ENERGY EFFICIENCY PROGRAM

Ameren Illinois Luminaire Level Lighting Controls (LLLC) Market Transformation Initiative Business Plan

Prepared For: Illinois SAG Market Transformation Savings Working Group

Date: 11.01.2023

Acknowledgements

This paper fulfils the requirements of Illinois Statewide Technical Reference Manual Version 12.0 for the Luminaire Level Lighting Controls Market Transformation Initiative within the Ameren Illinois Energy Efficiency Program. Ameren Illinois acknowledges the combined efforts and support from Resource Innovations and Opinion Dynamics Corporation in producing this report; in particular, Resource Innovations' role in developing the Logic Model, Energy Savings Framework (Natural Market Baseline, Unit Energy Savings and Market Transformation Savings), and Opinion Dynamics Corporation's role in developing the Evaluation Plan.

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List of Acronyms

AFRI = Awareness, Familiarity, Recommendation, Installation

AIC = AIC Illinois Company

AED = Architects, Engineers and Designers

DLC = DesignLights Consortium

EA = Energy Advisor

ESF = Energy Savings Factor

ESFr = Energy Savings Framework

IE = Industry Expert

LLLC = Luminaire Level Lighting Controls

LM = Logic Model

lm = Lumen

MT = Market Transformation

MTI = Market Transformation Initiative

NEB = Non-Energy Benefits

NEEA = Northwest Energy Efficiency Alliance

NLC = Networked Lighting Controls

NMB = Natural Market Baseline

ODC = Opinion Dynamics Corporation

PAT = Program Ally Training

PNW = Pacific Northwest

RA = Resource Acquisition

RI = Resource-Innovations

TEA = Trained Energy Advisor

SAG = Stakeholder Advisory Group

SQFT = Square Feet

TRM = Technical Resource Manual

QPL = Qualified Product List

UES = Unit Energy Savings

WHF = Waste Heat Factor

1 Background

Ameren Illinois Company (AIC) has worked in collaboration with Resource Innovations (RI) and Opinion Dynamics Corporation (ODC) to develop the Luminaire Level Lighting Controls (LLLC) Market Transformation Business Plan which embodies program strategy, MT program savings estimates, and the evaluation approach. The three principal program documents considered as part of a Market Transformation Initiative in the Illinois Technical Reference Manual (TRM) Attachment C are: 1) Program Theory of Change and Logic Model (LM), 2) Energy Savings Framework (ESFr), and 3) an Evaluation Plan.

LLLCs have a variety of benefits. LLLC systems, which are a subset of networked lighting controls (NLCs), have been available for about a decade. LLLC systems have the unique characteristic of sensors embedded in every fixture, enabling usage flexibility across a variety of different settings, including warehouses, offices, hospitals and healthcare facilities and schools.

LLLCs are also easy to install and offer many non-energy benefits. These include greater tenant comfort and productivity, and the ability for business owners to remotely address security and maintenance issues, as well as manage energy usage.

A recent study by NEEA showed significant (50 – 74%) annual energy savings from a 1:1 replacement of luminaire level lighting controls (LLLCs) compared to 59% savings of a full redesign. The report also highlighted that an LLLC replacement was about one-third to half of the cost of a full redesign.[1]

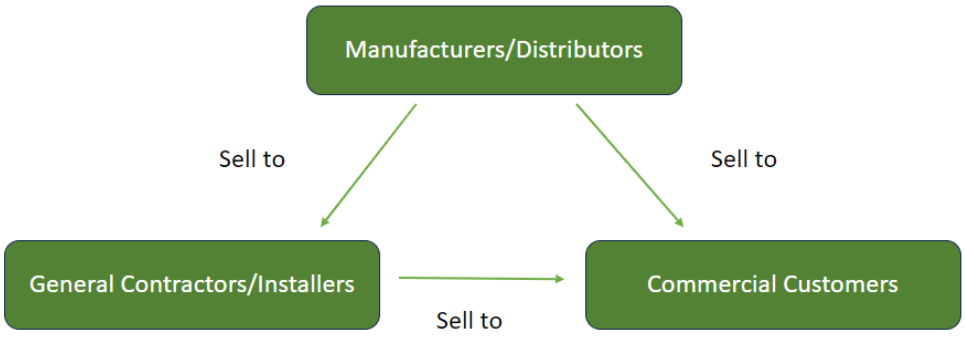
Despite these many benefits, LLLC adoption is low. Connected lighting comprises less than 1% of all luminaires in the United States.[2] AIC, along with Stakeholders, have recognized the huge savings potential of LLLCs and the opportunity for LLLCs as a Market Transformation Initiative. In 2021, AIC launched the Luminaire Level Lighting Controls (LLLC) market transformation initiative (MTI) pilot to accelerate adoption of the technology within AIC's service territory.

[1]NEEA 2020. Luminaire Level Lighting Controls Replacement vs Redesign Comparison Study. https://neea.org/resources/lllc-replacement-vs-redesign-comparison-study.
[2]Wolgamott, C., and T. Kisch. 2021. Trends in Lighting Controls. Trends In Lighting Controls: Luminaire Level Lighting Controls (facilityexecutive.com).

2 Target Market

The TRM defines Target Market as "an actual or nominal place where forces of demand and supply operate, and where buyers and sellers interact (directly or through intermediaries) to trade goods, services or contracts or instruments, for money or barter."[3] AIC used this definition to identify the LLLC MTI Target Market below.

Figure 1. LLLC Target Market



In Figure 1, General Contractors are organizations that manage construction and retrofit projects. They can do installation work or sub-contract to installer organizations. Installers are organizations that perform installation components of a construction or retrofit project. Manufacturers develop and manufacture LLLC products and distributors stock these products for retail to general contractors and installers. Commercial customers represent all building types in the commercial sector.

