls)	1	
Improved fixture longevity		1

Source: End-use customer Interview Guide, Q7a “What factors did you consider when choosing a lighting control system? What features were most important to you?”

Among respondents who mentioned utility incentives as a key consideration, several also said that the incentives were higher than they had expected, including one respondent who said the utility rebate covered 80% of the installation cost. Return on investment and energy cost savings were key decision factors for just three of 12 LLLC system respondents, but were mentioned by both respondents who installed other controls. Considerations were also sometimes project-specific, such as updating older or outdated systems (one mention) and accessibility needs (one mention). Some factors were not immediate needs. For example, one of the respondents who said integration with the building management system was an important consideration also said the company was still working on completing the integration and was unsure whether data access would prove as beneficial as hoped.

Respondents were asked whether their lighting projects were required to meet local energy codes. Only two respondents (one working mostly on new construction projects and one discussing a major renovation) had to meet local energy codes for their projects. One of the retrofit projects was subject to an ENERGY STAR benchmarking requirement for buildings over 50,000 square feet, but none of the other retrofit projects were required to meet energy code requirements. For projects subject to energy regulations, the LLLC system was a compliance option to meet those regulations.

### 3.5.3 Installation Challenges

When asked about installation challenges or issues, coordination with IT systems was mentioned most frequently (four mentions). Two respondents emphasized the need to engage IT staff at the outset of the project to ensure a successful installation, though another respondent avoided concerns about IT coordination by giving the facilities department sole responsibility for the lighting controls system. Three respondents said system ownership, responsibility, and maintenance were issues. Three respondents

also mentioned that an installation challenge was lack of contractor experience with LLLC and advanced lighting controls in general.

Two respondents said learning to use the system controls was a challenge. One of these respondents reported being given the choice to install the controls apps on mobile devices or tablets and choosing mobile devices. In retrospect, this respondent would have preferred tablet operation so more of the detailed interface could be seen at once. The second respondent said the company had initially planned to rely on an outside electrician to make any necessary updates to controls but was unable to find a knowledgeable contractor. Ultimately, the respondent learned to operate the system so programming needs could be managed internally.

Not all of the challenges and concerns are specific to LLLC technologies, as Table 27 illustrates. Although IT coordination and lack of contractor knowledge are specifically related to LLLC systems, issues like long-term maintenance responsibility, tenant coordination, and integration with other systems could also be challenges or concerns for other types of lighting control systems.

**Table 27. Installation and Coordination Challenges and Issues**

Installation Challenge or Issue	LLLC-Specific Issue?	Mentions
IT coordination	Yes	4
Lack of contractor knowledge/familiarity		3
Understanding and using control system software		2
System ownership/long-term maintenance	No	3
Tenant coordination		2
High ceilings (high-bay warehouse installation)		1
Understanding system details		1
Integration with other building systems and controls (lecture hall installation, audio-visual controls integration)		1

Source: End-use Customer Interview Guide, Q7a “Were there any design, construction, IT, or other coordination problems that you think were related to the system specifically?”

### 3.5.4 Experience with LLLC Systems

End-use customers were more likely to report positive than negative experiences resulting from their controls projects. Eleven respondents reported improvements with lighting quality and light levels from the LLLC system. Three respondents said occupants appreciate the flexibility and individual controllability of the lighting. Two respondents mentioned the benefit of “task tuning,” or having the system operator set the maximum output at a level less than full output to meet occupant preferences. Another said occupants are happy with the daylight harvesting feature. One also said occupants are supportive of the sustainability aspect of the lighting retrofit and think the new lighting is better for their health and wellness. One respondent each mentioned the benefits of less maintenance and that the lights automatically turn on for nighttime cleaning crews. Two respondents said other occupants or tenants have requested similar retrofits for their spaces.

Five respondents reported negative feedback about their LLLC experience. Three had minor complaints, including having to remove some automatic control functionality due to safety concerns in a dentist office, delays in lights turning on after a control input, and issues with system components failing shortly after installation. Another respondent reported significant challenges with system commissioning, with no real resolution after several years and multiple calls to the manufacturer. One respondent received complaints from occupants about new lighting functions after the system was installed. In this case, occupants initially complained that new occupancy controls in the hallway of a 24-hour laboratory that dropped light to low levels when unoccupied presented a safety concern. After discussing the lighting function with the occupants, the respondent did not change the occupancy setting because all agreed that the visual cue to others about building occupancy was a more important safety benefit than full lighting at all times.

End-use customers reported learning from their experience. Several respondents emphasized the importance of engaging with the contractor and building occupants about lighting and lighting control needs rather than just “leaving it up to the experts.” Two of these respondents, who represented buildings with laboratory or industrial production space, mentioned having to navigate the disconnect between engineers who wanted to maximize energy savings and staff who needed consistent, bright light to accomplish their work. Another respondent noted the importance of planning for task tuning from the outset and proactively communicating with occupants to set appropriate expectations.

Other respondents cited lessons learned about installing their systems. Two mentioned the importance of understanding the control system complexity and installation requirements before selecting a system. Similarly, one respondent mentioned the importance of understanding the functional capabilities and limits of the different system components (such as how many fixtures can realistically be controlled from a single area controller without creating lag or a system delay). One respondent reiterated the importance of communicating with IT on system needs and integration early in the project.

Overall, most respondents were satisfied with their lighting controls systems, including both the respondents who did not install LLLC. Of the respondents with LLLC, seven said they would use the same brand and product lines if they had a similar project in the future.

### 3.5.5 Reasons for Not Installing NLC

The two decision-makers with non-networked systems reported that networked control was not needed or not requested by tenants. These respondents represent warehouse facilities, and both installed new fixtures with sensors and controls in each fixture. One said the individual occupancy control at each high-bay fixture provides significant energy savings compared to the pre-retrofit condition where lights were on at all times despite limited occupancy, and the use of the space does not require any control zones beyond the individual fixtures. The other respondent had looked into networked systems in the past and would install a networked system if tenants requested it, but the tenants do not typically require that level of control complexity.

### 3.5.6 Additional Considerations

When respondents were asked for any additional thoughts or closing remarks, two mentioned the value of utility support in getting projects completed. However, one respondent who manages a portfolio of buildings across multiple utility territories said that different incentive application processes for each utility was burdensome to manage. One respondent encouraged building owners to actively engage in the process and to actively manage their lighting control systems to get the most out of the capabilities. Similarly, another respondent emphasized the importance of getting management buy-in on lighting retrofit projects. One respondent mentioned the importance of communication with the design team. Another reiterated the importance of growing contractor and installer knowledge in LLLC systems.



## 4 Conclusions and Recommendations

Based on the research conducted for this MPER, the Cadmus Team makes the following conclusions and recommendations about the market for LLLC.

### 4.1 Progress in Market Awareness, Perception, and Adoption of LLLC

**Conclusion 1: NEEA’s efforts are contributing to greater awareness and market uptake of LLLC as well as other NLC, as evidenced in the positive results for the MPIs evaluated in this MPER.**

NEEA staff report meeting several market intervention milestones, including the DLC launching of the LLLC specification and qualified product list (QPL) and NEEA’s success in influencing the incorporation of LLLC as an optional compliance path into the 2016 International Energy Conservation Code (IECC), which was carried forward into the 2018 IECC.

Staff also reported that NEEA influenced the incorporation of LLLC as an optional compliance path into Washington’s code in 2016. Idaho and Montana have now adopted the 2018 IECC.

NEEA is also making progress in these additional program focus areas: working with utilities to support incentives for LLLC; working with manufacturers to strengthen their LLLC product lines; partnering with manufacturers and their sales representatives to help education specifiers and distributors on how LLLC function and how to sell their benefits to customers; funding training for lighting industry professionals throughout the Northwest; and collaborating with a number of professional organizations to bring LLLC awareness and educational content to supply-chain market actors and end-use customers.

Tracking closely with these activities, several of the short-term (one to two years) and medium-term (three to five years) outcomes in the LLLC Logic Model are beginning to be realized.

Table 28 summarizes the results for this first year of tracking market progress indicators (MPIs).

**Table 28. Estimated Values for LLLC Program MPIs Assessed in MPER 1**

LLLC Program Outcome	MPI	LLLC Program MPI	2021 Estimate
<b>Outcome I (short term)</b> 1. Utilities support LLLC through programs with incentives	<b>MPI 1</b>	<b>1A.</b> Utilities establish LLLC incentive programs	7 utilities plus BPA <sup>a</sup>
<b>Outcome II (short term)</b> 1. DLC maintains QPL 2. Specification continues to advance	<b>MPI 2</b>	<b>2A.</b> DLC regularly reviews the LLLC QPL	Achieved
		<b>2B.</b> DLC regularly reviews LLLC specification and updates	Achieved

LLLC Program Outcome	MPI	LLLC Program MPI	2021 Estimate
<b>Outcome III (short term)</b> 1. Manufacturers formalize and provide LLLC training 2. LDL provides LLLC training 3 NEEA’s NXT Level training includes LLLC	MPI 3	3A. Manufacturers with LLLC products on the DLC QPL offer LLLC training to at least one type of supply-side market actor	Achieved
		3B. The percentage of lighting installation companies with at least one installer trained in LLLC	18%
		3D. Percentage of lighting installation companies with capability to bid on project that involves LLLC installation	66%
		3E. Percentage of companies with at least one LLLC-trained installer in each state	Data not available in this MPER <sup>a</sup>
<b>Outcome IV (short term)</b> 1. Increase in supply chain awareness among trade allies and lighting designers	MPI 4	4A. The percentage of (1) lighting installation companies and (2) the companies with lighting designers/specifiers who are aware of LLLC	Installers: 78% designer/specifiers: 68%
<b>Outcome V (short term)</b> 1. Lighting designers and specifiers recommend LLLC solutions	MPI 5	5A. The percentage of companies with lighting designers/specifiers who have recommended LLLC to a decision-maker for at least one project	44%
		5B. The percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35%
<b>Outcome VII (short term)</b> 1. LLLC is an optional path in Washington code, and LLLC is referenced in IECC 2018	MPI 7	7A. LLLC is an Optional Compliance Path in Washington code	Achieved
		7B. LLLC is referenced in IECC 2018	Achieved
<b>Outcome IX (medium term)</b> 1. LLLC is accepted as easiest-to-install lighting controls solution	MPI 9	9A. The percentage of installation companies that report having installed at least one LLLC system (“experienced installation firms”)	61%
		9B. The percentage of experienced installation companies that say LLLC systems are easier to install than non-LLLC NLC systems	43% <sup>a</sup>
		9C. The average number of LLLC projects companies have completed in the past 12 months	3.4

<sup>a</sup> An important associated finding was that 57% of experienced installation companies that say non-LLLC NLC systems are easier to install than LLLC.

<sup>a</sup>The region’s public utilities that purchase power from BPA can use the BPA lighting calculator for their commercial lighting incentives. BPA expanded the calculator to include NLC (including LLLC).

Seven Northwest utilities plus BPA are now offering incentives for NLC, including both LLLC and non-LLLC NLC. Supply-side market actors are also signaling interest in NLC generally, including LLLC, by seeking out training. As shown in Table 28 above, market-wide survey results indicate 18% of installation companies and 20% of companies that employ designers or specifiers have received training on LLLC.

Surveys also indicated considerable LLLC and non-LLLC project activity among installers, designers, and specifiers. The survey of installation companies found that 66% were capable of bidding on LLLC, and 61% had completed at least one LLLC project at some point in the past.

The survey of designer/specifier companies asked respondents if they had ever recommended LLLC for lighting projects and if they had ever written LLLC into lighting project plans: 44% had recommended LLLC at least once, and 35% had written LLLC into a project plan at least once. More detail on supply-side market actor awareness, capability, and project activity around both LLLC and non-LLLC NLC is provided in the body of the report.

**Conclusion 2: Perceived complexity, high first cost, and lack of interoperability among LLLC brands continue to be barriers to increased uptake of LLLC.**

**Complexity:** Although the NEEA program documents cite simple operation as part of the value proposition of LLLC, supply-chain market actors reported that end-use customers perceive LLLC as complicated and potentially difficult for facility managers to operate (i.e., to adjust fixture programming and troubleshoot issues). Another aspect of perceived LLLC complexity emerged from the survey of installation companies, with 45% reporting they consider LLLC difficult to program.

**Cost:** Cost continues to be another key barrier to customers installing LLLC rather than non-LLLC NLC. Many of the supply-chain market actors interviewed by the Cadmus Team said that, though LLLC installation is less expensive and easier than networked systems that rely on wired communications, total cost of an LLLC project (including equipment and installation) was consistently substantially higher than non-LLLC NLC. The Cadmus team also noted that, even though estimating a customer’s return on investment (i.e., how long it will take to pay back first cost or incremental cost compared to the less costly alternative) is a key way to address the first-cost barrier, survey results suggest that energy cost savings are not top of mind when supply-chain market actors compare the benefits of LLLC to non-LLLC NLC. When installers and designer/specifiers were asked “what benefits do LLLC have over other types of NLC systems,” only 13% of respondents mentioned that LLLC save more energy than non-LLLC NLC. (See Figure D-3 in *Appendix D* in the detailed findings for the full results from this question.)

**Interoperability:** One manufacturer and several other supply-chain market actors interviewed (trainees) said interoperability among different manufacturers’ LLLC systems is a barrier to customer adoption, and they recommended that manufacturers address this issue. This aspect of LLLC is counter to the flexibility and expected “future-proofing” of LLLC, because it ties the product usefulness to the existence and choices of the manufacturer.

One end-use customer reported they stopped using the networked features of their lighting because their mobile phone-based programming app is no longer supported by Android.

**Recommendation 1: Identify and highlight manufacturers with programming interfaces that are easiest for installers and facility managers to use.** Identify which LLLC controls systems installers find the easiest to program and which ones facility managers are most satisfied with from the perspective of adjusting programming and troubleshooting issues. Provide guidance to installers, in the form of a product list or similar easy-to-use resource that rates ease of use features of specific

brands and models. NEEA could collaborate on assembling this list with the DLC, the U.S. Department of Energy’s Next Generation Lighting Systems (NGLS) initiative, and utility trade allies.<sup>12</sup>

**Recommendation 2: Continue to complete and publicize studies showing that LLLC save substantially more energy than non-LLLC NLC, and educate the market about NEEA’s existing studies. Conduct studies to quantify the dollar value of non-energy benefits (NEBs).** Non-energy benefits are difficult to quantify, but solid information would be an advantage in making the business case for LLLC to customers. Depending on the business type, LLLC NEBs can include labor savings from being able to wirelessly change fixture groupings and function, rather than moving and reprogramming multiple sensors; the ability to track physical business assets through electronic tagging (e.g., medical equipment); the ability to send product coupons to customers’ smartphones as they pass a lighting fixture near the product.

## 4.2 Current Trainings and Potential New Topics and Approaches

**Context:** The research conducted on training as part of the MPER had two elements. The regional survey of installation and designer/specifier firms had a set of training-related questions, which were intended to assess the prevalence of training among these market actors (MPI 3B). A set of in-depth interviews with 19 trainees (excluded from the survey) were intended to provide the NEEA team with further insight on what LLLC topics trainees found useful and what other topics they would like to see included in future trainings.

**Conclusion 3: Existing trainings available in the market, including those sponsored by NEEA and those offered by other providers, are useful and effective, but most supply chain market actors, even those who have received some training, need more.**

Survey responses by trainees indicated that existing trainings available in the market, including those sponsored by NEEA and those offered by other providers (e.g., manufacturers, professional associations, and utilities), are effectively increasing trainees’ awareness of LLLC features and capabilities, including how they relate to non-LLLC NLC, and increasing their technical skills.

In the in-depth interviews, respondents said existing trainings available in the market helped them understand the best applications for LLLC versus non-LLLC NLC, and feel more comfortable talking to customers. Interview respondents were also asked about training topics they find most useful. They said topics related to LLLC installation, programming and commissioning, and sales techniques were most useful, including understanding the benefits of LLLC relative to non-LLLC NLC. Several designers/specifiers interviewed said they valued learning about protocols for how to communicate LLLC-specific system needs and design details to other professionals. Interview respondents also valued manufactures’ training for both LLLC and non-LLLC NLC, though most such training focused on technical skills and did not include sales training.