[3] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0 Volume 4: Cross-Cutting Measures and Attachments, Attachment C, p 128 IL-TRM_Effective_010124_v12.0_Vol_4_X-Cutting_Measures_and_Attach_09222023_FINAL.pdf (ilsag.info)

3 Program Theory of Change

The Logic Model for the AIC LLLC MTI provides a logical and measurable connection between Utility activities and the resultant market changes that occur with regard to accelerated LLLC adoption by customers in the territory. Per the Illinois TRM, "To qualify as an MT initiative, there needs to be a clearly delineated target market, as well as a documented theory of change in this market (or MT hypothesis) that is embedded in a defensible logic model. This logic model provides the linkages between program activities and the anticipated lasting market change that accelerates the adoption of energy efficiency."[4]

The Program Theory of change for the LLLC MTI consists of leveraging multiple Utility resources to address key barriers in adoption of LLLC technology by leveraging new and existing partnerships within the target market to accelerate the adoption of LLLC technology across the Utility territory. The Logic Model included in this Business Plan illustrates how key barriers are addressed through activities to accelerate the market adoption of LLLCs. The LM includes; the identification of primary barriers to LLLC adoption, Target Market engagement strategies that address those barriers to increase LLLC adoption, Market Progress Indicators that are quantifiable to provide supporting evidence of market effects regarding Utility efforts to affect the market, and a logical set of market outcomes that detail the lasting change that occurs resulting in increased installation of LLLCs. In 2021, AIC developed an initial LM for the LLLC MTI and in 2023 revised the LM to reflect learnings from pilot implementation.

3.1 Barriers to Adoption

The Logic Model, in Figure 2, illustrates how the activities of the AIC LLLC MTI will result in accelerated adoption of LLLC by customers based on addressing three primary barriers of adoption identified within the Target Market. The three primary market barriers addressed in the LLLC MTI are:

- **Lack of value proposition**: Low awareness and familiarity with the technology among the target market.[5]

[4] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0 Volume 4: Cross-Cutting Measures and Attachments, Attachment C, p 129 IL-TRM_Effective_010124_v12.0_Vol_4_X-Cutting_Measures_and_Attach_09222023_FINAL.pdf (ilsag.info)

[5] AIC interviews with Program Allies.

- **Lack of skilled contractors and installers**: Low volume of skilled contractors and installers that are comfortable bidding, installing, and commissioning LLLC equipment[6]
- **High upfront costs**: Per fixture cost of LLLC is approximately 50% more costly over standard LED fixtures – $149 for LLLC compared to $100 for standard LED fixture without controls.[7]

Table 1. LLLC Barriers to Adoption with Corresponding Activities

Barriers	Activities
Lack of value proposition: low awareness and familiarity	Educational and sales collateral; webinars
Lack of skilled contractors and installers	Training
High upfront costs	Incentives

AIC believes that the activities that remove or reduce the three primary barriers will result in accelerated adoption of LLLCs by customers. The Logic Model illustrates the importance of addressing all three barriers simultaneously so that accelerated adoption can occur, not just in the short term, but over a longer period of time even after the Utility is no longer engaged in the market with those activities.

Lack of value proposition

Installation and operation of LLLCs are more complicated than traditional luminaires, but LLLCs offer greater value for building operations. A fundamental barrier to adoption of LLLCs is an understanding of the value proposition that accompanies the adoption of an LLLC system. As awareness and familiarity with the value proposition of LLLCs increase, distributors, contractors, and installers will be more likely to recommend LLLCs to their customers and as a result will see higher uptake from customers for LLLC systems.

AIC will be engaging in education to end-use customers, as well as distributors and installers, so that customers are more aware of the value proposition of LLLC systems and are more likely to adopt LLLCs when they are proposed by contractors and installers. Among the many features and functions of LLLC systems, the LLLC MTI will seek to increase familiarity and understanding of the non-energy benefits (NEBs) of LLLC systems as a key aspect of the value proposition for LLLCs.

[6] AIC interviews with Program Allies.
[7] NEEA 2021, 2020 Luminaire Level Lighting Controls Incremental Cost Study.

Lack of skilled contractors and installers

AIC focuses key LLLC MT efforts on increasing education and awareness of LLLCs among distributors and installers. Distributors are included in the scope of addressing the barrier of skilled contractors and installers because of the bidding and procurement aspect of selling an LLLC system to an end user. It is understood that distributors play an essential role in aiding contractors and installers with pricing, bidding, and procurement of LLLC equipment to facilitate installation sales to end-use customers. Education and awareness of LLLCs for distributors and installers consists of an understanding of and competence with; features and functions of LLLCs, bidding and quoting installation of LLLCs, procurement of LLLC equipment, and commissioning LLLCs so that end-users are able to interface with the features and functions of the LLLC systems.

Education and awareness engagement activities identified in the LM seek to address each of the distributor, contractor, and installer perspectives and roles in the process of bidding, selling, procuring, and installing LLLC equipment in facilities for customers. AIC understands that the approaches to further increase education and awareness of the Target Market will require continual refinement of the types, approaches, and specialization of education and awareness efforts as the MTI moves forward into progressive program years and seeks deeper and more accelerated market change.

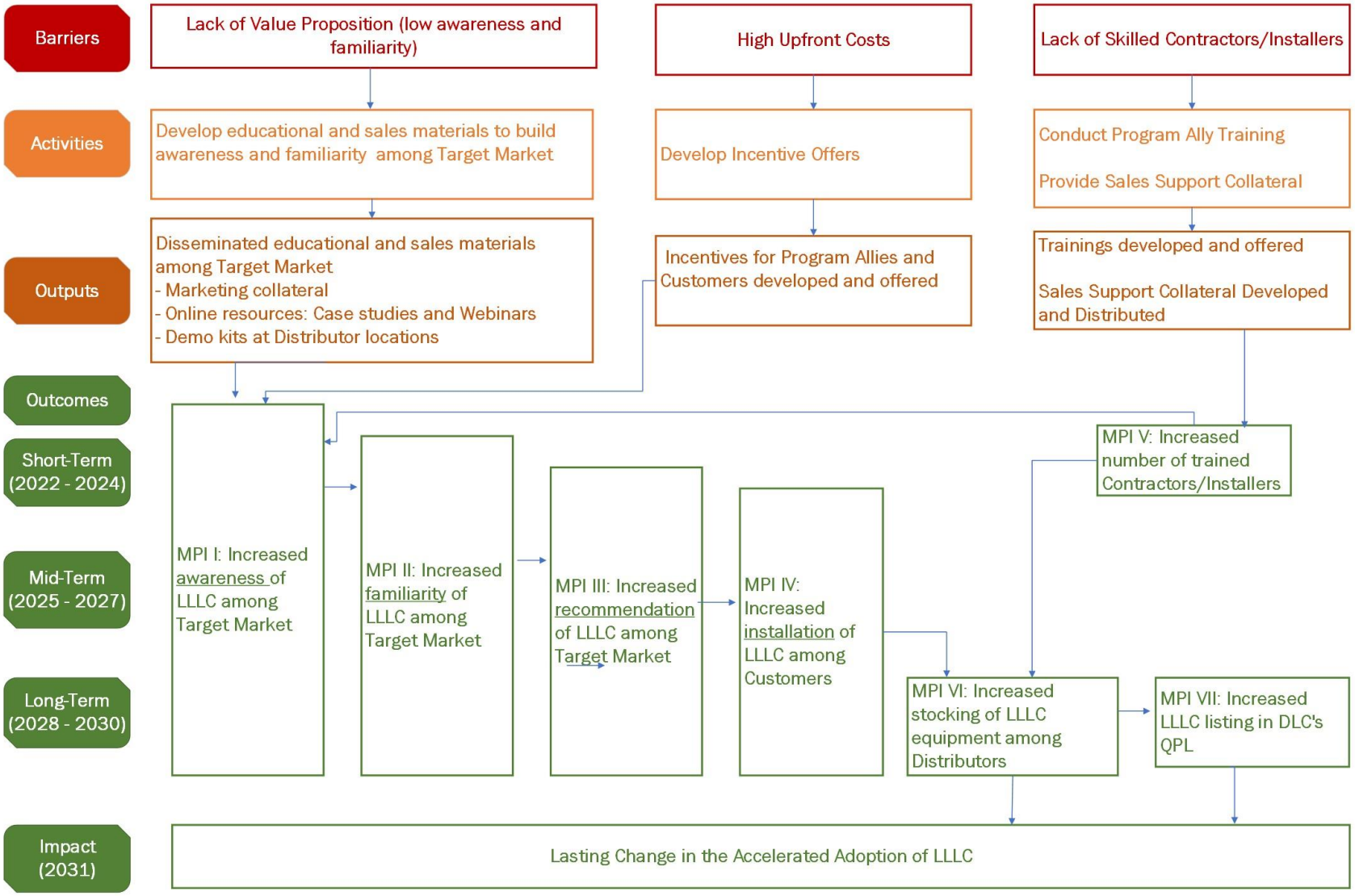
High upfront costs

In the early stages of the LLLC MTI, AIC will provide higher incentives for LLLC projects. The incentives will be offered through multiple channels within the traditional AIC Energy Efficiency Portfolio. The level of incentive and availability of incentive in different Energy Efficiency offers will vary throughout the life of the LLLC MTI based on adoption rates and efficacy of those channels to engage the Target Market. All incentivized LLLC products must be listed in the Design Lights Consortium's (DLC) Qualified Products List (QPL) to be eligible for incentives. AIC will continue to provide some form of traditional incentives for LLLC equipment that is on the DLC QPL to further motivate manufacturers to include the required functions and features in their successive LLLC product lines so that their products meet eligibility of the DLC QPL and also meet eligibility for Utility incentives. Manufacturers wishing to support distributors and installers who leverage AIC's incentives will need to ensure that their products are listed in the DLC QPL.

3.2 Logic Model

Figure 2 is the Logic Model for the AIC LLLC MTI that demonstrates the connection between barriers to adoption, utility MT activities, outcomes, and market progress indicators.

Figure 2. 2023 AIC LLLC Logic Model



2.1 3.3 Market Outcomes

Figure 3 details the linkages between activities and impact and the chronological order of Market Outcomes.

Figure 3. Chronological Impact of Market Outcomes

3.4 Market Progress Indicators

The MPIs of the LLLC MTI are detailed in Table 2 below. These MPIs are an integral part of the Logic Model and provide quantifiable data points that describe LLLC adoption by the Target Market and allow the Utility and Evaluation partners to adequately determine positive effects of Utility MTI efforts on the Target Market for the MTI. These MPIs will be measured regularly, at intervals determined by the Evaluation Plan included herein, as evidence of positive market effects from the Utility MTI for LLLCs.

Table 2. Description and Goals of MPIs

MPI #	Outcome	Market Progress Indicator	Data Source	Goals
I & II	Increased awareness, familiarity with LLLC among Target Market	Awareness is determined by the percentage of Target Market who have never heard of LLLC Familiarity refers to the knowledge that the Target Market has about the features of LLLCs including understanding of the non-energy benefits (NEBs) of LLLC systems	Surveys among Target Market	Awareness by 2027: 50% Customer awareness, 95% Installer awareness Familiarity by 2027: High familiarity demonstrated of LLLCs and NEBs by 20 installers

III	Increased recommendation of LLLC among Target Market	Target Market recommends LLLC when recommending lighting equipment including Manufacturer recommendations to Distributors, Distributor recommendations to Contractors/Installers, and Contractor/Installer recommendations to End-Use Customers	Surveys among Target Market	65% of applicable Target Market surveyed recommends LLLCs by 2027
IV	Increased installation of LLLC among End-Use Customers	End-users ask for LLLC for lighting retrofits End-users agree with recommendations from Target Market	Surveys among Target Market Dodge Data	65% of Customers install LLLCs when recommended by Contractors/Installers
V	Increase in trained Program Allies	Trained Program Allies can explain, describe, and sell LLLC	Utility data of Program Allies who participate in AIC LLLC training Post-training evaluation surveys	25% of Program Allies can explain, describe, and sell LLLCs by 2027
VI	Increased stocking of LLLC equipment among Distributors	Distributors stock more LLLC equipment due to increased demand	Surveys among Distributors Sales data from Distributors	At a minimum, three key distributors stock LLLCs as a business practice by 2027