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<sup>12</sup> “Trade allies” are usually installation-type firms that have some affiliation with utilities, whether formal or informal. For example, utilities may list firms that meet certain qualifications on their websites.

Nearly all installer and distributor trainees who were interviewed reported attending multiple trainings on LLLC and non-LLLC NLC from various providers. Across in-depth interviews and surveys, respondents mentioned several training providers. These include LDL, which developed and delivered utility-hosted trainings; NEEA, which developed and delivered the NXT Level-hosted training; manufacturers and other supply chain actors; lighting industry associations; and others. Notably, installer survey respondents reported a high level of LLLC awareness (78%) and installation experience (61%). This indicates that businesses are building their LLLC knowledge base through training including LDL or NEEA training, and training from other providers. Businesses may also be employing other strategies, such as hiring staff who are already knowledgeable.

Despite reporting medium to high levels of understanding of both LLLC and non-LLLC NLC, all interviewed trainees requested additional training on both LLLC and non-LLLC NLC systems. Additional training topics and preferred training formats requested by trainees are detailed in Recommendation 3.

**Recommendation 3: Continue to offer and facilitate training through other providers (e.g., manufacturers, professional associations, and utilities) tailored to various supply-chain market actors on the topics interview respondents said were most useful. These are how to install and program LLLC; how to sell LLLC effectively by clearly understanding and effectively communicating their benefits and best applications; and, for designers/specifiers, how to communicate LLLC-specific design details to other professionals.**

Work to expand training to include the additional topics and formats respondents requested. NEEA may want to fund some training content directly; other content may be best offered by manufacturers and professional associations, in which case NEEA can continue to influence content through its market relationships. In general, respondents wanted to learn through hands-on practice and grappling with real-world case studies. Topics of interest included how to program LLLC more efficiently; how to select, design, and program LLLC (or other NLC) for different space types and applications; how to maximize energy savings from LLLC; how to provide ongoing customer support; and updates on new products.

**Recommendation 4: Continue to collaborate with industry training partners to offer trainings that are even more tailored to specific supply chain market actors, in particular designers and specifiers.** Continue to collaborate with industry training partners to develop training and other informational materials specifically designed for designers and specifiers. These trainings should also include case studies highlighting how LLLC can enable occupants to use lighting differently than traditional lighting systems (such as by allowing individuals more control or adjusting light color or brightness) and how building owners, facility managers and occupants respond to those design and function elements.

### *4.3 Best Use Cases for LLLC versus other Non-LLLC NLC Systems*

**Conclusion 4: Large offices, institutions, and industrial buildings in states and municipalities where the energy code identifies LLLC as a compliance path and utilities offer incentives are factors favorable to LLLC adoption.**

Though this study did not have sufficient evidence to state that most LLLC projects fit this description, projects described by utilities, market actors, and survey respondents share many of these characteristics. Utilities, market actors, and surveyed installers and designers/specifiers reported that LLLCs are installed primarily in larger buildings such as offices, retail, warehouses, K-12 schools, universities, hospitals, and production facilities. The end-use customers interviewed for this study largely fit this profile as well. Utilities reported growing participation in rebate programs, and market actors agreed that incentives are an important driver of uptake.

In addition, many of the utility programs offering LLLC incentives are in Washington or Idaho. These states' building codes allow LLLC as an optional compliance path for lighting controls. In Oregon and western Montana, NEEA's funding utilities can incentivize LLLC through their custom programs, and Montana's code allows LLLC as an optional controls compliance path. However, Oregon's code does not include LLLC. The Cadmus Team also noted that at least one manufacturer representative had recommended LLLC as the best way to meet code.

**Recommendation 5: Continue to incorporate content and collaborate with utilities to reach customers that align with market segments, project types, and other project characteristics amenable to LLLC.** Since certain sectors and project sizes appear to be more common, the Cadmus Team recommends that NEEA continue to identify and incorporate content on the value proposition for LLLC that resonates and align with the specific business needs of these customer types and help supply-chain market actors effectively sell to and serve them.

In addition, as part of the program's plan to expand engagement with professional associations, NEEA might explore state-level hospital engineering associations (e.g., MSHE, OSHE, WSSHE) and school facility management associations (e.g., OSFMA, WAMOA), among others.

**Conclusion 5: Supply-chain market actors' opinions were highly variable regarding the best applications for LLLC within building types and space types, suggesting their understanding of the value proposition of LLLC is limited.**

The topic of best applications for LLLC was explored through in-depth interviews. In general, most supply-chain market actors and nearly all trainees interviewed said they preferred LLLC for almost all spaces and project types. However, there was less consensus about the best use cases for LLLC among specific market segments, building types, space types, project types, or other project circumstances. Respondents often disagreed about whether more granular and flexible programming—the key benefits of LLLC relative to non-LLLC—were useful or necessary in a given space.

For example, many supply-chain market actors and trainees thought LLLC were often a good fit for office buildings, but several did not think LLLC were necessarily the best fit for open floor plan spaces, closed floor plan spaces, or common-use areas such as kitchen and bathrooms or other types of spaces found in office buildings because they did not perceive a demand for granular and flexible programming in those spaces. Similarly, some trainees interviewed said LLLC were a good fit for classrooms, but at least one utility representative said classrooms were not a good fit because they are rarely repurposed to a different use. Nevertheless, utilities and installers said LLLC projects have been installed in offices and

schools. In addition, end-use customers interviewed, three of whom represented office LLLC projects and two of whom represented K-12 schools with LLLC, reported benefits specifically from the improved lighting quality due to adjustable light levels and the ability to tailor lighting to meet occupant preferences.

## 4.4 Key Factors Influencing End-Use Customer Decisions

**Conclusion 6: For some end-use customers, the granularity and flexibility of fixture control afforded by LLLC systems have value and are key considerations in selecting an LLLC lighting system.**

Interviewed end-use customers who installed LLLC confirmed that granularity and flexibility of fixture control provided by LLLC systems were of primary importance in their decisions about projects, closely followed by utility incentives and energy savings. Interviewed supply-chain market actors also reported that the small set of end-use customers who adopt LLLC systems were attracted to the ability to flexibly program fixtures to be grouped and function to meet specific space and occupant needs along with the ability to change groupings and function any time by reprogramming them.

**Conclusion 7: Although manufacturer representatives and distributors see potential for LLLC’s data mining to be an attractive feature for end-use customers, this feature is not a priority for them.**

Interviewed manufacturer representatives and distributors mentioned data capture and analytics, beyond maximizing energy savings, as one of the key benefits of LLLC. However, only one interviewed trainee (distributor) mentioned a similar feature (asset tracking) as a customer priority. Among end-use customers interviewed, only two mentioned they wanted a system that could integrate with their building management system, and none mentioned non-energy data capture as an important factor.

**Recommendation 6: Conduct further end-use customer research to define how LLLC end users value the NEBs of LLLC systems, especially benefits related to data capture and analytics.**

- Research customers’ business needs for data capture and analytics and whether these align with what LLLC provides. If not, assess whether customers see value in what LLLC provides.
- Regarding LLLC integration with other building systems, research market readiness, costs and benefits, and real-world experience with implementation to decide if the program should feature this as a benefit at this stage.
- Interview the end-use customer staff tasked with troubleshooting LLLC system issues and adjusting programming to identify whether further information or assistance might be needed.
- Streamline the process for obtaining customer contact lists for research from NEEA’s funding utilities to avoid impacts on project timelines, research goals, and budgets. Ultimately, the Cadmus Team completed 12 LLLC project interviews and two non-LLLC NLC project interviews (though the goal for the latter was 10 interviews).



## 4.5 Lessons Learned from Customer Experience

**Conclusion 8: Successful implementation of LLLC requires some decisions and actions from end-use customers that are not necessary for other lighting control systems and may not be recognized by supply-chain market actors.**

End-use customers mentioned a few challenges during LLLC installation that were specific to LLLC systems. These challenges included navigating information technology (IT) communication system capacity, contending with installers who did not have good understanding of LLLC system needs and functions, and learning to operate the system controls. In addition, respondents mentioned several specific actions they took or wished they had taken to avoid challenges. These included:

- Coordinating with the party responsible for the IT network during system planning and installation to ensure the network and wireless communication system can support the number and type of fixtures to be installed
- Determining who will have authority to operate the system controls and who will have responsibility for long-term maintenance of control system, among owners and tenants and among specific staff with administrative, operational, or facility management roles
- Engaging and informing occupants about range of function LLLC system is expected to provide

**Recommendation 7: Develop resources to inform end-use customers installing LLLC for the first time about actions that can help ensure successful system installation and operation, they should take when installing LLLC for the first time along with the tools to help them complete those actions.** NEEA could develop a guide in lay terms for end-use customers to help them understand LLLC system components and function at a high level, with a focus on how an LLLC system functions compared to other types of lighting control systems and how it will impact other building systems and occupants and other parties. Customers would also benefit from clear descriptions of the specific steps and timing considerations for effectively coordinating LLLC system needs with managers of the IT network and other building systems, educating occupants and collecting their feedback, and establishing long-term control and maintenance roles and protocols for who to contact about various issues.

In addition to the guide, simple tools would be helpful, such as a survey template that both educates occupants and collects information on key preferences, lists of important talking points or questions for building system managers, and sample language for describing lighting system control and maintenance responsibilities that might help inform rental or lease agreements.

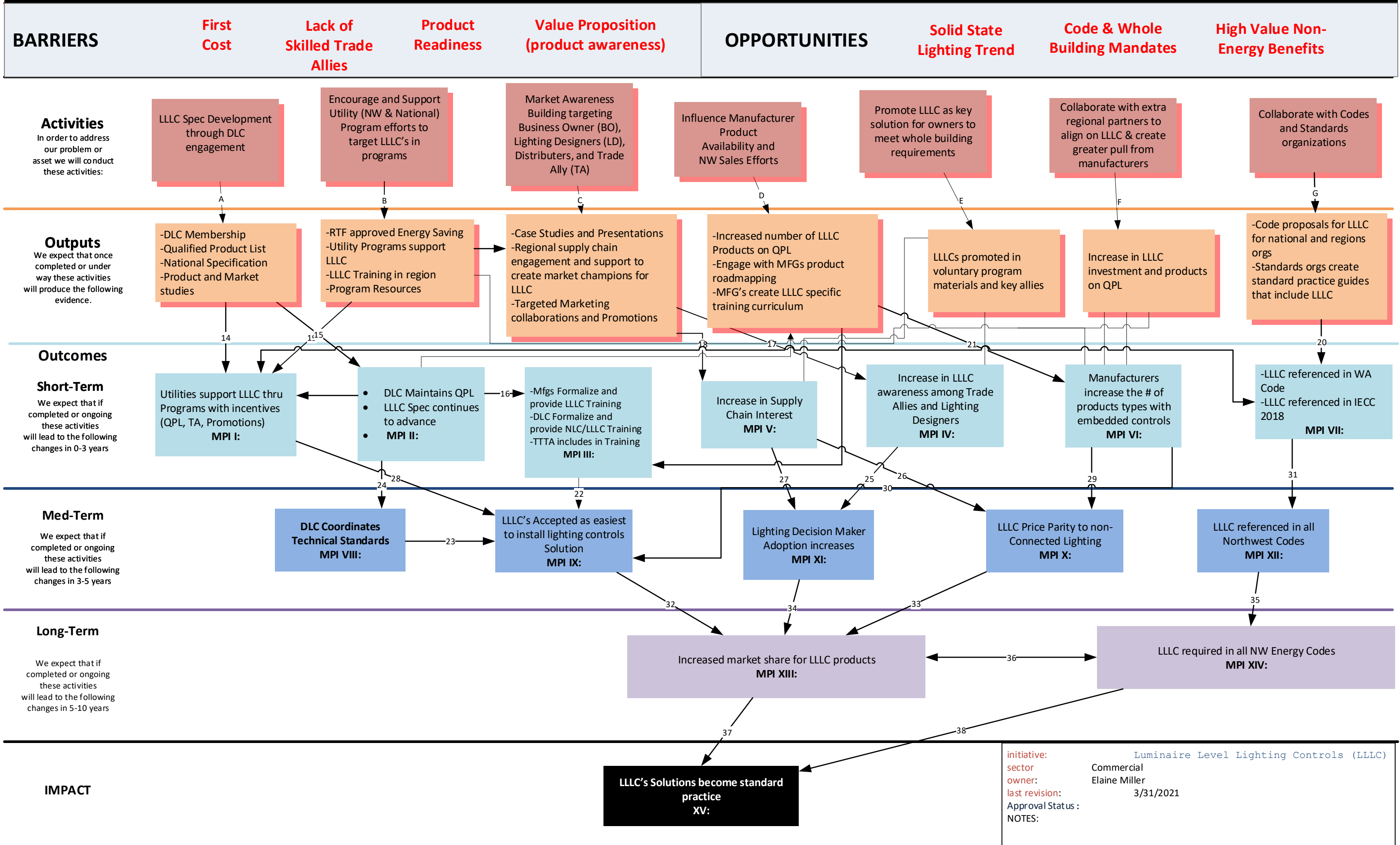
**Recommendation 8: Develop training modules for supply-chain market actors about the end-use customer experience when installing LLLC for the first time.** These trainings, if they do not already exist, would address the potential challenges faced by the end-use customer and the important steps for customers to take if they are installing an LLLC system for the first time to ensure successful installation and operation. The training should also recommend ways service providers can help customers overcome potential challenges by, for example, informing them about LLLC-specific issues (coordination with IT, determining long-term management roles, gathering feedback



from occupants, etc.), and helping them navigate the necessary steps to address these issues. If NEEA develops the guide and resources discussed in this recommendation, vendors should also be made aware.

Appendix A. LLC Logic Model

# LLLC LOGIC MODEL -



## Appendix B. Program Documents Included in Document Review

To address the research objectives, the Cadmus team reviewed the documents listed in Table B-1. Links are provided to publicly available documents where possible.

**Table B-1. Documents Reviewed**

Document Title	Last Updated
LLLC Logic Model Documentation Packet	October 30, 2018
LLLC Logic Model	August 14, 2018
LLLC Market Transformation Story	March 2021
LLLC Logic Model Review: Recommendation Memo	July 2, 2018
Market Transformation Theory Guidance – NEEA Directors	No Date
LLLC Market Progress Indicator Table	Updated in January 2021 – confirmed via email
LLLC Product Assessment Plan	2018
LLLC Product Definition	August 2018
Initiative Lifecycle Milestone Document	February 25, 2019
LLLC Marketing Strategic Plan	No Date
LLLC Program Implementation Plan	Mid-2019
TTTA Interim Program Assessment Final Report	February 4, 2020
Draft Concept Document for Additional Outreach with Trade Allies for LLLC/NLC	November 25, 2020
LDL Training Website and Training Documents	Various
NXT Level Training Website and Training Documents	Various
Luminaire Level Lighting Controls Energy and Human Factors Study Final Report	January 27, 2020
<a href="#">2019-2020 Luminaire Level Lighting Controls Market Assessment</a>	November 4, 2020
<a href="#">Energy Savings from Networked Lighting Control Systems With and Without Luminaire Level Lighting Controls</a>	October 6, 2020
<a href="#">2020 Luminaire Level Lighting Controls (LLLC) Incremental Cost Study</a>	December 18, 2020
<a href="#">Luminaire Level Lighting Controls (LLLC) Market Characterization and Baseline Report</a>	December 14, 2016
<a href="#">South Lander Business Park Adopts Luminaire Level Lighting Controls</a>	No Date
<a href="#">Pacific Tower Installs Luminaire Level Lighting Controls</a>	No Date
<a href="#">The Future Of Lighting Is Here: PSE Achieves 72 Percent Energy Savings with Luminaire Level Lighting Controls</a>	No Date

## Appendix C. Summary of MPI 2021 Estimates

Table C-1 presents a summary of the market progress indicator (MPI) tracked in Market Progress Evaluation Report (MPER) 1 for the Luminaire Level Lighting Controls (LLLC) program and results of corresponding research questions on non-LLLC NLC. This first MPER evaluated six of the seven total MPIs associated with short-term program outcomes (one to two years) and evaluated one of four MPIs for medium-term outcomes. The remaining MPIs (including three for long-term outcomes (six to ten years)) will be tracked in future MPERs.