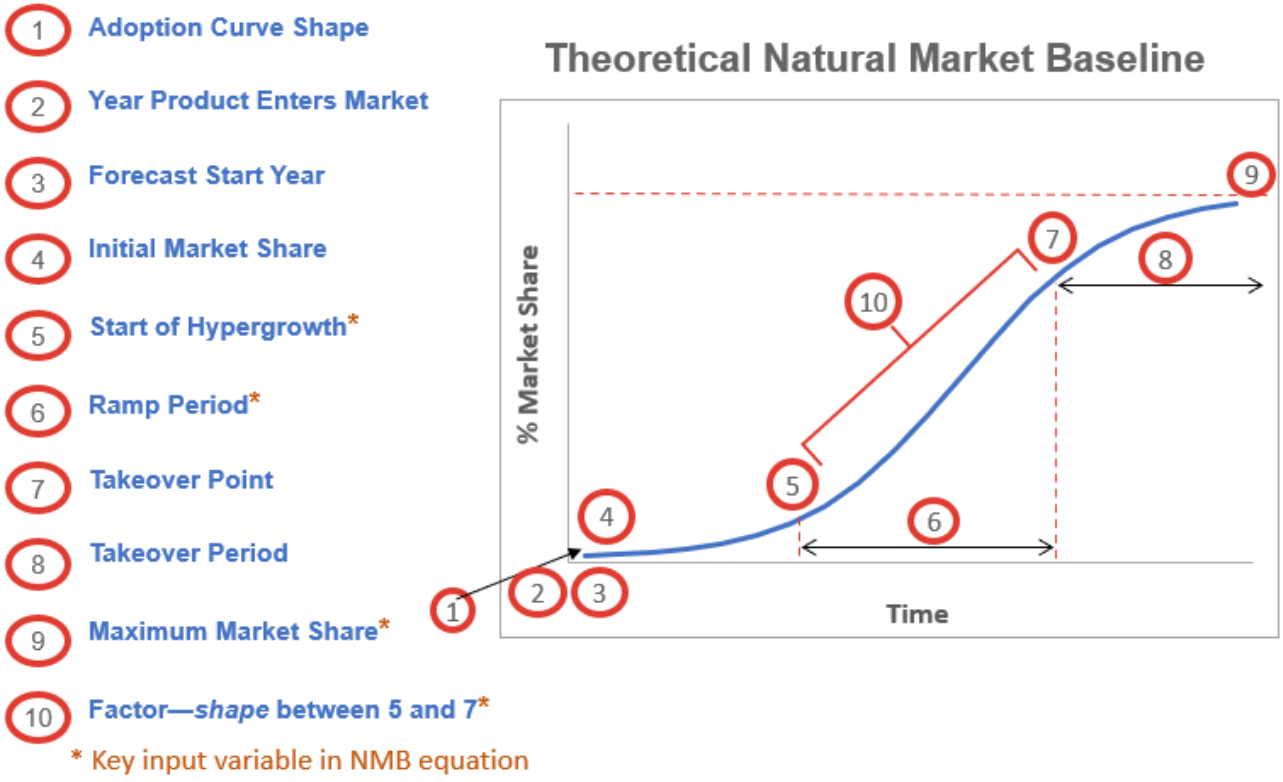
VII	Increased LLLC Listing in the DesignLights Consortium (DLC) Qualified Products List (QPL)	Manufacturers list their LLLC equipment on the DLC QPL	Number of Manufacturers listed in the DLC QPL	Five additional manufacturers list their product on the DLC QPL by 2027
Impact	Lasting Change in the Accelerated Adoption of LLLC	Consistent recommendation and installation of LLLCs among Target Market	Surveys among Target Market Dodge Data	Market share of LLLC reached a level where a significant portion of the Early Majority have adopted LLLC

4 Energy Savings Framework

4.1 Natural Market Baseline

The Illinois TRM defines the natural market baseline (NMB) as a "forecast of the future in which no utility-funded energy-efficiency programmatic intervention exists."[8] Figure 4 depicts a theoretical NMB and includes labels of the curve's key components.

Figure 4 .Natural Market Baseline Curve Key Components



AIC leveraged this theoretical NMB curve and component list to develop a specific NMB for LLLCs in the AIC territory. The evaluation and determination of the key input variables are in this section of the Business Plan. For the development of the NMB for the LLLC MTI, the y-axis of the NMB curve is the percentage of total commercial-sector luminaires sold that include LLLCs in time *t*, as defined by the following equation:

[8] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0 Volume 4: Cross-Cutting Measures and Attachments, Attachment C, p 134 IL-TRM_Effective_010124_v12.0_Vol_4_X-Cutting_Measures_and_Attach_09222023_FINAL.pdf (ilsag.info)

Equation 1. Percentage of Total Luminaires Sold at a Point in Time

$$\frac{\%\ all\ luminaires\ sold\ with\ LLLCs(t)}{\%\ all\ luminaires\ sold\ (t)}$$

Note that the NMB illustrates the percentage of sales *in any given year*; it does not depict cumulative equipment saturation.

While all the NMB components shown in Figure 4 contribute to an understanding of LLLCs' projected market adoption, the key input variables are used directly in calculation of the NMB curve. The curve calculation is defined as:

Equation 2. Market Penetration

$$Market\ Penetration(t) = \frac{Maximum\ Market\ Share}{1 + Factor \wedge \left(\frac{Start\ of\ Hypergrowth + \left(\frac{RampPeriod}{2}\right) - Current\ Year(t)}{Ramp\ Period}\right)}$$

Each of the NMB components shown in Figure 4 are detailed individually in the following sections.

NMB Adoption Curve Shape (1)

Selected Value: S-curve

Rationale: This analysis assumes the market's adoption of LLLCs in the absence of utility intervention follows the widely accepted "S-curve" diffusion of innovation theory. Under this model, few LLLCs are sold early in the forecast, LLLCs sales gain momentum at the Start of Hypergrowth, LLLCs experience accelerated adoption during the Ramp Period, LLLC adoption decelerates at the Takeover Point, and LLLC adoption continues at a decreasing rate during the Takeover Period until LLLC adoption eventually reaches its Maximum Market Share.