**Table C-1. Estimated Values for MPIs and for Corresponding Questions About non-LLLC NLC**

LLLC Program Outcome	MPI	LLLC Program MPI	2021 Estimate	Corresponding Research for non-LLLC NLC	2021 Estimate
<b>Outcome I (short term)</b> 1. Utilities support LLLC through programs with incentives	<b>MPI 1</b>	<b>1A.</b> Utilities establish LLLC incentive programs	7 utilities plus BPA <sup>a</sup>	Whether utilities establish non-LLLC NLC incentive programs.	7 utilities plus BPA <sup>a</sup>
		<b>Outcome II (short term)</b> 1. DLC maintains QPL 2. Specification continues to advance	<b>MPI 2</b>	<b>2A.</b> DLC regularly reviews the LLLC QPL	<b>Achieved</b>
	<b>2B.</b> DLC regularly reviews LLLC specification and updates	<b>Achieved</b>		Whether DLC regularly reviews non-LLLC NLC specification and updates	<b>Achieved</b>
<b>Outcome III (short term)</b> 1. Manufacturers formalize and provide LLLC training 2. LDL provides LLLC training 3. NEEA's NXT Level training includes LLLC	<b>MPI 3</b>	<b>3A.</b> Manufacturers with LLLC products on the DLC QPL offer LLLC training to at least one type of supply-side market actor	<b>Achieved</b>	Whether manufacturers with non-LLLC NLC also offer training for these products	<b>Achieved</b>
		<b>3B.</b> Percentage of lighting installation companies with at least one installer trained <sup>b</sup> in LLLC	18%	Percentage of lighting installation companies with at least one installer trained in non-LLLC NLC	16%
		<b>3D.</b> Percentage of lighting installation companies with capability to bid on project that involves LLLC installation	66%	Percentage of lighting installation companies with capability to bid on project that involves non-LLLC NLC installation	66%
		<b>3E.</b> Percentage of companies with at least one LLLC-trained installer in each state	Data not available in this MPER <sup>c</sup>	Percentage of companies with at least one LLLC-trained installer in each state	Data not available in this MPER <sup>a</sup>
<b>Outcome IV (short term)</b> 1. Increase in supply chain awareness among trade allies and lighting designers	<b>MPI 4</b>	<b>4A.</b> Percentage of lighting installation companies and of companies with lighting designers/specifiers who are aware of LLLC	Installers: 78% Designer/ specifiers: 68%	Percentage of lighting installation companies, and percentage of companies with lighting designers/specifiers who are aware of non-LLLC NLC	Installers: 77% designer/ specifiers: 57%

LLLC Program Outcome	MPI	LLLC Program MPI	2021 Estimate	Corresponding Research for non-LLLC NLC	2021 Estimate
<b>Outcome V (short term)</b> 1. Lighting designers and specifiers recommend LLLC solutions	<b>MPI 5</b>	<b>5A.</b> Percentage of companies with lighting designers/specifiers who have recommended LLLC to a decision-maker for at least one project	44%	Percentage of companies with lighting designers/specifiers who have recommended non-LLLC NLC to a project decision-maker for at least one project	37%
		<b>5B.</b> Percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	35%	Percentage of companies with designers/specifiers who say they have written non-LLLC NLC into at least one project plan	29%
<b>Outcome VII (short term)</b> 1. LLLC is an optional path in Washington code, and LLLC is referenced in IECC 2018	<b>MPI 7</b>	<b>7A.</b> LLLC is an Optional Compliance Path in Washington code	<b>Achieved</b>	N/A	N/A
		<b>7B.</b> LLLC is referenced in IECC 2018	<b>Achieved</b>	N/A	N/A
<b>Outcome IX (medium term)</b> 1. LLLC is accepted as easiest-to-install lighting controls solution	<b>MPI 9</b>	<b>9A.</b> Percentage of installation companies that report having installed at least one LLLC system (“experienced installation firms”)	61%	Percentage of region’s installation companies that have installed and programmed at least one non-LLLC NLC	59%
		<b>9B.</b> Percentage of experienced installation companies that say LLLC systems are easier to install than non-LLLC NLC systems	43%	Percentage of these experienced installation companies that say non-LLLC NLC systems are easier to install than LLLC	57%
		<b>9C.</b> Average number of LLLC projects companies have completed in the past 12 months	3.4	Average number of non-LLLC NLC projects that companies have completed in the past 12 months	8.2

<sup>a</sup> The Cadmus Team did not collect sufficient data to evaluate this MPI, since the MPI was revised during the survey analysis. *Appendix D* includes other survey data related to the geographic distribution of LLLC-trained installers.

<sup>b</sup>The region’s public utilities that purchase power from BPA can use BPA’s lighting calculator for their commercial lighting incentives. BPA expanded the calculator to include NLC (including LLLC).

<sup>c</sup>Defined as completing training on at least three topics. See Section 3.3 in body of report for detail.

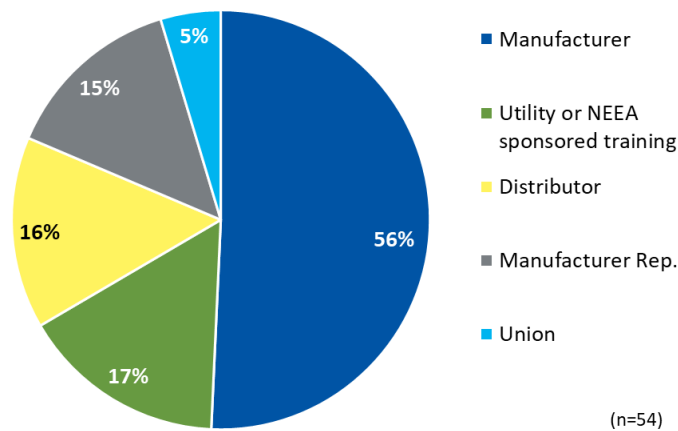
## Appendix D. Additional Survey Topics

The survey captured information on additional topics related to training, LLLC sales trends, benefits and drawbacks of LLLC, and the geographic distribution of installers.

### Training Providers

Respondents receiving NLC training reported the organizations from which they had received training. As shown in Figure D-1, manufacturers were the most common source of training for installers, followed by utilities/NEEA-sponsored trainings, distributors, and manufacturers’ representatives.

**Figure D-1. Organizations Providing NLC Training**



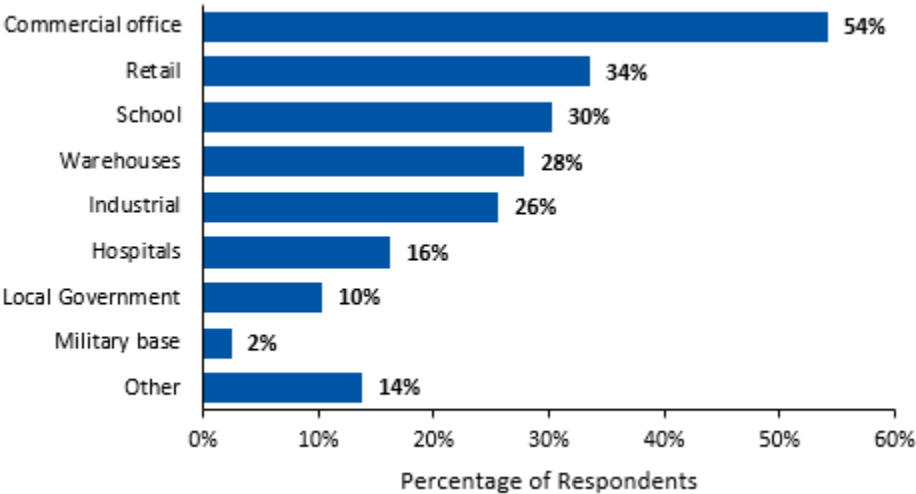
Source: Installer and Designer/Specifier survey, QC2: “What organization offered the training?” (Multiple responses allowed.)

### Sales Trends

The survey asked installation companies that were aware of LLLC whether they thought sales of LLLC in the Northwest were increasing, staying the same, or decreasing then asked the same question about non-LLLC NLC. About half of installation companies overall thought LLLC sales were increasing. Installers were more likely to view LLLC sales as increasing than were non-LLLC sales, and they were also more likely to view non-LLLC NLC sales as decreasing (11%) than LLLC sales (2%).

Installers who had experience installing LLLC listed the types of business or industries they had worked with, as shown in Figure D-2. The most common market segment was commercial office space, where 54% of installers said they had installed an LLLC system.

Figure D-2. Market Segments Where Installers Have Installed LLLC



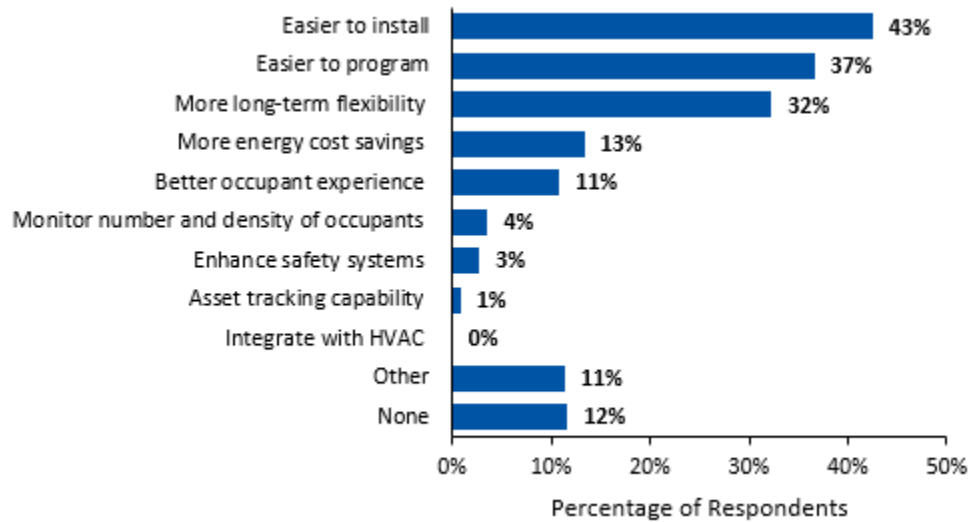
Source: Installer and Designer/Specifier survey, QE3: Thinking about your customers, what types of businesses or industries have you worked with that have installed LLLC? (n=90)  
Other includes a wide variety of business types, such as fast food, a casino, and a senior living facility.

Benefits and Drawbacks of LLLC Relative to Non-LLLC NLC

The survey also asked installers aware of LLLC to list what they considered the benefits and drawbacks of LLLC systems compared to other networked controls. The question was posed in a general way—it did not ask respondents to answer from just their perspective. Figure D-3 shows the benefits mentioned by installation companies as whole. Respondents were most likely to say LLLC were easier to install, easier to program, and offered more long-term flexibility than other systems. However, 12% of respondents saw no benefit to LLLC.



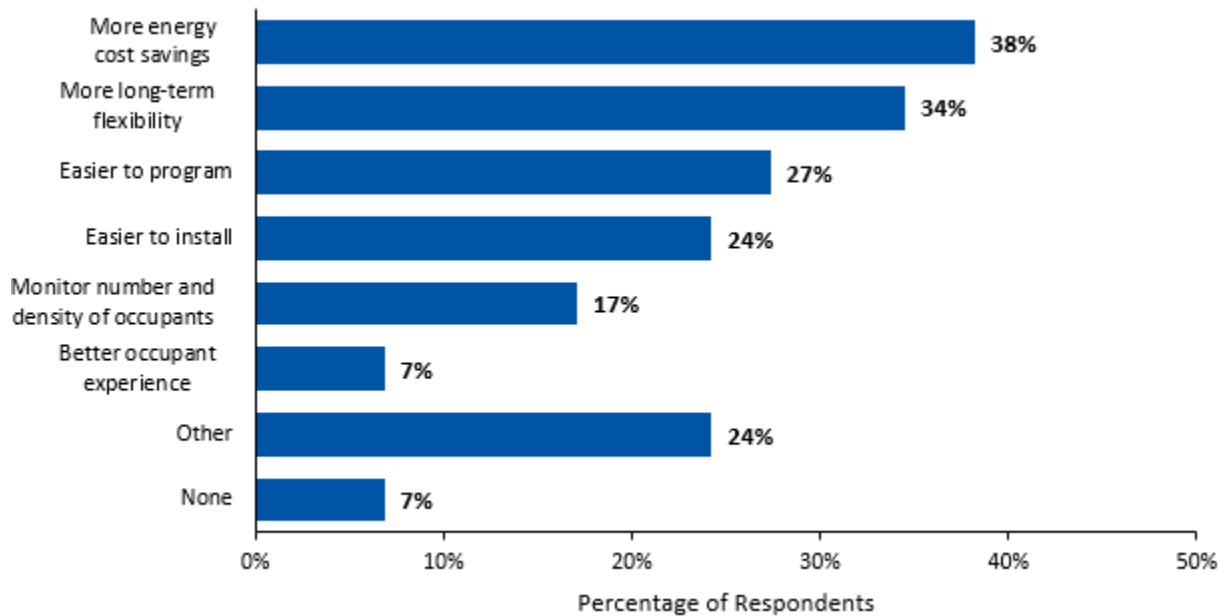
**Figure D-3. Installer Perceptions of Benefit of LLLC Systems**



Source: Installer and Designer/Specifier survey, QE4: What are the benefits of LLLC over other networked controls systems, if any? Please list up to three. (n=97)

Designer-specifiers were also asked to list what they considered the benefits and drawbacks of LLLC systems compared to other networked controls. Designer/specifiers were more likely to note that LLLC provided more energy cost savings and more long-term flexibility than did installers, while still noting that LLLC systems are easier to program and easier to install. Others noted that LLLC systems were less expensive to install (two designer/specifiers), provided more options for customizing and controlling lights (two designer/specifiers), or would have better lighting quality (one designer/specifier). However, 7% (n=32) of respondents indicated there were no benefits to LLLC compared to other networked controls.

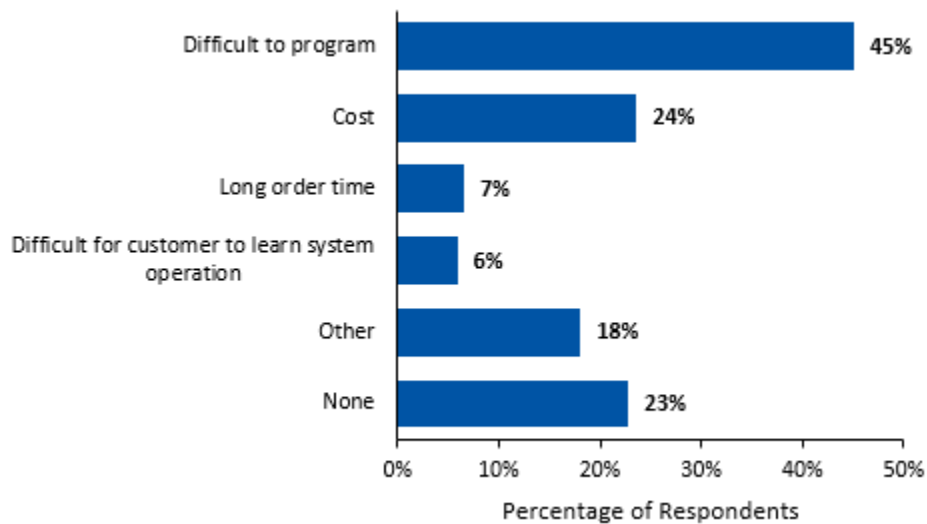
**Figure D-4. Designer/Specifier Perceptions of Benefits of LLLC Systems**



Source: Installer and Designer/Specifier survey, QE4: What are the benefits of LLLC over other networked controls systems, if any? Please list up to three. (n=32)

Thirty-seven percent of installers thought LLLC systems were easier to program, but 45% thought they were difficult to program, as shown in Figure D-5. This was the most frequently mentioned drawback, followed by 24% who mentioned cost. However, 23% of installers saw no drawback to LLLC relative to non-LLLC NLC.

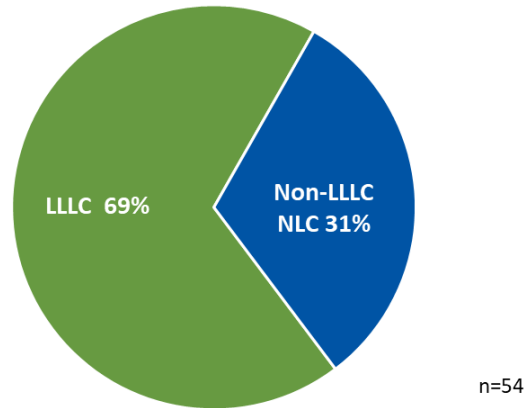
**Figure D-5. Installer Perceptions of Drawbacks of LLLC Systems Relative to Non-LLLC NLC**



Source: Installer and Designer/Specifier survey, QE5: What are the drawbacks of LLLC over other networked controls systems, if any. Please list up to three. (n=103)

Installers were also asked what kind of lighting system (LLLC or non-LLLC NLC) was more likely to result in customer satisfaction. As shown in Figure D-6, the majority of installers thought that an LLLC system would be more likely to result in customer satisfaction.

**Figure D-6. System Most Likely to Result in Customer Satisfaction**



Source: Installer and Designer/Specifier survey, QC11: “Based on your experience with lighting controls, do you think customers are more likely to be satisfied with LLLC or with another type of networked lighting control?”

### Geographic Distribution of Installers

Survey results showed that most companies provided services beyond just their local area and that many served multiple states. As shown in Table D-1, the percentage of installers serving each state is higher than the percentage located in that state. However, these percentages may be underestimating the actual percentage of all installers who serve each state, because the Cadmus Team used proxy data rather than survey responses for 17 of the 179 respondents. These 17 respondents were not asked survey question F1, “In which of the following Northwest states does your company operate?” Rather than exclude them from the analysis, the Team assumed their companies at least served the state in which they resided. This assumption is supported by the fact that all 151 respondents who did answer question F1 identified the state where they lived as one of the states their company served. (Eleven respondents chose not to answer F1, and the Team decided to include them as “States Served Unknown” rather than apply proxy responses.)

**Table D-1. Installers Providing Services vs. Geographic Distribution of Respondents**

Stratum	Total (n=179) <sup>1</sup>	Total (n=179)
Idaho	15%	23%
Montana	15%	20%
Oregon	25%	31%
Washington	39%	46%
States Served Unknown	5%	6%

Source: Third-party data and data provided by NEEA

Finally, the Team analyzed the percentage of installers who served each state who are trained in either LLLC or non-LLLC NLC. This analysis was limited to respondents who answered questions about their company’s training status. Because many respondents did not know their training status, the sample size for this analysis is small. In addition, the sample includes all 17 respondents who did not answer

survey question F1 and for whom the Team assumed they served their resident state. For these reasons, readers should interpret these results with caution.

Table D-2 presents the percentage of installers serving each state who are “fully trained” in LLLC, defined by the Team as having received training in three out 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.

Table D-3 presents the percentage of installers serving each state who are “fully trained” in non-LLLC NLC, defined by the Team as having received training in both non-LLLC NLC installation and non-LLLC NLC programming but did not have to have received training in other topics.

**Table D-2. Percentage of Installers Serving Each State Trained in LLLC**

State	n	Fully Trained in LLLC
Idaho	18	22%
Montana	16	8%
Oregon	24	30%
Washington	32	27%

**Table D-3. Percentage of Installers Serving Each State Trained in Non-LLLC NLC**

State	n	Fully Trained in Non-LLLC NLC
Idaho	20	10%
Montana	16	20%
Oregon	27	16%
Washington	35	22%

## Appendix E. NEEA LLLC MPER 1 – Market Actor Survey

## NEEA LLLC MPER 1 – Market Actor Survey

This survey is the first 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 LLLCs in the Northwest by addressing the below Market Progress Indicators.

MPI	Additional Research Element (A.R.E)	Question Number (LLLC)	Question Number (non-LLLC NLC)
3B. YOY increase in the percentage of lighting installation companies with at least one installer trained in LLLC	3B. Track percentage of lighting installation companies with at least one installer trained in non-LLLC NLC	C1,C4	C1,C4
3C. deleted	3C. deleted		
3D. YOY increase in the percentage of lighting installation companies with the capability to bid on a project that involves LLLC installation	3D. Track percentage of lighting installation companies with the capability to bid on a project that involves non-LLLC NLC installation	C5	C6
3E. YOY, companies with at least one LLLC-trained installer become more evenly distributed across the region	3E. Track if companies with at least one non-LLLC NLC-trained installer become more evenly distributed across the region	F1	F1
4A. YOY increase in (1) the percentage of lighting installation companies and (2) the percentage of companies with lighting designers/specifiers who are aware of LLLC	4A. Track (1) the percentage of lighting installation companies and (2) the percentage of companies with lighting designers/specifiers who are aware of non-LLLC NLC	B6	B7
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	5A. Track percentage of companies with lighting designers/specifiers who have recommended non-LLLC NLC to a project decision maker for at least one project	D6	D7
5B. YOY increase in the percentage of companies with designers/specifiers who say they have written LLLC into at least one project plan	5B. Track percentage of companies with designers/specifiers who say they have written non-LLLC NLC into at least one project plan	D8	D9
9A. YOY increase in the percentage of installation companies that report having installed at least one LLLC system (“experienced installation firms”)	9A. Track percentage of the region’s installation companies that have installed and programmed at least one non-LLLC NLC	C7	C9
9B. YOY increase in the percentage of these experienced installation companies that say LLLC systems are easier to install than non-LLLC systems	9B. Track percentage of these experienced installation companies that say non-LLLC systems are easier to install than other types of NLC	C11	C12
9C. YOY increase in the average number of LLLC projects that companies have completed in the past 12 months	9C. Track the number of non-LLLC NLC projects that companies have completed in the past 12 months	C8	C10

## A. Introduction

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

My name is [NAME] from VuPoint Research, calling on behalf of the Northwest Energy Efficiency Alliance (or NEEA). We are conducting research on commercial lighting systems being installed in the Northwest. Are you the best person to speak to regarding commercial lighting **[IF INSTALLER: installation] [IF D/S: design and specification]** services?

**IF YES, CORRECT PERSON – MOVE INTO SURVEY**

**IF NOT THE RIGHT PERSON, ASK FOR INDIVIDUAL MOST KNOWLEDGABLE ABOUT COMPANY'S COMMERCIAL LIGHTING [IF INSTALLER: installation] [IF D/S: design and specification] SERVICES.**

**IF COMPANY DOES NOT OFFER LIGHTING-RELATED SERVICES USE DISPOSITION CODE 08 TO TERMINATE**

Do you have 10-12 minutes to speak with me today? Because we value your time, we will enter you in a sweepstakes for a \$500 VISA gift card if you are eligible and complete this survey.

**[IF NOT A GOOD TIME – SCHEDULE A CALL-BACK FOR A MORE CONVENIENT TIME FOR RESPONDENT]**

**[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. THIS IS ONE OF THE PRIMARY METHODS NEEA USES TO UNDERSTAND THE STATE OF THE MARKET. YOUR PERSPECTIVE HELPS NEEA TRACK ENERGY USE, TRENDS, AND TECHNOLOGY IN THE NORTHWEST.”]**

**[ONLY IF ASKED FOR A NEEA CONTACT TO VERIFY THE SURVEY AUTHENTICITY, OFFER JENNIFER STOUT AT [JSTOUT@NEEA.ORG](mailto:JSTOUT@NEEA.ORG)]**

## B. Screeners

B1. **[IF INSTALLER]** Thank you. First, can you confirm [COMPANY NAME], meaning the direct employees, does 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. **[IF D/S]** Thank you. First, does your company offer lighting design services, meaning you design the lighting layout, appearance, and function of a space for major renovations or new construction projects?
1. (Yes) **[ASSIGN D/S = TRUE]**
  2. (No)
    98. (Don't know)
    99. (Refused)
- B4. **[IF D/S]** 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) **[ASSIGN D/S = TRUE]**
  2. (No)
    98. (Don't know)
    99. (Refused)
- B5. **[IF B1 ≠ 1, OR B2 ≠ 1, OR B3 AND B4 ≠ 1]** What business is your current company in?
1. **[ALLOW TEXT ENTRY] [SKIP TO G1]**
  98. (Don't know) **[SKIP TO G1]**
  99. (Refused) **[SKIP TO G1]**
- B6. 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)
  2. (No)
    98. (Don't know)
    99. (Refused)
- B7. Are you aware of another type of networked lighting control system, in which one sensor—typically mounted in the ceiling—controls a group of programmable fixtures, usually wirelessly?
1. (Yes)
  2. (No)
    98. (Don't know)
    99. (Refused)

**[IF B6 ≠ 1 AND B7 ≠ 1, SKIP TO G1]**



B8. **[IF INSTALLER = TRUE]** Is your company a franchise?

1. Yes
2. No
98. (Don't know)
99. (Refused)

B9. Does your company have multiple office locations?

1. Yes
2. No **[SKIP TO B12]**
98. (Don't know) **[SKIP TO B12]**
99. (Refused) **[SKIP TO B12]**

B10. **[IF B9=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 B12]**
5. (Refused) **[SKIP TO B12]**

B11. **[IF B9=1]** Ok. For the rest of these questions, please answer from

1. **[IF B10=1]** the perspective of your specific location
2. **[IF B10=2]** the perspective of your company as a whole across all locations
3. **[IF B10=3]** that perspective

**B12. [IF D/S=TRUE, SKIP TO SECTION D]**

**B13. [IF INSTALLER = TRUE, CONTINUE]**

## C. *Installer Only Questions*

C1. Have you or other staff at your company received training on LLLC or other network lighting controls?

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. (Utility sponsored)
3. (BetterBricks)
4. (Professional or industry association)  
(1) Which association? **[ALLOW TEXT RESPONSE]**
5. (Manufacturer)
6. (Manufacturer representative)
7. Distributor
8. (Other) **[ALLOW TEXT RESPONSE]**
98. (Don't know)
99. (Refused)

C3. Are you familiar with the contents of this training?

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. **[IF B6=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. **[IF B6=1]** 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. **[IF B6=1]** Have any staff been trained on how to install LLLC?
    - (1) (Yes)
    - (2) (No)
    - (3) (Don't know)
  4. **[IF B6=1]** Have any staff been trained on how to program LLLC?
    - (1) (Yes)
    - (2) (No)
    - (3) (Don't know)
  5. **[IF B7=1]** Have any staff been trained on how to install other types of networked controls?
    - (1) (Yes)
    - (2) (No)
    - (3) (Don't know)
  6. **[IF B7=1]** Have any staff been trained on how to program other types of networked controls?
    - (1) (Yes)
    - (2) (No)
    - (3) (Don't know)
- C5. **[IF B6=1]** Without hiring subcontractors, would you say that your company is currently capable of installing an LLLC system, installing and programming an LLLC system, or neither?
1. (Installing)
  2. (Installing and programming)
  3. (Neither)
  4. (Don't know)
  5. (Refused)

- C6. **[IF B7=1]** Without hiring subcontractors, would you say that your company is currently capable of installing a non-LLLC networked controls system, installing and programming a non-LLLC networked controls system, or neither?
1. (Installing)
  2. (Installing and programming)
  3. (Neither)
  4. (Don't know)
  5. (Refused)
- C7. **[IF B6=1]** How many LLLC systems has your company installed, not including work done by subcontractors? Your best estimate is fine.
- 1. [ENTER NUMERIC VALUE]**
98. (Don't know)
  99. (Refused)
- C8. **[IF C7>0]** And about how many of these LLLC systems has your company installed in the last 12 months?
- 1. [ENTER NUMERIC VALUE]**
98. (Don't know)
  99. (Refused)
- C9. **[IF B7=1]** How many non-LLLC networked controls systems has your company installed, not including work done by subcontractors?
- 1. [ENTER NUMERIC VALUE]**
98. (Don't know)
  99. (Refused)
- C10. **[IF C7>0]** And about how many of these non-LLLC networked controls systems has your company installed in the last 12 months?
- 1. [ENTER NUMERIC VALUE]**
98. (Don't know)
  99. (Refused)
- C11. **[IF C7>0]** Based on your experience with lighting controls, do you think customers are more likely to be satisfied with LLLC or with another type of networked lighting control?
1. (LLLC system)
  2. (Another type of networked controls system)
  98. (Don't know)
  99. (Refused)

- C12. **[IF C7>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)

## *D. Designers and Specifiers Only Questions* **[ASK IF D/S=TRUE, ELSE SKIP TO SECTION E]**

- D1. Have you or other lighting professionals at your company received training on LLLC or other networked lighting controls?
1. (Yes)
  2. (No) **[SKIP TO D4]**
  98. (Don't know) **[SKIP TO D4]**
  99. (Refused) **[SKIP TO D4]**
- D2. **[IF D1=1]** What organization or organizations offered the training? **[MULTIPLE RESPONSE ALLOWED].**
1. (Lighting Design Lab [LDL])
  2. (Utility sponsored)
  3. (BetterBricks)
  4. (Professional or industry association)
    - (1) Which association? **[ALLOW TEXT RESPONSE]**
  5. (Manufacturer)
  6. Manufacturer representative
  7. Distributor
  8. (Other) **[ALLOW TEXT RESPONSE]**
  98. (Don't know)
  99. (Refused)

D3. **[IF B6=1]** Please indicate if you or other lighting professionals at your company have been trained on the following subjects.

1. First, have you or other staff been trained on the best types of buildings and spaces for LLLC?

(1) (Yes)

(2) (No)

(3) (Don't know)

2. Have you or other staff been trained on the benefits and capabilities of LLLC relative to other types of controls systems?

(1) (Yes)

(2) (No)

(3) (Don't know)

3. Have you or other staff been trained on the requirements for connecting through wireless protocols such as WiFi or Dali

(1) (Yes)

(2) (No)

(3) (Don't know)

D4. **[IF B4=1 AND B6=1]** Would you say your company is capable of specifying an LLLC system?

1. (Yes)

2. (No)

98. (Don't know)

99. (Refused)

D5. **[IF B4=1 AND B6=1]** 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)

D6. **[IF B6=1]** How many times would you estimate your company has included a recommendation for LLLC in a project?

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

2. (Not applicable)

98. (Don't know)

99. (Refused)

D7. How many times would you estimate 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)

D8. **[IF B6=1]** Approximately how many times would you estimate your company has written LLLC into a project plan?

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

2. (Not applicable)

98. (Don't know)

99. (Refused)

D9. Approximately how many times would you estimate your company has written networked control systems other than LLLC into a project plan?

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

2. (Not applicable)

98. (Don't know)

99. (Refused)

## E. Market Insights

E1. **[IF B6=1]** 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)

E2. Would you say sales of networked control systems other than 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 D6>0 OR D8>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. **[IF B6=1]** What are the benefits of LLLC over other networked controls systems, if any. Please list up to three. **[MULTIPLE RESPONSES ALLOWED]**

1. (Easier to install)
2. (Easier to program)
3. (More long-term flexibility)
4. (More energy cost savings)
5. (Better occupant experience)
6. (Asset tracking capability)
7. (Monitor number and density of occupants)
8. (Enhance safety systems)
9. (Integrate with HVAC)
10. (Other) **[ALLOW TEXT ENTRY]**
11. (None)
98. (Don't know)
99. (Refused)

E5. **[IF B6=1]** 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)



- E6. **[IF INSTALLER=TRUE AND B6=1]** 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)
- E7. **[IF INSTALLER =TRUE AND B6=1]** Using that same scale, how confident are you in your company's ability to sell other types of networked controls systems to customers? **[REPEAT SCALE IF NEEDED]**
1. (Not at all confident)
  2. (Not very confident)
  3. (Somewhat confident)
  4. (Very confident)
  98. (Don't know)
  99. (Refused)

## F. Firmographics

Just a few more questions.