Year Product Enters Market (2)

The Year Product Enters Market is the year that LLLCs became commercially available in Illinois.

Selected Value: 2016

Rationale: Recent primary LLLC research conducted for the Northwest Energy Efficiency Alliance (NEEA) found that LLLC availability and installations are driven by: a) building codes that favor LLLC installations, and b) the availability of incentives for LLLCs.[9] This research, which covered Idaho, Montana, Oregon, and Washington, stated that LLLCs were introduced in Oregon and Washington in 2012-2013, and in Idaho and Montana in 2015-2016. The researchers noted that LLLC introduction in Idaho and Montana lagged that in Oregon and Washington because building codes in Idaho and Montana lag building codes in Oregon and Washington. Since the timing of Illinois' adoption of IECC building code is aligned with Montana's timing, 2016 was selected as the most likely year when LLLCs entered the Illinois market.

Corroborating the 2016 selection for Illinois, note that Puget Sound Energy, a utility located in Washington state – which is often among the first states to adopt new codes and offer incentives for new technologies – initially piloted LLLCs in 2015.[10] Since Illinois has historically not been among the first states to adopt new building codes, it is unlikely that LLLCs were introduced in Illinois before 2015/2016.

Further evidence for LLLCs entering the Illinois market in 2016 is based on the timing of the first Networked Lighting Control (NLC) standards. DesignLights Consortium (DLC), a non-profit organization that develops and publishes up-to-date specifications for lighting technologies as part of its mission to promote high-performance commercial lighting, issued its first specification for NLCs – and explicitly included LLLCs (which are a subset of NLCs) – in May 2016. DLC used the 2016 NLC specifications to develop the first NLC Qualified Product List (QPL) in 2016. Utilities commonly rely on DLC's QPLs to specify equipment that qualifies for incentives, and the first utility rebates for NLCs based on DLC's QPL became available in 2017.

Forecast Start Year (3)

Selected Value: 2021

Rationale: The NMB forecast begins in 2021, the year AIC began its LLLC market transformation initiative.

Initial Market Share (4)

The Initial Market Share is the energy-efficient technology's portion of annual sales in the product category at the start of the forecast period.

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[9] Research Into Action and Energy 350. Luminaire Level Lighting Controls (LLLC) Market Characterization and Baseline Report. Prepared for Northwest Energy Efficiency Alliance. December 14, 2016.

[10] Puget Sound Energy. "The Future of Lighting is Here: PSE Achieves 72 Percent Energy Savings with Luminaire Level Lighting Controls."

Selected Value: 0.25%

Rationale: Although the Initial Market Share is not a required input to the market penetration equation shown above, it was determined that the market share at the start of the forecast could be used to verify the curve generated by the NMB equation. Two data sources were evaluated to calculate the initial market share for LLLCs in the AIC territory. Dodge data, which is a database of construction projects, was used to determine the percent penetration of LLLCs in construction projects in the AIC territory. For further verification of non-residential penetration of LLLCs, data from a Bonneville Power Authority study was evaluated.

The analysis of the Dodge construction data for projects within AIC's service area was performed on a sample set of 2019 projects with a 90/10 confidence interval .[11] 2019 Dodge data was used rather than data from the forecast start year of 2021, because it was recognized that 2021 data may not provide an appropriate estimate of the early LLLC market share due to COVID-19 pandemic-related supply shortages and capital restrictions in the construction market.

For Dodge data analysis of market penetration, the Initial Market Share was calculated using the following equation:

Equation 3. Initial Market Share Calculation

$$\frac{Project\ area\ covered\ by\ LLLCs\ (sqft)}{Total\ Area\ of\ all\ projects\ (sqft\ )}$$

The 2019 Dodge sample set included just one project with LLLCs and 51 projects that had no LLLCs. The total applicable square feet of the project with the LLLCs was 3,200 square feet. The total applicable square feet of new projects that did not include LLLCs was 1,292,152 square feet.

The 2019 Dodge Data project that used LLLCs had 32 LLLC units. Making a general assumption that each LLLC unit covers 100 sqft, the project area covered by LLLCs would be 3,200 (100 sqft * 32 LLLCs = 3,200 sqft). Using 3,200 sqft in the numerator of the above equation yields an initial market share of 0.25% with a 90/10 confidence interval.

A review of the Bonneville Power Administration's (BPA) distributor sales data for 2019 found that LLLCs were 0.44% of non-residential lighting sales in that year.[12] The awareness and adoption of LLLCs in BPA territory had been supported and influenced by the

[11] The Dodge Construction Network assembles a database of construction projects across the United States at every stage, from predesign to operation, including projects that are abandoned at any stage. The team's analysis included only cities and counties withing AIC's service area.
[12] Bonneville Power Administration. *Northwest Distributor Nonresidential Lighting Sales Data Collection, Aggregated Sales Data Spreadsheet*. July 29, 2022.

Northwest Energy Efficiency Alliance (NEEA) MTI in the BPA territory for several years prior to 2019, which can be assumed to have had an effect on the penetration rate identified in the BPA 2019 data. Since LLLCs have not had that type of influence or support in Illinois prior to 2019, the 2019 market share of LLLCs in AIC's service territory is likely to be less than the 0.44% identified in the BPA 2019 data.

Start of Hypergrowth (5)

The Start of Hypergrowth is the year in which a product's market share begins to accelerate, i.e., the first inflection year on the NMB curve.