- F1. In which of the following Northwest states does your company operate? **[ALLOW MULTIPLE RESPONSE]**
1. Idaho
  2. Montana
  3. Oregon
  4. Washington
  99. (Refused)
- F2. Does your company partner with any utilities in the Pacific Northwest, such as but not limited to through a rebate program or in some other way ?
1. (Yes)
  2. (No)
  98. (Don't know)
  99. (Refused)

## G. Incentive & Closing

G1. Those are all my questions today! Would you like to be entered into the drawing to win a \$500 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 card to if you are selected? **[IF NEEDED: We will not use your email 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)

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

**[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!

## Appendix F. NEEA LLLC MPER 1 – Program Stakeholder Interviews

## NEEA LLLC Program Stakeholder Interview Guide

Researchable Questions	Question Number
Understand program MT theory, market diffusion theory, goals and progress made to date	A7, B4-B5
Define target groups for program engagement	B6-B8
Identify emerging trends that might impact the MT theory, strategy, logic model, and MPIs (LLLC and other NLC)	D2
Assess the current state and perceived impact of program activities	A4-A14
Identify any challenges impacting the program and future needs	A8-A9, D1
Assess current status of training offerings to address LLLC barriers	C1-C9
Review questions on specific components of the logic model, program documentation, and MPIs	B1-B15
Document efforts to date to obtain sales and market data	A11

**Target Quota** = two (2) interviews with NEEA LLLC staff and one (1) interview with Cadeo staff, each interview lasting ~45-60 minutes.

Thank you for making the time to speak with me (us). The purpose of this interview is to make sure we have a thorough understanding of the LLLC Program, including progress, activities, challenges, and trends that might impact the strategy. Prior to this interview, we reviewed the program documentation sent thus far, including the Logic Model (LM), LM documentation packet, Market Progress Indicators (MPIs), Market Transformation (MT) Theory, Lifecycle Milestone document, Product Definition, Product Assessment Plan, and Implementation Plan, among others. This interview should take ~45-60 minutes. Do you have any questions before we begin?

### A. Program Overview and Progress

A0. [AC, CW, EM] Can you tell me your title and your role in the LLLC Program?

First, I have a few broad questions about the overall program theory.

- A1. [AC, CW, EM] Can you briefly describe what the Market Transformation theory is for the LLLC Program? (Probe: Can you tell me more about the market diffusion piece when NEEA ultimately reduces its activities?) [Diffusion is a piece largely absent from, or not specifically described in, the program documents.]
- A2. [AC, CW, EM] What would you say is or are the one or two barriers that are most important to overcome currently, and what are the activities that the program is doing to overcome them? How are program resources allocated to reflect these priority activities?
- A3. [AC, CW, EM] Can you talk about where you think the biggest leverage points are for NEEA to drive market transformation?

Now, I'd like to discuss the core program activities and program progress to date.

- A4. [AC, CW, EM] According to the MT Theory and Implementation Plan, there are several activities planned or underway to address market barriers, including working with market actors (DLC, manufacturers) on the development of an LLLC specification, supporting utilities, collaborating with Codes and Standards organizations, raising decision maker, influencer, and trade ally awareness, and supporting training efforts, among other items. Are there any other critical activities or strategies we should be aware of?

[EM SKIP TO SECTION B]

- A5. [AC, CW only] We recognize that the program was expanded into a full offering in mid-2019. How has progress been on the program to date?
- A6. [AC, CW only] Which program activities have already begun? Which have yet to start?
- A7. [AC, CW only] What accomplishments have you achieved since program inception?
1. What has driven these accomplishments/caused them to be successful?
- A8. [AC, CW only] Conversely, what has not gone as well/been challenging about this program?
1. What has caused these challenges?
  2. What ways do you plan to overcome these challenges?
  3. Do you see any issues reaching the program's exit criteria (see graphic below)? If so, please elaborate on which criteria and why.
- A9. [AC, CW only] What activities are utilities taking to promote the adoption of LLLC? (Probe for support with incentives, other education/outreach, designing of LLLC programs, and integration with other program offerings)
1. Do you think NEEA has had an influence on these activities? Why or why not?
  2. Utility programs typically offer a combination of promotion to end-users, promotion to trade allies, technical assistance to select specific products or develop projects, and incentives. Within these categories, what kind of support are you expecting utilities to provide for LLLC?
  3. Have you engaged with utilities about support for other NLC technologies? Do utilities demonstrate any preference for one type of NLC over another, and if so, do you have any sense of what drives their preference?
- A10. [AC, CW only] How do manufacturers view the markets for LLLC differently than for other NLC? Are they more enthusiastic about one type of product over another?
- A11. [AC, CW only] With regard to collecting sales and market data, I know you have been working with manufacturers, distributors, and utilities to try to get this data. Can you tell me about what you have tried and what information you have obtained from each of these? How has data collection for this sector been different than for other initiatives or sectors you have worked on?

We have several questions/clarifications about the activities noted in the program documentation:

- A12. [AC, CW only] In the Supply Chain Intervention notes within the Initiative Lifecycle Milestone Document (page 2), “collaborating with sales agencies to change product recommendation habits” is included. Can you expand on what you mean by “habits”? *(Interviewer note: Jennifer believes the barrier here is broader than habits and instead is perhaps tied to cost and manufacturer representatives’ perceptions about the complexity of LLLC.)*
- A13. [AC, CW only] In the LLLC Program Implementation Plan, one of the strategies to address the “Product Readiness” barrier (#4, page 3) is to “continue coordination with manufacturers on product roadmaps, training, and specifications.”
1. Can you define what “product roadmaps” refers to?
  2. The ACEEE paper on DOE Next Generation Lighting Systems (NGLS) design competition describes difficulties with programming/configuration tools (usually a phone app), and poor or lacking tech support either on manufacturers’ web sites or by phone. Is there support to address this barrier included in the Implementation Plan? [From speaking to Jennifer, we understand that you believe this happened because NGLS didn’t arrange to have a manufacturer rep on site]
  3. (Follow-up) Do you think it’s necessary to have a manufacturer’s representative on-site during the installation?
  4. Are there other ways to overcome this?
  5. One of the Near-Term strategies to address “Product Readiness” notes creating “champions for LLLC in the market.” Can you define what being a “champion” means? What would a champion say/do/know about LLLC that would indicate they are acting as a “champion”?
- A14. [AC, CW only] In the LLLC Marketing Strategic Plan, it is noted that there are no downstream marketing activities planned at this time. However, one of the key activities in the MT Theory is “Raising customer decision maker and influencer awareness of the technical features and value proposition of LLLC through the development and dissemination of informational materials (for example, articles, fact sheets, case studies, and videos).”
1. Why did NEEA decide not to pursue any direct outreach to end-users, such as building owners and property managers?
  2. We know of materials that are posted on the NEEA’s BetterBricks website, such as case studies and several articles/posts. Who developed these materials, who does NEEA expect to use them, and how does NEEA expect them to be used?

## B. Logic Model and MPI Review

[SKIP FOR CADEO]

Now, we'd like to dig a bit deeper into some other details of the Logic Model and MPIs.

- B1. [AC, CW, EM] In the LM and throughout the documentation, it appears that the following are tied to lowering first cost. Can you explain how each of these will push LLLC manufacturer prices down?
1. Utility Incentives (in various documents)
  2. Supply chain familiarity with LLLC (LM linkage #26)
  3. Formalized training (LM linkage #22)
- B2. [AC, CW, EM] In the LM, linkage #19 connects “Utility Programs support LLLC” from Outputs to “Utilities support LLLC THROUGH Programs with incentives” in Short-Term Outcomes. Can you explain the difference between these two?
1. What types of support are you looking for utilities to offer? *(Probe for the types of programs that could include LLLC or other NLC)*

[EM SKIP TO B5]

- B3. [AC, CW only] The graphical LM and the LM Documentation packet have slightly different Long-Term Outcomes, with the Documentation packet noting “other electrical devices” in addition to LLLC. Can you confirm what the most up-to-date Long-Term Outcomes are for the Program?
- B4. [AC, CW only] In the Initiative Lifecycle Milestone document, the Transition Strategy outlines NEEA’s exit criteria (see screenshot). Are there quantified targets for each of these criteria? Three of the four say “a majority” – does this indicate that once each reaches 51%, the condition will be met?

The criteria that will inform NEEA’s decision to exit the market are based upon the program [Logic Model](#) and MPIs outlined in the [Logic Model Documentation Packet](#). They include:

- LLLC is included in the energy code in all NW states for new construction projects
- A majority of the top lighting manufacturers offer LLLC as a standard feature (i.e., not an optional add-on) on all their LLLC-appropriate fixtures
- A majority of trade allies who install lighting controls agree that LLLC is the easiest-to-install lighting controls solution
- A majority of the top regional distributors offer LLLC at near price parity to similar non-controlled luminaires from the same manufacturer

- B5. [AC, CW, EM] Are there any other outcomes that you have identified since these documents were written that are not included in the Program LM, or addressed by MPIs?

To assess the MPIs, we have some questions about how the program is defining some of the key terms.

- B6. [AC, CW, EM] [Pre-question note: we recognize that a key part of the MPER scope is to identify the best circumstances for LLLC and other NLC installation, but we feel this is an important question to ask.] One of these is the target market for this initiative. In the program theory, the target market is described as “commercial new construction, renovation, and retrofit projects,” but in the kick-off meeting NEEA staff suggested really the market is narrower than this, limited to larger projects. What criteria do you think NEEA should use to define the segment of the market they expect to influence with their initiative over the long-term? (If needed: Consider factors such as project dollar value, number of lamps/fixtures affected, building type, end-user sector, etc.)
- B7. [AC, CW, EM] The indicators also reference tracking the percentage of installers, and designers and specifiers taking specific actions. What characteristics do you think would define an individual as an installer, subject to this indicator? These characteristics may include level of education, years of experience, current role or responsibilities, or other factors.
- B8. [AC, CW, EM] Similarly, what characteristics define designers and lighting specifiers?

Next, we have some questions related to barriers, specifically their definitions:

- B9. [AC, CW, EM] Can you further define what is included in “product readiness”? In the LM Documentation Packet, both “product complexity” and “limited availability” are listed but not included in the graphical LM. Are these the components that make up “product readiness”?
1. How does this relate to the lack of simple, installer-friendly configuration tools and documentation?
- B10. [AC, CW, EM] The LM identifies “first cost” as a barrier. What is this cost compared to? Is this referring to the full cost compared to no lighting controls, or the cost of LLLC compared to more basic controls?
- B11. [AC, CW, EM] For the “lack of skilled trade allies” barrier, is this referring only to lighting controls installers or also other types as well?
1. Additionally, does this only reference contractors affiliated with utilities, or all contractors serving the market? [“Trade allies” is typically used to refer to installers affiliated with utilities, and typically does not include designers or specifiers.]
- B12. [AC, CW, EM] For the “value proposition (product awareness)” barrier, which market actors and end-use customer types is this referring to? What is the specific barrier linked to the value proposition?
- B13. [AC, CW, EM] How, if at all, are the barriers related to poorly understood non-energy benefits listed in the LM Documentation Packet incorporated into the graphical LM?

[EM SKIP TO B16]



- B14. [AC, CW only] Integration with other systems, specifically HVAC systems, is noted at various points throughout the Program documentation. Can you further define what this integration can look like? Do we know that HVAC systems have the capability to support the greater level of control from the LLLC system?
- B15. [AC, CW only] In the LLLC Product Definition document, it's noted that "at first, LLLC might complicate how lighting distributors do business because they will have an increase in the number of SKUs." Is this referencing all lighting fixtures, not just LLLC? We would expect a small number of LLLC SKUs at first which would then ramp up as the technology becomes standardized.
- B16. [AC, CW, EM] Can you further explain the "Opportunities" listed in the LM, specifically what is meant by "SSL trend" and "code"?

[EM SKIP TO D1]

## C. Training

Now, we'd like to talk a bit more about training courses for LLLC and other NLC. [NOTE: SPEND ADDITIONAL TIME ON THIS SECTION WITH Anne/Elaine]

- C1. [AC, CW only] There are several target groups for training mentioned throughout the documents, such as installers, manufacturers' representatives, and designers/lighting engineers (specifiers).
1. What skills or information does each group need to be trained on? (*Probe for how in-depth the material should be, if sales techniques should be included, if installation techniques should be included, etc. Note: We have reviewed the LDL and NXT Level training content.*)
  2. What is the status of training availability for each of these elements?
  3. Do some groups' trainings have a higher priority than others? Is appropriate training available for all market actors that need it (designers, specifiers, installers, end-users).

[CW SKIP TO D1]

- C2. [AC only] We are aware of two trainings currently offered by NEEA or with significant NEEA support – the LDL training and the NXT Level training. How do these trainings differ, in terms of content, format or target audience?
- C3. [AC only] What is the value proposition for an installer to participate in one of these trainings?
1. Are businesses participating as expected (sending the number, type and level of staff that you expected?)
  2. How do you expect businesses to navigate selecting which training programs are new/necessary as more of them are offered?
  3. What feedback have you received from participants about the NXT Level certification? Do you have any sense of how participants are using it?

- C4. [AC only] We know some utilities have been involved in offering the Lighting Design Lab Training. Can you describe utilities involvement in developing, promoting, and implementing this training? How do you expect utilities to continue to be involved going forward, now that the training has been moved online?
- C5. [AC only] How, if at all, have utilities been involved in supporting the NXT Level training to date?
- C6. [AC only] In what ways do the LDL training and the NXT Level training differ, in terms of the target market, content/duration of training, or other aspects?
- C7. [AC only] How many manufacturers are providing trainings and to which types of supply chain market actors?
  - 1. How much support from NEEA do they need to develop and implement training?
  - 2. Do trainings focus on LLLC or do they include other NLC tech as well?
- C8. [AC only] What data do you receive in terms of what trainings are occurring and who is attending, if any?
- C9. [AC only] What barriers currently exist to an improved training infrastructure for LLLC? We see that funding is a noted barrier in the LM Documentation Packet – is there anything beyond funding?

## D. Program Needs and Outside Forces

- D1. [AC, CW, EM] The LM Documentation Packet notes resource constraints related to funding for incentives and training and data acquisition. Do any other gaps still exist in NEEA’s resources and research to support the LLLC Program? *(Probe for further savings research and market data; we recognize that NEEA has brought Encentin on as a data provider but their availability is somewhat limited.)*
  - 1. [IF GAPS EXIST] Is there plan to address these gaps? If so, please describe.
  - 2. Given these resource constraints, what is NEEA deeming a higher priority and what is a lower priority? What factors are driving that decision?
- D2. [AC, CW, EM] What sort of trends (locally, regionally, and nationally) are there that might impact the LM and MPIS, that you haven’t already mentioned?
  - 1. Are these trends noted in the program documentation, including any actions that NEEA would need to take?
- D3. [AC, CW, EM] Are there any specific questions you have that you would like answered through this study?

## *E. Closing*

E1. [AC, CW, EM] Is there anything else you'd like to add that we didn't discuss today?

This completes the interview – thank you very much for your time. Have a good [evening/day].

## Appendix G. NEEA LLC MPER 1 – Guide for End-User (Decision Maker) Interviews

# MEMORANDUM – End-Use Customer Interviews

## Research Topics

This interview guide is designed to address the following research topics:

1. Level of awareness of LLLC and non-LLLC NLC, and awareness/perceptions of specific features and attributes.
2. Past experience with lighting controls, if any, including whether or not the space had controls previously.
3. How the decision-making process was structured, including sources of awareness/information about LLLC or non-LLLC NLC, key decision influencers.
4. Real and perceived barriers or challenges with LLLC or non-LLLC NLC including how/why end-use customers overcame or disregarded these barriers (only respondents with systems installed).
5. Experience and satisfaction with LLLC and non-LLLC NLC.
6. Relative importance of various decision-making factors for installing LLLC or non-LLLC NLC (such as cost, maintenance, futureproofing, flexibility, lighting quality and experience, aesthetics, or other business benefits), even if respondent ultimately did not install.
7. For benefits of LLLC and non-LLLC NLC that are intangible or difficult to measure (such as aesthetics, flexibility), how did respondents become convinced of these benefits and how strongly did these benefits influence decisions.
8. For those that did not purchase LLLCs or non-LLLC NLCs - what equipment was installed, and why was that specific equipment chosen?
9. Whether specific circumstances made 1) LLLC systems, or 2) non-LLLC NLC systems the best-suited application, and why. Circumstances could include: <ul style="list-style-type: none"><li>a. building types (e.g., office buildings, warehouses, etc.), complexity, square footage;</li><li>b. space types (e.g., open or closed areas, certain square footages), and;</li><li>c. other circumstances (e.g., new construction vs. retrofit, owned vs. leased, single-building property management vs. large multi-property manager, particular organizational needs, etc.)</li></ul>

## Scheduling Survey

[This survey will be sent to respondents via email, and respondents will be asked to email it back ahead of the interview date. If they do not, the interviewer will walk through these questions (which mirror Q1 below) in the interview.]