Selected Value: 2030

Rationale: Research shows that LLLC adoption is most likely in areas where: 1) energy code explicitly identifies LLLCs as a compliance path, and 2) utility incentives are available.[13]

Illinois communities use the International Energy Conservation Code (IECC) to specify energy-efficiency codes and standards. IECC is updated every three years, though most Illinois communities have historically not adopted the latest IECC until several years after a new code has taken effect. As shown in Figure 5, most Illinois communities are currently using 2018 IECC, although a 2021 version is now available. LLLCs are, or are expected to be, explicitly included in some IECC versions, but not others:

- 2018 IECC: mentions LLLCs; has not resulted in high LLLC adoption.
- 2021 IECC: mentions LLLCs but is not in effect in AIC's service area; has not resulted in high LLLC adoption.
- 2024 IECC: expected to be technology agnostic and will not require new controls with new luminaires; therefore, unlikely to have a large effect on LLLC adoption.[14][15]

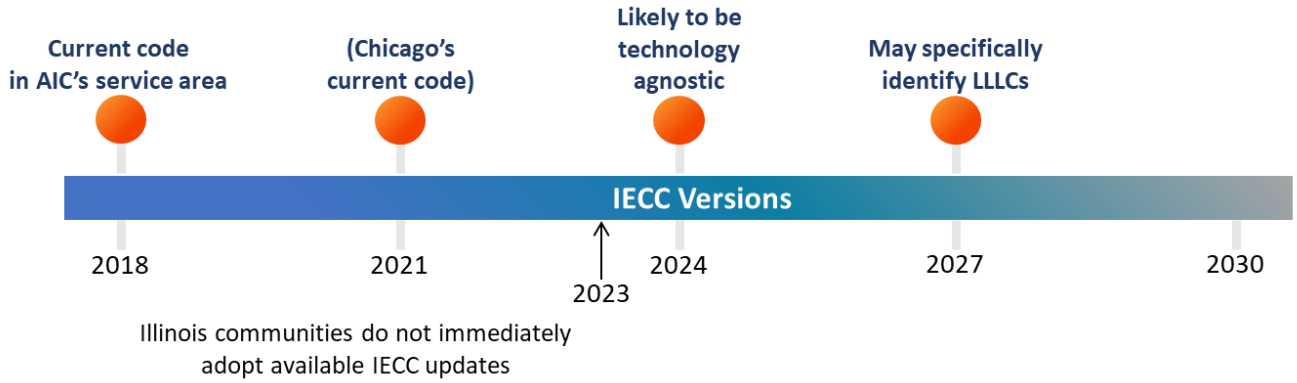
[13] The Cadmus Group and TRC Companies, Inc. *Luminaire Level Lighting Controls -- Market Progress Evaluation Report #1.* Report #E21-431. Prepared for Northwest Energy Efficiency Alliance. November 29, 2021.

[14] International Code Council. *Energy Complete Monograph: Code Changes and Public Comments to the 2022 IECC Commercial Public Comment Draft #1.* November 2022. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.iccsafe.org/wp-content/uploads/Commercial-PCD1-monograph-reduced.pdf

[15] New Buildings Institute's (NBI) proposal for new luminaires in alternations to have lighting controls that comply with current code requirements was *not* accepted. As a result, new luminaires can be controlled by old, even obsolete controls. See: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://newbuildings.org/wp-content/uploads/2022/02/IECC2024_LightingControlUpgradesinAlterations_NBI.pdf

- LLLC 2027: may go into effect in 2029 or 2030 and may explicitly mention LLLCs; therefore, LLLC 2027 could have a large effect on LLLC adoption starting around 2030 or 2031.

Figure 5. IECC Code Version Timeline



It is concluded that hypergrowth is likely to start in 2030. The conclusion that hypergrowth will not start in the near term is supported by research that found high numbers of recent LED luminaire retrofits are expected to slow adoption of LLLCs for 15 years.[16] That is, commercial customers who recently retrofit their lighting systems with LEDs are unlikely to retrofit these systems with LLLCs for several years or more.

The conclusion is also corroborated by NEEA's LLLC adoption curve which shows hypergrowth starting approximately 13 years after the introduction of LLLCs to the market.[17] Since it is estimated that LLLCs became commercially available in AIC's region in 2016, hypergrowth would be expected to begin around 2030.

Ramp Period (6)

The Ramp Period is the number of years between the start of hypergrowth and the takeover point.

- Start of Hypergrowth: when market adoption begins to rapidly accelerate, the first inflection year on the NMB curve, and
- Takeover Point: when market adoption begins to decelerate, the second inflection year on the NMB curve.

[16] DNV. *2020 C&I Lighting Market Characterization, Final Report*. Massachusetts Energy Efficiency Programs. Report No. MA20C09-E-LMC. April 23, 2021. https://ma-eeac.org/wp-content/uploads/MA20C09-E-LMC_LightingMarketCharacterization_FinalReport.pdf

[17] Research Into Action and Energy 350. *Luminaire Level Lighting Controls (LLLC) Market Characterization and Baseline Report*. Prepared for Northwest Energy Efficiency Alliance. December 14, 2016.

Selected Value: 14 years

Rationale: Because the projected Ramp Period for a new technology is highly speculative, researchers often estimate ramp periods based on the observed Ramp Periods of other products that have been commercially available for some time and that have similar characteristics and market barriers.

Earlier research into LLLC adoption estimated an LLLC Ramp Period of 14 years.[18] This analysis was based on an adoption curve for DALI lighting systems with photocells and occupancy sensors, which is a similar technology. Analysis of these alternate technologies is considered representative for these purposes and the 14-year ramp period is considered appropriate for the LLLC NMB.

Takeover Point (7)

The Takeover Point is the year when hypergrowth (aka the Ramp Period) ends—that is, when the market share of LLLCs decelerates and asymptotically begins approaching the Maximum Market Share.

Selected Value: 2044

Rationale: The Takeover Point is defined as:

Equation 4. Takeover Point

$$Takeover\ Point = Start\ of\ Hypergrowth + Ramp\ Period$$

Using the values for Start of Hypergrowth (#5) and Ramp Period (#6) from above, the Takeover Point is calculated to be 2030 + 14 years resulting in a 2044 takeover point.

Takeover Period (8)

The Takeover Period is the number of years from the Takeover Point until the Maximum Market Share (estimated in this analysis as the end of the forecast period).

Selected Value: 6 years

Rationale: Using a forecast end date of 2050, a Takeover Period of 6 years is established using the following equation:

Equation 5. Takeover Period

[18] Research Into Action and Energy 350. Luminaire Level Lighting Controls (LLLC) Market Characterization and Baseline Report. Prepared for Northwest Energy Efficiency Alliance. December 14, 2016.

$$Takeover\ Period = 2050 - 2044 = 6\ years$$

Maximum Market Share (9)

The Maximum Market Share is the greatest portion of annual sales in the product category that the energy-efficient product (LLLC) is expected to achieve maximum market adoption.

Selected Value: 40%

Rationale: Figure 6 depicts the logic approach to estimating the maximum market share of LLLCs. The derivation used the following steps:

a. LLLCs are an option only where LED lamps are installed (whether or not the LLLCs are installed at the same time as LEDs or as a fixture retrofit). The US Department of Energy (DOE) estimates that over half of the installed stock of commercial lighting installed is LEDs, and DOE forecasts that the saturation of LEDs in commercial buildings will continue to grow rapidly over the next 10 to 15 years so that the saturation will exceed 90% by 2035.[19] Since nearly all of the commercial lamps in AIC's service area will turn over in the next 15 years (according to the Illinois TRM, the deemed measure life of commercial lighting measures caps out at 15 years),[20] and the vast majority of new and replacement lamps will be LEDs, means that close to all commercial lighting—98%—will be eligible for LLLCs in 2038 (15 years from the date of this analysis) and beyond.

b. An estimated 75% of commercial customers will consider some type of NLCs.

c. Annual non-residential lighting sales data from Pacific Northwest distributors for 2013 and 2014, when NEEA had just begun supporting LLLCs, shows that LLLCs represented 58% of all NLC sales in the region.[21] Since the intention of this analysis is to estimate LLLC sales in the absence of any programmatic interventions, the figure was rounded downward from 58% to 50%.

d. Multiplying the factors from a., b., and c. together yields an estimated Maximum Market Share of 36.8%, which was rounded up to 40% as shown in Figure 6.

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[19] US Department of Energy, Office of Energy Efficiency and Renewable Energy. *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications.* December 2019. Projections based on Table 4.1.

[20] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency. Version 12.0 Volume 2: Commercial and Industrial Measures. Section 4.5.

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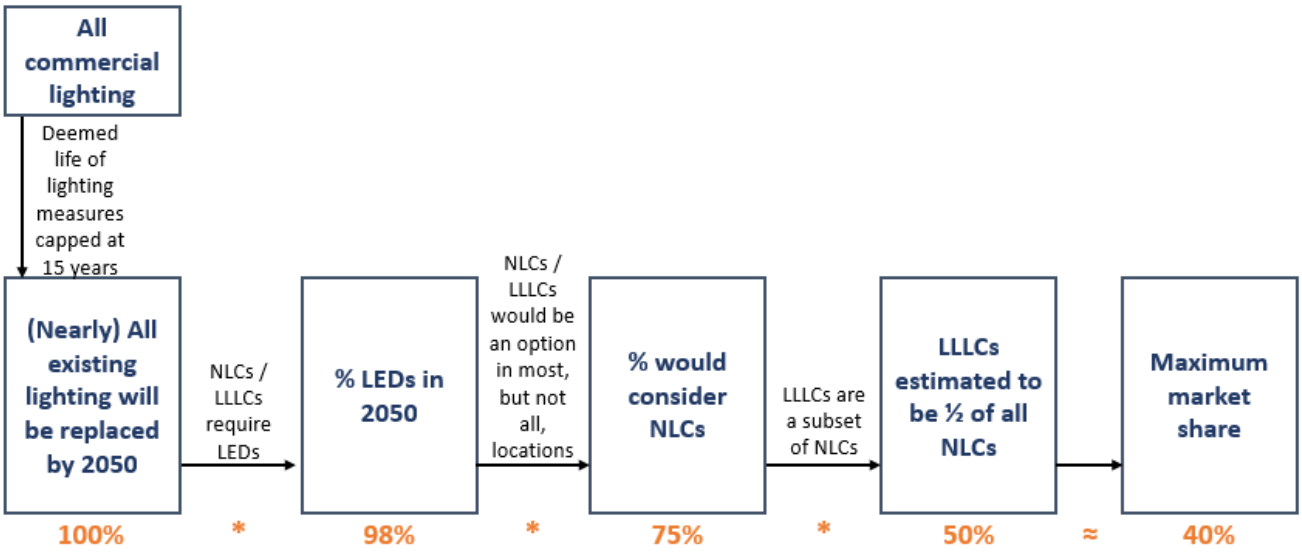
[21] Bonneville Power Administration. *Northwest Distributor Nonresidential Lighting Sales Data Collection, Aggregated Sales Data Spreadsheet*. July 29, 2022.

Figure 6. Derivation of Maximum Market Share



Factor (10)

The computed Factor value uses the following equation:

Equation 6. NMB Curve Factor

$$Factor = \frac{(Percent\ of\ Maximum\ Market\ Share\ at\ the\ time\ Hypergrowth\ ends)}{(Percent\ of\ Maximum\ Market\ Share\ at\ the\ time\ Hypergrowth\ begins)}$$

Selected Value: 81

Rationale: In the absence of any product-specific information, modelers can assume that Hypergrowth begins when the market share is 10% of the Maximum Market Share, and Hypergrowth ends (i.e., the Takeover Point occurs) when the market share is 90% of the Maximum Market Share. Using these values in the above equation yields $\frac{90^2}{10^2} = 81$.