Thanks for agreeing to participate in our study on end-user experiences with advanced lighting controls. Prior to our scheduled interview on \_\_\_\_\_, please answer the questions below related to the following lighting upgrade project:

\_\_\_ *[whatever detail we have on the project]* \_\_\_\_\_

For each of these questions, your best guess or a rough estimate is fine. Our purpose is to have a general understanding of your project to provide context for our interview.

1. When was this project completed?  
\_\_\_\_\_
2. How would you describe the facility where the project was completed? (E.g., school, hospital, small office building, warehouse, etc.)?  
\_\_\_\_\_
3. Was this project new construction or an addition, a major renovation, or a lighting-only retrofit?  
\_\_\_\_\_
4. Approximately was square footage addressed through the lighting portion of this project?  
\_\_\_\_\_
5. Approximately how many fixtures were installed/retrofitted?  
\_\_\_\_\_
6. Description of the primary light fixtures that you installed/retrofitted in the project (E.g. lensed troffers, parabolics, direct/indirect pendants, highbay, etc.)?  
\_\_\_\_\_
7. What types of distinct spaces were addressed through the lighting portion of the project? (For example: individual offices, classrooms, hallways, lobby and common space, etc.)  
\_\_\_\_\_
8. Can you estimate the dollar value of the lighting portion of the project including equipment and labor?  
\_\_\_\_\_

## Preamble

Thank you for taking the time to speak with us today. As a reminder, we are conducting this interview on behalf of the Northwest Energy Efficiency Alliance (NEEA) to help them better understand the market for commercial lighting controls. NEEA is a non-profit organization in the Northwest that works to accelerate market adoption of energy saving technologies, such as Luminaire Level Lighting Controls. NEEA is funded by many of the largest utilities in Idaho, Montana, Oregon, and Washington, as well as the Bonneville Power Administration.

The information you provide will be used to develop strategies and recommendations related to lighting controls program offerings. As we do for all our market studies, your participation in this interview will remain anonymous and any answers you provide will be pooled with responses from the other participants.

This study will provide each participant with a \$100 gift card for participating in this approximately 60 minute interview.

Is it okay with you if I record the interview? The recording will only be used for our internal record-keeping, and will not be shared with anyone outside of TRC.

Do you have any questions before we get started?

## Background

- 1) **[IF PRE-INTERVIEW SURVEY NOT COMPLETED]** We emailed you a brief survey, but I'm not sure if you saw it. I don't think I got a response. That's not a problem, since I understand you are busy. I'd like to quickly walk through those questions right now.

Thanks. Now, I have just a few questions about your relationship to the project.

- 2) What is your title or role?
  - 3) How long have you been in this role?
  - 4) Do you work for the owner of the building directly or do you work in the building through an outside firm?  
*(If outside firm, follow up with a question to collect the name of the company)*
- 

## Lighting Controls Decision-making

- 1) Thank you. My next questions relate to the specific project.
- 2) What types of outside service providers supported the project? (Probe: Owners rep? Architect? M&E firm? General contractor? Installers? Commissioning agent?)
- 3) In this lighting project, were lighting controls also installed and/or upgraded? **[IF NO, SKIP TO #15]**
  - a) In which spaces, or how much of the space, were controls installed or upgraded?

*[Proceed to #4]*

## "YES" to Question #3 Follow-Up

- 4) Why did you decide to [install/upgrade] lighting controls in this space?
  - a) Did the space have lighting controls previously? How did your previous experience with controls influence your decision-making on this project? *(Probe for OC, daylight, timeclock, other controls strategies. Probe for whether the controls were a networked system or not. Probe if the system was fully operational at the time of retrofit/upgrade)*
- 5) How would you describe the primary lighting controls system that was installed? *(Respondent may indicate a brand, or type of control, or have more limited awareness of the equipment.) [Probe: Do you know if it's an LLLC system, where every fixture has embedded controls? Or is it the kind of system where one control and one sensor operate multiple fixtures?]* **[IF NOT NETWORKED, SKIP TO #16]**
- 6) *(If not already answered)* It sounds like *[state type of system: [an LLLC][a networked lighting control]* system was installed, where

*(If LLLC)* each individual light fixture has its own built-in sensor and controller and they communicate wirelessly and transmit data. So you can program them in any grouping you need, all the way down to the individual fixture level.

*(If non-LLLC NLC)* the sensors and controllers are typically separate from the fixtures. One sensor and controller – often mounted in the ceiling – will control a group of fixtures in a space, sometimes wirelessly.

- a) Does that sound right? *[If yes, SKIP to #7]*
  - b) *(Only if they haven't confirmed one of the two above)* Lighting controls can also be non-networked. These are older-style controls that are wired circuit-by-circuit and often have timers or light levels programmed into the sensor, do not send data beyond their specific circuit, and cannot be adjusted remotely. Does this describe your control system? *[If non-networked is confirmed, skip to #17]*
- 7) I'd like to get more detail on your decision making.
- a) What factors did you consider when choosing a lighting control system? What features were most important to you? *(Probe: total cost, maximize energy savings, multiple zones, central programming, easy to maintain, reliable, flexible, etc.)*
  - b) When you were completing this project, who did you consult to help you understand and select lighting controls? *(Probes for people: Self, specifier, manufacturer rep, a peer or coworker, etc.)*
  - c) What other sources of information did you find useful when making decisions about lighting and lighting control systems? *(Probes for sources: Specific publication (what?), association (what?), manufacturer website (which?), or word-of-mouth, etc.)*
  - d) *(If respondent was influenced by multiple people or sources)* Who or what source had the most influence on your thinking about lighting control systems? Why do you say that?
  - e) What pros and cons of the system were discussed at the time?
    - i) *[Record positives] (Probe for multiple)*
    - ii) *[Record negatives] (Probe for multiple)*
  - f) What factors outweighed, or how did you overcome, the potential negative aspects of the *[SYSTEM INSTALLED]*?
  - g) *(If already not answered)* Why did your company ultimately choose the *[SYSTEM INSTALLED]* instead of the *[OTHER SYSTEMS]*? *(Probe for budget, cost effectiveness, functional needs, functional capabilities, product availability, project speed and lead times, etc.)* *[Probe: Did one factor stand out as tipping the decision? Which and for whom?]*
  - h) *(If not addressed)* What information did you have on the cost to install *[SYSTEM INSTALLED]*, relative to other options? What about the relative cost to operate your lighting system, with and without networked controls? Do you feel that the information you had proved to be helpful? *(Probe: aware of potential for energy savings?)*
  - i) *(If programming flexibility NOT mentioned)* Programming flexibility is often mentioned as a benefit of networked lighting controls systems, especially LLLC, which allow for every fixture to be programmed separately. Is this a valuable feature for your organization? Why or why not?
- 8) Now I'd like to learn about your experience installing the system.
- a) Were there any design, construction, IT, or other coordination problems that you think were related to the system specifically? *(Probe for details to help define the problem)*
  - b) *(If response is YES)* Do you feel that this issue would have not existed with a different kind of lighting control system? Please describe how the chosen lighting control system may have been the source of the problem.



- c) *(If response is YES)* What might have been done to alleviate this issue? Do you feel that more or better training of the installer/designer/consultant may have alleviated or eliminated the problems that you experienced?
- 9) Is the lighting control system fully operational now?
- a) *(If response is YES)* Which features of the system have you used? *(Probe: have they used the features they thought were important when selecting the system? (See #7a))*
  - b) What is your impression of the system now that you are using it? *(Probe for both positive and negative experiences.)*
  - c) What feedback, if any, have you received from occupants in the spaces? *(Probe for both positive and negative experiences.)*
  - d) *(If negative feedback)* What have you done to address any complaints that you have received from the occupants?
- 10) *(If not operational)* Have you experienced any problems or delays in commissioning or set-up? If so, can you describe the issues?
- a) *(If yes)* How long has the system been in the installation and/or setup/troubleshooting or commissioning stages? *(Probe with follow-up if the time seems inordinate)* Do you feel that the process has taken too long?
- 11) Based on your experience so far, what have you learned and what do you wish you knew about [LLLC systems][non-LLLC NLC systems][other – describe] before you had started this project?
- 12) Are there any specific features of the lighting control system that appear to make the choice of that system ideal for your building circumstances (building type, uses, specific programmatic needs)?
- 13) Would you make any changes to your approach if you were to do a similar project again in the near future?
- 14) Would you choose to install the same brand and product lines for the lighting controls in a near future project? Why or why not?

*[Skip to #23]*

“NO” Question #3 Follow-Up (For those who did NOT install/upgrade controls)

- 15) *(If NO to #3)* Did the space have lighting controls already installed that you chose to retain? If yes, can you describe the existing controls?
- 16) *[If no controls existed, or if non-networked controls existed]*
  - a) Were you aware of networked lighting controls at the time you made your decision?
  - b) Were you aware of luminaire-level lighting controls, or LLLC? (If needed: In LLLC, each individual light fixture has its own built-in sensor and controller and they communicate wirelessly and transmit data. So you can program them in any grouping you need, all the way down to the individual fixture level.)

*[If yes to either, continue to #17]*

## #5 / #6 Follow-up - If no NETWORKED controls installed

- 17) At the time of your project, did you consider installing/upgrading to LLLC?
- a) Did you consider installing/upgrading to another type of networked control system?
- 18) *[If "YES" to #17 or 17a]* I'd like to get more detail on your decision making. Even though you decided not to install LLLC *[or other networked controls]*, did you see any potential benefits to doing so at the time? *(Probe carefully – "Anything else, related to purchasing? Installing? Operating and maintaining the system?" Avoid suggesting benefits. Keep respondent focused on what they considered at the time of the decision. Possible benefits include energy savings, maximize energy savings, multiple zones, central programming, easy to maintain, reliable, flexible, etc..)*
- a) *(If aware of both types of systems)* Did you perceive any differences in the benefits of LLLC compared to another type of networked control system?
- 19) Ok, now can you describe what you considered to be the drawbacks of an LLLC or other type of networked controls system? *(Probe carefully. Possible negatives include cost, product availability, project speed and lead times, complex maintenance, reliability, etc.)*
- a) Were there any concerns expressed by the IT department or other sources regarding internet security or risk posed by a networked lighting control system?
- b) *(If aware of both types of systems)* Did you perceive any differences in the benefits of LLLC compared to another type of networked control system?
- 20) When you were completing this project, who did you consult to help you understand and potentially select lighting controls? *(Probes for people: Self, specifier, manufacturer rep, a peer or coworker, etc.)*
- 21) What other sources of information did you find useful when making decisions about lighting and lighting control systems? *(Probes for sources: Specific publication (what?), association (what?), manufacturer website (which?), or word-of-mouth, etc..)*
- 22) *(If respondent was influenced by multiple people or sources)* Who or what source had the most influence on your thinking about lighting control systems? Why do you say that?
- 23) *[If not addressed]* At the time of your project, what information did you have on the cost to install networked controls? Do you feel that the information you had proved to be helpful? What about the relative cost to operate your lighting system, with and without networked controls? *(Probe: aware of potential for energy savings?)*

## Codes

Now I'd like to talk about building codes.

- 24) Just to confirm: For this project, did your lighting system have to meet energy code requirements?
- 25) *[If installed NLC/LLLC]* Did the installation of *[SYSTEM INSTALLED]* make meeting code easier, harder, or about the same? (Probe: How so?)
- 26) Did installing *[SYSTEM INSTALLED]* result in a project that exceeded code? In what ways?

## COVID Impacts

- 27) Were you aware that some LLLC or NLC sensors can support COVID safety protocols, by monitoring occupant density or individual temperatures?
- 28) Did your organization utilize this capability through the past year?
- 29) Would you be interested in it?  
*(If yes, then follow with...)* Do you expect these needs to persist in the market long-term?

## Closing

Thank you so much for your time today.

- 30) Finally, to ensure that you get the \$100 gift card, can you please provide a mailing address? It may take up to 4 weeks; thank you for your patience.

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...

## Appendix H. NEEA LLC MPER 1 – Guide for Manufacturers, Manufacturers’ Representatives, and Distributors Interviews

# MEMORANDUM

## LLLC MARKET PROGRESS EVALUATION: DRAFT INTERVIEW GUIDE FOR MARKET ACTOR INTERVIEWS

### Overview

This document includes a draft interview guide for manufacturers, manufacturers’ representatives, and distributors for review and comment, to support the NEEA LLLC Market Progress Evaluation. At the end, it also includes an outline of a separate interview guide for the DesignLights Consortium (DLC) interview. We have treated this as a separate guide because the DLC interview must cover different topics than the other interviews and at least some of those topics might be influenced by the results of interviews with the NEEA staff as part of this evaluation process.

The purpose of the LLLC market supply chain market actor interviews is to develop an understanding of the key MPIS identified for this evaluation and other topics identified in the workplan. This will also establish starting values for the MPIS to build upon in future years of evaluation. There is a plan to collect 14 interviews based on this guide, following the targets as described in Table 1 below.

**Table 1. Market Actor Interview Approach**

Market Actor	Target Completes	Sample Description	Notes
Design Lights Consortium Staff	1	NEEA provided 3 DLC contacts; one familiar with NEEA’s QPL work.	Interview familiar contact (Kevin Lock) and ideally all three together.
LLLC Manufacturers	7	NEEA provided a list of 4 people with the 4 manufacturers with whom NEEA is working on action plans, plus a much longer list of other manufacturer contacts.	The interview guide is divided into two parts – one for just the 4 engaged manufacturers and the second for all respondents. Any suggestions of manufacturers from DLC staff will be cleared by NEEA.
LLLC Manufacturer Representatives	4	NEEA provided a combination of man reps who program staff say have and haven’t been impacted by or engaged in activities NEEA has facilitated in the market.	If the Contractor exhausts the list, they will work with NEEA to review a “second-string” list of man reps; . Some secondary research and/or referrals may be fruitful, but contacts need to be cleared with NEEA program staff.
LLLC Distributors	2	NEEA staff provided recommendations for three distributors particularly active in and aware of the controls market.	If the Contractor exhausts the list, they will work with NEEA to review a “second-string list” of distributor contacts.
<b>Total</b>	<b>14</b>		

<sup>a</sup> Inside Lighting. Last updated 2020. “Seattle Lighting Agents.” <https://inside.lighting/lighting-megabase/local-market-info.php?territory=96>

The interview is broken into different sections, listed below with a brief explanation of the purpose of each section. The guide covers the following topics:

- **Preamble** – This provides context for the interviewee and establishes rapport with the interviewer.
- **Background** – This collects basic information from the interviewee and confirms the level of experience and knowledge the interviewee has related to LLLC.
- **Market Actor Engagement** – This collects information on the interviewees awareness and engagement with the LLLC market. This includes products/services offered, offering (manufacturers) and/or awareness of trainings on LLLC, as well as overall knowledge of the LLLC market.
- **Market Landscape** – This collects information on what types of projects are installing LLLC and other types of NLC systems, and additional information on the breakdown of LLLC compared to NLC and more broadly with all luminaires.
- **COVID Impacts** – This asks if COVID-19 has changed the level of interest in LLLC due to the heightened interest in controlling air supply rates associated with the virus response.
- **LLLC Capabilities** – This asks about features that are desirable for the market.
- **Closing** – This finishes the interview and gives the interviewee an opportunity to ask questions.

TRC developed interview guides for the three key market actor types:

- Manufacturers (Mfgs)
- Manufacturers’ representatives (Reps)
- Distributors (Dists)

Following below in Table 2, we have mapped the collection of both MPIs and other information stated in the Work Plan to the interview questions to establish the coverage of the survey questions. **Due to the limited time available for interviews of this nature (a 30-minute interview is normally preferable to ensure that the interviewee does not experience fatigue), we have had to prioritize the information gathering that we are able to achieve. We prefer to have about 15 open-ended questions for an interview of this length.**

*Table 2. MPI or Research Topics Addressed by Interviews*

MPI or Research Topic	Information Captured	Question #
MPI 2	DLC Regularly reviews the Qualified Product List (QPL) for LLLC and other NLC	<i>In DLC interview guide</i>
MPI 2	DLC regularly reviews the specification for LLLC and other NLC and develops updates	<i>In DLC interview guide</i>
-	General candidate information	Background section
Market Actor Engagement	LLLC and NLC market participation (products manufactured, represented, or distributed)	Mfgs: 1 Reps: 1-2 Dists: 1-4

MPI or Research Topic	Information Captured	Question #
MPI 3	LLLC and other NLC training through manufacturers offered to market actors	Mfgs: 2-7
Market Actor Engagement	Engagement and satisfaction with NEEA initiatives: collaboration, action plan development and being positioned as LLLC “champions” to provide training	Mfgs: 8-10
Market Actor Engagement	Engagement and satisfaction with LLLC training received, where applicable	Reps: 3-6 Dists: 5-8
Market Landscape	Characteristics of typical buyers/target audiences and industries for LLLC and other NLC	Mfgs: 11, 12 Reps: 7, 8, 9 Dists: 9, 10
Market Landscape	Commercial and industrial (C&I) building types and circumstances best suited for LLLC and/or other NLC systems, and why	Mfgs: 13 Reps: 7, 8, 9 Dists: 9, 10
Market Landscape	<ul style="list-style-type: none"> <li>▪ Trends in total sales and in market mix between LLLC and NLC</li> </ul>	Mfgs: 15 Reps: 12, 13 Dists: 11
Market Landscape	<ul style="list-style-type: none"> <li>▪ Customer motivations and barriers in choosing control systems (LLLC vs NLC vs basic)</li> </ul>	Mfgs: 16, 17, 18 Reps: 14, 15, 16 Dists: 12
LLLC Integration	<ul style="list-style-type: none"> <li>▪ Trends in integration with other buildings systems</li> </ul>	Mfgs: 19 Reps: 17 Dists: 13
COVID Impacts	<ul style="list-style-type: none"> <li>▪ COVID-19 impacts on product features, and whether features such as occupant density sensors and individual temperature monitoring are expected to persist in products long-term.</li> </ul>	Mfgs: 20 Reps: 18 Dists: 14

We have a separate outline for the DesignLights Consortium (DLC) staff person that will be interviewed because this interview will involve different topics than the guide for the other groups listed above.

The interview guides 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 may be slightly modified, re-ordered, or skipped, depending on the interviewee’s experience and the time available.

# LLLC AND NLC MARKET INTERVIEW GUIDE

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## 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: \_\_\_\_\_

## DLC QPL Presence (Manufacturers Only)

Number / types of LLLC Products listed on the DLC QPL	
Number / types of other NLC Products listed on the DLC QPL	

## Preamble – All Groups

Thank you for taking the time to speak with us today. As a reminder, we are conducting this interview on behalf of the Northwest Energy Efficiency Alliance (NEEA) to help them better understand the market for commercial lighting controls. NEEA is a non-profit organization in the Northwest that works to accelerate 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 the Bonneville Power Administration.

The information you provide will be used to develop strategies and recommendations related to lighting controls program offerings. As we do for all our market studies, your participation in this interview will remain anonymous and any answers you provide will be pooled with responses from the other participants.

This study will provide each participant with a \$50 gift card for participating in this approximately 30 minute interview.

Do you have any questions before we get started?

## Background

- 1) What is your title or role?
- 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 they can communicate wirelessly and transmit data. So you can program them in any grouping you need, 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 controller – typically mounted in the ceiling – will control a group of fixtures, usually wirelessly.



## Manufacturers

### Market Actor Engagement in LLLC Market

- 1) How many distinct NLC product lines do you offer? Of these, how many do you classify as LLLC? How, if at all, has this changed over the last five years? *(Probe: increased, decreased, stayed the same? More LLLC or more NLC? Proportion of LLLC to other NLC?)*
- 2) Does your company offer training(s) on lighting controls?  
*(If no) Do you have any plans to offer controls trainings in the future?*  
*(If no) Why don't you offer trainings? (Skip to Q8)*
- 3) *(If offer/plan to offer controls training)* What types of lighting controls [do][will] your trainings cover?  
*(Probe: LLLC, other types of NLC, non-networked controls)*
- 4) Who [will][does] the training target? *(Probe: Manufacturer reps, distributors, designers/specifiers, other)*
- 5) What topics [are][will be] covered and how long [is the training][will the training be]? *(For topics, probe on product benefits, product challenges for end-users and installers, system design, installation, communications wiring and wireless systems, etc.)*
- 6) *If they currently offer/plan to offer training on LLLC:* When [did][will] you start offering the LLLC training(s) and how many sessions [have you held][do you plan to hold]?
- 7) Why did your company decide to offer trainings on LLLC?

### MANUF ENGAGED WITH NEEA CONTINUE (ALL OTHER MANUF SKIP TO Q11)

- 8) I understand from NEEA that your company has been working with NEEA's program team (including staff from its program implementers Cadeo and Evergreen Consulting) on LLLC-related activities. What are the activities and what assistance is that team providing? *(Probe: Trainings, action plans development, etc.)*
- 9) Why did your company decide to work with NEEA's program team on these activities?
- 10) How has the collaboration been going so far? *(Probe on what is going well, what might be improved, any suggestions)*

### Market Landscape

- 11) Who are the typical customers or market sectors that are purchasing LLLC systems? What factors do you think make certain industries or market sectors [office, retail, schools, universities, hospitals] more likely to use LLLC systems than other types of NLC? *(Record sectors, and specific factors influencing each sector)*
- 12) Now I'd like you to think about other types of NLC systems. Again, we're defining "other NLC" as systems with an external sensor and controller controlling a group of fixtures. Are different types of customers or market sectors purchasing these as compared to LLLC? *(Probe on differences)*
- 13) Now I'd like to go back again to LLLC. Think about the LLLC projects you're aware of. What are the typical characteristics of those projects? That is, in what situations do LLLCs seem like the best fit? *(Prompt for large-small floor area, type or vintage of building, reasons for project, new construction vs. renovation vs.*

*retrofit, features that are chosen, etc. if needed*) And now think about projects that involve other types of NLC. What are the typical characteristics of those projects? Are those different from LLLC projects? *(Probe on differences.)*

- 14) What role have utility incentives played in encouraging LLLC and NLC? Are there other actions utilities could take to encourage greater adoption of LLLC and NLC? *(Probe: difference in sales/interest in regions with incentives and those without)*
- 15) Of the total indoor office luminaires sold in the Northwest - not just by your company but across all companies – approximately what percentage would you say is LLLC luminaires? A ballpark estimate is fine.

### LLLC and NLC Capabilities

- 16) What appears to be the most requested or desirable feature or capability of LLLC products based on sales and product requests? And how about the most desirable feature or capability of other types of NLC?
- 17) What do you think are the remaining barriers to further market adoption of LLLC? And what about other types of NLC – what are the remaining barriers to those? *(Probe for LLLC and other NLC: For customers or players on the supply-chain side.) (If barriers to LLLC and/or NLC)* What suggestions do you have for overcoming these barriers?
- 18) In general across 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?)* And what opportunities do you see for improvement to other types of NLC? *(Same probes)*
- 19) How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?

### COVID Impacts

- 20) Have you seen any changes in interest in LLLC as a result of COVID? Has there been any interest in utilizing LLLC or NLC sensors to support COVID safety protocols, such as occupant density sensors or temperature monitoring?  
*(If yes, then follow with...)* Do you expect these needs to persist in the market long-term?

### Closing

Thank you so much for your time today.

- 21) Finally, to ensure that you get the \$50 gift card, can you please provide a mailing address? It may take up to 4 weeks; thank you for your patience.

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...

## Manufacturer Reps

### Market Actor Engagement in LLLC Market

- 1) Does your company represent any manufacturers that offer NLC product lines? Of these, how many are classified as LLLC?
- 2) What role does your company play in the sales process for LLLC or other NLC? Does your company engage with the project decision-makers on whether to include those products for a particular project, or influence their decision? In what way?
- 3) Have you or other staff at your company participated in trainings on NLC systems?
- 4) Did the training include detail about LLLC systems as a distinct type of NLC?
- 5) Who offered the training? (*Probe: Manufacturers? Other entity and if so who?*)
- 6) What additional training or resources would help your staff more effectively promote LLLC

### Market Landscape

- 7) Who are the typical customers or market sectors that are purchasing LLLC systems? What factors do you think make certain industries or market sectors [office, retail, schools, universities, hospitals] more likely to use LLLC systems? (*Record sectors, and specific factors influencing each sector*)
- 8) Now I'd like you to think about other types of NLC systems. Again, we're defining "other NLC" as systems with an external sensor and controller controlling a group of fixtures. Are different types of customers or market sectors purchasing these as compared to LLLC? (*Probe on differences*)
- 9) Now I'd like to go back again to LLLC. Think about the LLLC projects you're aware of. What are the typical characteristics of those projects? That is, in what situations do LLLCs seem like the best fit? (*Prompt for large-small floor area, type or vintage of building, reasons for project, new construction vs. renovation vs. retrofit, features that are chosen, etc. if needed*) And now think about projects that involve other types of NLC. What are the typical characteristics of those projects? Are those different from LLLC projects? (*Probe on differences.*)
- 10) Who are the main decision-makers for choosing to install LLLC or other types of NLC in the new construction market? (Probe for role of Architect/engineer, contractor, owner, lighting designer). Does this vary by market sector? If so, how?  
Are the decision-makers different for major renovation projects? Are they different for lighting retrofits?
- 11) What role have utility incentives played in encouraging LLLC and NLC? Are there other actions utilities could take to encourage greater adoption of LLLC and NLC?
- 12) Of the total luminaires sold in the Northwest - not just by your company but across all companies – approximately what percentage would you say are LLLC luminaires? A ballpark estimate is fine.
- 13) How would you describe the overall trend in LLLC sales and order activity? Would you say it is increasing, staying about the same, or decreasing?

## LLLC and NLC Capabilities

- 14) What appears to be the most requested or desirable feature or capability of LLLC products based on sales and product requests? And how about the most desirable feature of capability of other types of NLC?
- 15) What do you think are the remaining barriers to further market adoption of LLLC? And what about other types of NLC – what are remaining barriers to those? *(Probe for LLLC and other NLC: For customers or players on the supply-chain side.) (If barriers to LLLC and/or NLC)* What suggestions do you have for overcoming these barriers?
- 16) In general across 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?)* And what opportunities do you see for improvement to other types of NLC? *(Same probes.)*
- 17) How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?

## COVID Impacts

- 18) Have you seen any changes in interest in LLLC as a result of COVID? Has there been any interest in utilizing LLLC or NLC sensors to support COVID safety protocols, such as occupant density sensors or temperature monitoring?  
*(If yes, then follow with...)* Do you expect these needs to persist in the market long-term?

## Closing

Thank you so much for your time today.

- 19) Finally, to ensure that you get the \$50 gift card, can you please provide a mailing address? It may take up to 4 weeks; thank you for your patience.

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...

## Distributors

### Market Actor Engagement in LLLC Market

- 1) How many different brands of NLC product lines does your company distribute? Of these, how many are classified as LLLC?
- 2) What services does your company offer related to [LLLC][other NLC] systems? *(Probe for each type: order fulfillment, direct sales to customers, system design or specification, system installation, training)*
- 3) Do you have a division or department that focuses on controls? *(If yes)* How long have you had this? What was the driver for creating this?
- 4) What role does your company play in the sales process for LLLC or other NLC? Does your company engage with the project decision-makers on whether to include those products for a particular project, or influence their decision? In what way?
- 5) Have you or other staff at your company participated in trainings on NLC systems?
- 6) Did the training include detail about LLLC systems as a distinct type of NLC?
- 7) Who offered the training *(Probe: Manufacturers? Other entity and if so who?)*
- 8) What additional training or resources would help your staff more effectively promote LLLC in particular?

### Market Landscape

- 9) Who are the typical customers or market sectors that are purchasing LLLC systems? What factors do you think make certain industries or market sectors [office, retail, schools, universities, hospitals] more likely to use LLLC systems? *(Record sectors, and specific factors influencing each sector)*
- 10) Now I'd like you to think about NLC systems other than LLLC. Again, we're defining "other NLC" as systems with an external sensor and controller controlling a group of fixtures. Are different types of customers or market sectors purchasing these than are purchasing LLLC? *(Probe on differences)*
- 11) How would you describe the overall trend in LLLC sales and order activity? Would you say it is increasing, staying about the same, or decreasing?

### LLLC Capabilities

- 12) In general across 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?)* And what opportunities do you see for improvements to other types of NLC? *(Same probes.)*
- 13) How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?

## COVID Impacts

- 14) Have you seen any changes in interest in LLC as a result of COVID? Has there been any interest in utilizing LLC or NLC sensors to support COVID safety protocols, such as occupant density sensors or temperature monitoring?

*(If yes, then follow with...)* Do you expect these needs to persist in the market long-term?

## Closing

Thank you so much for your time today.

- 15) Finally, to ensure that you get the \$50 gift card, can you please provide a mailing address? It may take up to 4 weeks; thank you for your patience.

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...

## INTERVIEW GUIDE FOR DLC STAFF

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This is designed as a set of talking points for the conversation with the DLC rather than a specific set of questions. The interview will be influenced heavily by the initial responses that the interviewee will make, leading to a more freeform discussion.

The following topics will be used to guide the conversation:

- **Preamble** – TRC will introduce the research project and its goals, to establish the groundwork for the 1-hour conversation.
- **DLC Process to maintain Technical Requirements for LLC (for MPI 2)**– This will explore how and whether DLC is maintaining and/or upgrading the technical requirements for LLC and other NLC over time. Questions will include: What is the decision-making process behind updating the Technical Requirements? Are there any deviations to the process or schedule compared to the roadmap on the DLC website?
- **DLC Update Process (for MPI 2)**– This will explore the process for qualifying new products and delisting old products. Questions will include: What does a manufacturer need to do to list a product? How long that process take? How does DLC confirm that products continue to meet the Technical Requirements? What is the process to delist a product?
- **Role of Innovation in DLC Process** – This will explore how DLC balances the need to identify high-quality products without creating a structure of rules that stifles innovative and unique solutions. The intent is to understand how the DLC is allowing innovation (and feedback from manufacturers) to influence how the standards are set and what happens if an innovative product is introduced that produces a market disruption.
- **Role of DLC on the LLC Market** - This will explore the role that DLC plays in influencing the national market for LLC and other types of NLC. What changes has DLC observed in the LLC market since the LLC Technical Requirements and QPL were launched? To what degree is that change due to DLC involvement?

Have there been any changes to the NLC technical requirements as a result of developing and launching the LLLC requirements? If so, what aspects changed? How have these changes affected NLC products available on the market? (Probe: are products more viable? Are products achieving greater energy savings?)

- **Role of NEEA** – This will explore how NEEA influences the market for LLLC nationally through its partnership with DLC. What role has NEEA played in the DLC’s processes with regards to LLLC? How does the DLC envision NEEA’s role with regard to DLC’s activity in the LLLC market going forward? What about the technical requirements for NLC more broadly?
- **Role of utilities:** This will explore how local utilities influence the market for LLLC nationally. What additional things should local utilities do to encourage adoption of LLLCs? Anything different for NLCs?
- **Manufacturer Recommendations** – TRC will ask DLC to provide the best contact at the various manufacturers to interview for the other part of these stakeholder interviews, if additional interviewees are needed beyond the contacts NEEA provided. TRC will clear these additional suggestions with NEEA staff.
- **Closing** – Final thoughts and remarks from the interviewee.

## Appendix I. NEEA LLLC MPER 1 – Guide for Utility Interviews



## NEEA LLLC Program Utility Interview Guide

Researchable Questions	Question Number
Understand utilities’ current LLLC and NLC market engagement and offerings	A1-A11
Assess awareness of and motivation to participate in NEEA’s efforts in the LLLC market	B1-B4; C1
Understand utility perspectives and feedback on the LLLC Program	C2-C3
Identify utilities’ perceptions of NEEA’s influence on utility programs and the market adoption of LLLC and other NLC	C2-C3

**Target Quota** = five (5) interviews with utilities, each interview lasting ~30 minutes.

Interviewee(s) and Organization: \_\_\_\_\_

Interviewer: \_\_\_\_\_

Date of Interview: \_\_\_\_\_

Thank you for making the time to speak with me (us). The purpose of this interview is to better understand your thoughts on the market for Luminaire Level Lighting Controls and other types of Networked Lighting Controls, and the programs and other efforts your utility offers. And then we’d like to get your impressions of the various aspects of NEEA’s LLLC Program that you’re aware of. This interview should take ~30 minutes and all quotes will be kept anonymous (we won’t identify who said what). Do you have any questions before we begin?

[IF NEEDED: LLLC stands for Luminaire Level Lighting Controls, which is a subset of NLC, Networked Lighting Controls. Throughout the interview we will refer to both LLLC and other NLC. Luminaire Level Lighting Controls, or LLLC, are a type of networked lighting control. In an LLLC system, each individual light fixture has its own built-in sensor and controller, and they can communicate wirelessly and transmit data. So you can program them in any grouping you need, 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 controller – typically mounted in the ceiling – will control a group of fixtures, usually wirelessly.]

### A. Current LLLC/NLC Engagement

I’d like to begin the interview by discussing [UTILITY’S] engagement and efforts with LLLC and other types of NLC to date. Please note that for today’s discussion, we would like to focus on programs that actively target customers for LLLC or other NLC installations.

- A1. Can you please provide details on what programs you offer for LLLC and other types of NLC?  
(Probe: design, delivery channel, year launched, incentive structure, annual performance, educational efforts, marketing efforts)

1. Do you have any offerings that are specific to LLLC? For example, do you offer difference incentive levels for LLLC compared to other NLC? Please explain any differences.
2. Do you offer incentives that are specific to lighting controls that are not networked? Some utilities refer to these as “basic” lighting controls.

[IF UTILITY DOES NOT HAVE LLLC/OTHER NLC PROGRAMS, SKIP TO A6]

- A2. Who is the target market for your Networked Lighting Control offerings? *(Probe for both customer type [office, warehouse, etc.] and the project type [new construction/ renovation versus retrofit].)*
  1. Why is this your target market?
  2. [IF NOT ADDRESSED] Are there any differences in the target market for LLLC versus other types of NLC, from your perspective?
- A3. How successful have your Networked Lighting Controls offerings been to date? *(Probe for specifics, such as customer participation, trade ally participation, engagement with market actors, cost-effectiveness of program offerings, etc.)*
  1. What’s led these offerings to be successful?
  2. [IF OFFERING INCENTIVES FOR BOTH LLLC AND OTHER NLC] How do trade allies or customers respond differently to incentives for LLLC versus other NLC, if at all?
  3. [IF OFFERING INCENTIVES FOR BOTH LLLC AND OTHER NLC] What is the proportion of incentive funding given to LLLC vs. other NLC? How, if at all, is this proportion changing?
- A4. What challenges have you encountered with your Networked Lighting Control offerings? Have you encountered challenges specific to LLLC? And how about any challenges specific to other types of NLC? *(If offering both LLLC and other NLC programs, probe for differences across LLLC versus other NLC)*
  1. What’s caused these challenges? *(If offering both LLLC and other NLC programs, probe for differences)*
  2. What actions have you taken to overcome these challenges? *(If offering both LLLC and other NLC programs, probe for differences)*
- A5. What plans do you have for your Networked Lighting Control offerings in the future and specifically for LLLC? How will these offerings be designed? *(Probe: technical assistance, trade ally engagement, incentive structure, tracking, etc. Ask about differences across LLLC versus other NLC.)*
  1. What support do you need to achieve these plans, if any?

[AFTER A5, SKIP TO A9]

- A6. Why have you not developed any LLLC or other NLC offerings?
- A7. Do you offer incentives for lighting controls generally (not differentiated by type of lighting control)?

- A8. Do you have any LLLC or other NLC offerings planned for the future?
1. **[IF YES]** What type of programs do you think you will offer and why? How will these programs be designed? *(Probe for prescriptive savings or performance-based savings and incentive levels/structure)*
  2. **[IF NO]** Why not? What would need to change for you to create LLLC or other NLC offerings?
- A9. How important do you think NLC in general are as a driver of savings for your portfolios, both now and in the future?
1. Do you expect LLLC or other NLC products to replace some of the savings you will lose when LEDs are no longer incented through your programs?
- A10. What key barriers do you see to the increased adoption of **LLLC**?
1. What do you think is needed to overcome these barriers?
  2. Is there a difference between LLLC and other NLC for how easy the barriers are to overcome?
- A11. What key barriers do you see to the increased adoption of **other NLC** (i.e., non-LLLC)? *(Probe if not addressed: Are the barriers different for LLLC as compared to other types of NLC? If so, please describe the differences.)*
1. What do you think is needed to overcome these barriers? *(Probe if not addressed: Is there a difference between LLLC and other NLC for how easy the barriers are to overcome?)*

## B. Program Awareness

Next, I'd like to discuss your awareness of NEEA's LLLC Program.

- B1. Before this interview, were you aware of NEEA's LLLC Program?
- B2. **[IF B1=NO]** What had you heard about NEEA's LLLC Program?
1. What specific activities are you aware of?
- [IF NOT AWARE, PROVIDE DESCRIPTION: NEEA is working to accelerate market adoption of LLLC in the region in a number of ways including helping utilities develop incentive programs and co-funding Trade Ally training, supporting manufacturers to train their reps in selling LLLC, and raising supply chain awareness and knowledge of LLLC through targeted media and educational materials.**
- B3. **[IF NOT MENTIONED]** Are you aware of the LLLC trainings that are offered through Lighting Design Lab (LDL)? *(Probe on both on-site trainings offered before COVID and current online trainings)*
1. If you are aware, do you think the LDL training has an impact on the market? Why or why not? *(Probe on on-site versus online)*
  2. Are there additional training topics not currently covered that you'd like to suggest?
- B4. **[IF NOT MENTIONED]** Are you aware of the LLLC research and case studies by NEEA?

- B5. **[IF YES]** Have you used these or referred these resources to anyone, or do you see a potential use for them? *(Probe on whether have used NEEA research for program design.)*
1. Are there other research topics that would like to suggest?
- B6. Are there any other aspects of NEEA’s LLLC Program that we haven’t discussed that you have heard about?

## C. Program Perceptions

**[ASK IF AWARE OF NEEA’S PROGRAM.]** Now, I’d like to discuss your thoughts on NEEA’s LLLC Program. Just as context NEEA began full program implementation in early 2020, and for several years prior to that had started working with utilities on trainings and incentive program development.

- C1. How have you engaged with NEEA's LLLC Program so far, and if so in what ways? *(Probe for the following components: collaborated with NEEA on Trade Ally trainings, collaborated with NEEA in developing LLLC incentive programs, served on one of NEEA’s LLLC-related committees, used LLLC marketing templates, case studies, and other educational materials that NEEA offers on the BetterBricks website, used research and reports for program planning, other)*
1. Can you describe your role in engaging with NEEA?
  2. How long (in months) have you been involved with NEEA’s work on LLLC?
  3. **[IF NOT INVOLVED IN ALL COMPONENTS]** Why are you involved in some aspects of the LLLC Program but not in others? **OR** Why are you not involved in the program?
- C2. Thinking about the past **[INSERT RESPONSE FROM C1.2]** months of your interactions/work with NEEA related to LLLC, what has worked well for you? *(Probe if needed: How has NEEA’s work on LLLC supported your work? What about it did not work as well from your perspective?)*
- C3. **[ASK IF RESPONDENT MENTIONS ANYTHING THAT DIDN’T WORK IN C2]** Are there any near term adjustments that NEEA can implement to help support you better or improve their work in the area of LLLC. *(Probe as needed to identify actionable improvements.)*

## D. Closing

- D1. Is there anything else you’d like to add that we didn’t discuss today?

This completes the interview – thank you very much for your time. Have a good [evening/day].

## Appendix J. NEEA LLLC MPER 1 – Guide for Trainee Interviews

## NEEA LLLC Trainee Interview Guide

### Introduction

Thank you for making the time to speak with me (us).

So back when I called you to schedule the interview, you said you had participated in some training on networked lighting controls. The purpose of this interview is to get your insights on what training topics you've found particularly useful, and what other topics you'd like to see covered. Additionally, we have some questions about the lighting controls market. Again, this interview should take about 45 minutes and all feedback will be kept anonymous – we won't attach your name to a specific quote.

This interview is meant to be conversational in nature, so please feel free to expand on any topics where you have interest or insight – that kind of information is very valuable to us. Be aware that I may jump in from time to time to move us onto the next topic. This is not a reflection on what you are saying, its only to make sure I can get to all my questions without taking up too much of your time.

Do you have any questions before we begin?

[ADDRESS QUESTIONS]

### A. Background and Introduction

First, I have a few broad questions about your lighting controls work.

- A1. What is your title or role?
- A2. How long have you been in this role?

Before we start the main 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 they can communicate wirelessly and transmit data. So you can program them in any grouping you need, 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 controller – typically mounted in the ceiling – will control a group of fixtures, usually wirelessly. In the interview questions, we'll call these "other types of NLCs".

### B. Training Feedback

- B1. What training or education have you participated in on LLLC and on other types of NLC?  
(Probe without leading on whether it covered LLLC, other NLC, or both; who offered and/or taught it [e.g. utility, LDL/DLC, manufacturer, industry group, academic program])

- B2. Why did you decide to participate in training on LLLC and other NLC? (Probe for each training mentioned) What were you hoping to get out of it?
- B3. What topics were covered in the training(s) you've taken? (Probe for topics on LLLC and topics on other NLC trainings).
- B4. What training topics have been the most useful to you on NLC generally? And how about on LLLC specifically?
- B5. Have you recommended training on LLLC or other NLC to others? If yes: Which training(s)?
- B6. What additional training topics or information on LLLC would be useful to you? How about on other NLC?
- B7. What education and training formats do you prefer? (Probe: In-person, webinar, videos on demand, self-paced online learning, written materials) Why?
- B8. What publications and organizations do you trust for information about lighting trends and best practices?

## C. Training Impact

- C1. At this point, how clear would you say you are on what the best applications and circumstances are for LLLC versus for other NLC? Would you say not very clear, fairly clear, or very clear? (Record response) (Confirm response to B4 makes sense given this response. If not, ask What additional information would help you feel "very clear"?)
- C2. [IF VERY/FAIRLY CLEAR] Would you say the content in trainings you've taken had no effect, some effect, or a lot of effect on increasing your clarity about the best applications and circumstances for LLLC versus other NLC? IF SOME OR A LOT: What training was most helpful for that clarity?
- C3. At this point, how comfortable would you say you are in recommending LLLC systems to customers? Would you say not very comfortable, fairly comfortable, or very comfortable? And how comfortable are you recommending other types of NLC systems to customers? Not very comfortable, fairly comfortable, or very comfortable?  
  
[IF FAIRLY /NOT VERY COMFORTABLE] What aspects are you less comfortable with at this point?
- C4. [IF VERY/FAIRLY COMFORTABLE] Would you say the content in the trainings you've taken had no effect, some effect, or a lot of effect on increasing your comfort with recommending LLLC and other NLC?

- C5. Would you say the training you've taken has had no influence, some influence, or a lot of influence on how you do your day-to-day work? (If some or a lot) Which training had an influence and in what way? (Probe: system installation, programming, designing, specifying, other] and which training) (For all responses: What else has changed your day-to-day work? (Probe on other trainings, information, field experience, articles, papers, colleagues' input)
- C6. Have you recommended LLLC for a project or been involved in any LLLC projects? If yes: How many? (Probe for number recommended and number involved) How about projects with other types of NLC? If yes: How many? (Probe for number recommended and number involved) Would you say the trainings you've taken had no influence, some influence, or a lot of influence on your recommendations or involvement in projects with LLLC or other NLC? (If some or a lot) Which trainings and in what way?
- C7. Considering everything we've discussed about trainings, what would be your ideal LLLC and other NLC-focused training? (Probe for topics and format)

## D. Market Insights

Finally, I'd like to discuss the lighting controls market and your interactions with customers related to lighting controls.

- D1. How would you describe the overall trend in LLLC sales and order activity in the Northwest? Would you say it is increasing, staying about the same, or decreasing? [If response is "increasing" or "decreasing" probe on why they think that is] (If needed, prompt without leading: Greater awareness of LLLC (Who (i.e. customer v. market actor)? How are they finding out?); More efforts to influence or make sales of customers (By whom (e.g. manufacturer reps, architects, designers)? What's driving that?); availability of utility incentives?]
- D2. And how about the overall trend in sales and order activity for other types of NLC? Would you say it is increasing, staying about the same, or decreasing? [If response is "increasing" or "decreasing" probe on why they think that is]
- D3. What would you say most customers are looking for in a lighting system generally? How about in lighting controls? (Probe on occupants versus owners versus facility staff).
- D4. Have you been involved in any projects where you or someone else on the team recommended LLLC to a customer or project manager, but the customer or project manager chose basic controls or no controls instead? If yes: Can you describe that project? (Probe on what was done instead, any insights on why and how the decision was made)
- D5. Similarly, have you been in a situation where a customer or project manager rejected a recommendation for another type of NLC system? If yes: Can you describe that project? (Probe for same elements as above)



- D6. Based on your own experience, what do you think are the biggest benefits of LLLC from the customer’s perspective? And how about the biggest benefits of other types of NLC from the customer’s perspective?
- D7. In what circumstances do you think LLLC systems are a better fit than other NLC systems and vice versa? And why? **(Using the list below, probe on the benefits/capabilities that can make one system a better fit than another.)**
- i) Market sector (Office, retail, schools, universities, hospitals, warehouses)
  - ii) Type or size of the space (Open floor versus enclosed spaces, square footage, daylighting)
  - iii) Project type: new construction, renovation, retrofit?
  - iv) Owned versus leased or rented buildings?
  - v) Type or age of building?
- D8. In what circumstances might you not recommend LLLC or other NLC, but instead recommend non-networked lighting controls?
- D9. In what circumstances might you recommend lighting with no controls?
- D10. In general, across 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?)** And what opportunities do you see for improvement to other types of NLC? **(Same probes.)**
- D11. How often, if at all, are your customers integrating LLLC sensor outputs with HVAC systems or other building systems?

## E. Closing

- E1. Is there anything else you’d like to add that we didn’t discuss today?
- E2. We are also conducting research with building owners, owner’s representatives or others that have made a decision to install LLLC or other NLC systems. Since we have fewer building owner contacts we are offering a \$100 gift card to anyone who participates in an interview similar to this one. Would you be willing to send an email to your customers that have installed LLLC or other NLC, letting them know about the study, and asking them to get in touch with us if they are interested? We can send an email that you could forward.
- E3. We appreciate your time today. We would like to send you a \$50 VISA gift card as a thank you. Can you confirm the mailing address we should use?

This completes the interview – thank you very much for your time. Have a good [evening/day].

## *F. Email for Forwarding*

Dear Customer,

We are writing to let you know of an opportunity to participate in a research study. NEEA – a Northwest non-profit dedicated to promoting energy efficiency and funded by local electric and gas utilities - is working with the Cadmus Group to conduct a study to learn more about why building owners and others are choosing to install networked lighting controls, and how the controls are performing. They are looking for a limited number of building owners that have installed networked lighting controls to participate in a one-on-one phone interview that takes about 45-60 minutes. The Cadmus Group will send anyone who participates – a \$100 gift card as a thank you. If you are interested in participating, please email Michael Laurienti (Michael.laurienti@CadmusGroup.com) to schedule a time that works for you.

If you have any questions about this study, please contact Jennifer Stout at JStout@neea.org. You can learn more about NEEA at NEEANet.org.

[Signature]