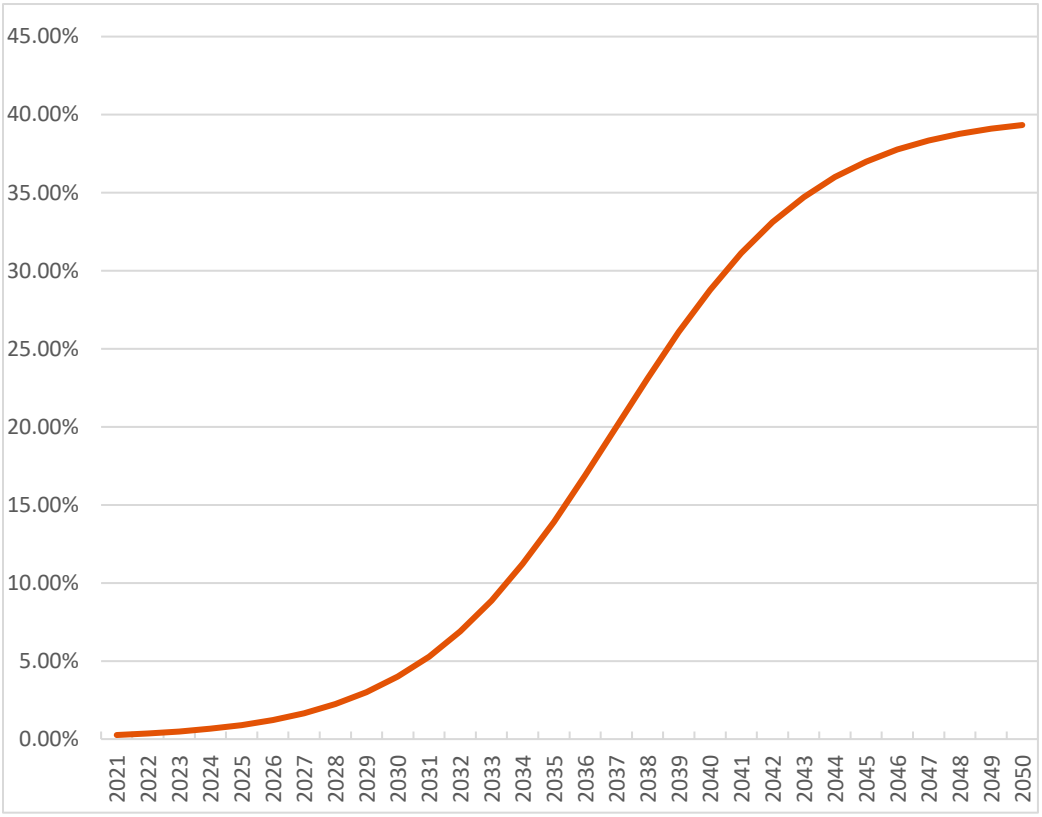
4.2 Natural Market Baseline Curve

The NMB curve that results from the inputs detailed above and summarized in Figure 4 is shown in Table 3. Figure 7 illustrates the resultant NMB curve.

Table 3. LLLC Natural Market Baseline Data Point

Year	Market Share	Year	Market Share
2021	0.26%	2036	16.89%
2022	0.36%	2037	20.00%
2023	0.49%	2038	23.11%
2024	0.66%	2039	26.08%
2025	0.90%	2040	28.78%
2026	1.23%	2041	31.13%
2027	1.66%	2042	33.11%
2028	2.24%	2043	34.72%
2029	3.00%	2044	36.00%
2030	4.00%	2045	37.00%
2031	5.28%	2046	37.76%
2032	6.89%	2047	38.34%
2033	8.87%	2048	38.77%
2034	11.22%	2049	39.10%
2035	13.92%	2050	39.34%

Figure 7. LLLC Natural Market Baseline Adoption Curve



4.3 Unit Energy Savings (UES)

The UES for networked lighting controls are largely prescribed by the IL TRM[22], but applications and fixture sizes impact the final savings. In order to apply a single UES for LLLCs across the range of facility types, applications, and fixture sizes, weighted energy savings values were used to derive a single UES that is representative of the luminaires and LLLCs in AIC's service territory. The following equation for calculating LLLC savings is from the TRM:

Equation 7. Savings per Unit of LLLC

[22] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0. Volume 2: Commercial and Industrial Measures, p 756 IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf (ilsag.info)

$$\Delta kWh = kW_{Controlled} * Hours * (ESF_{EE} - ESF_{Base}) * WHF_e$$

Much of the weighting was based on the prevalence of different building types in AIC's territory. This information was sourced from the September 2020 AIC Illinois Market Potential Study.[23] The six main building types in the Study were aligned with the commercial building types identified in the TRM. The categories and their associated building prevalence are detailed in Table 4.

Table 4. AIC Commercial Building Prevalence

Building Type	Floor Area (Million Sqft)	Building Prevalence
Education	134.7	12%
Office	169.2	15%
Retail	168.9	15%
Warehouse	352.8	31%
Health	75.6	7%
Unknown	223.7	20%
		100%

kW Controlled

The TRM has two deemed "classes" of kW Controlled categories based on how much light output, in lumens (lm), of a fixture. Those two categories are greater than 10,000 lm and less than 10,000 lm. The category of fixtures that are greater than 10,000 lm were identified as high-bay lighting fixtures. A two-step analysis was performed to separate the LLLC use cases for this MTI into the two kW Controlled categories.

The first step was to determine the fixture prevalence within each building type. Analysis revealed that across *all* building types, 75% of fixtures were < 10,000 lm and 25% of fixtures were ≥ 10,000 lm.

Second, each building type was weighted by its prevalence within AIC service territory, which determined that across all buildings, 62% of fixtures were < 10,000 lm and 38% of fixtures were ≥ 10,000 lm.

[23]AIC Illinois Market Potential Study Preliminary Potential Estimates. https://www.ilsag.info/wp-content/uploads/AIC-MPS_Prelim.-Electricity-Potential-for-SAG_09-02-2020.pdf

Table 5. Fixture Prevalence by Building Type, Weighted by Building Prevalence

Building Type	% luminaires: < 10k lm	% luminaires: ≥ 10k lm	Building Prevalence	Weighted: < 10k lm	Weighted: ≥ 10k lm
Education	90%	10%	12%	10.8%	1.2%
Office	90%	10%	15%	13.5%	1.5%
Retail	90%	10%	15%	13.5%	1.5%
Warehouse	5%	95%	31%	1.6%	29.5%
Health	95%	5%	7%	6.7%	0.4%
Unknown	80%	20%	20%	16.0%	4.0%
Average	75%	25%		**62.0%**	**38.0%**

Lastly, the 62% and 38% values were used to weight the TRM prescribed values for kW Controlled (see Table 6 below).

Table 6. Weighted kW Connect Power of LLLCs in AIC Territory

Control Type	kW Controlled[24]	Fixture Prevalence	Weighted kW Controlled
< 10,000 lm	0.031	62%	0.1922
≥ 10,000 lm	0.118	38%	0.04484
			0.06406

Hours

The TRM prescribes lighting hours of operating by building type. Four building types (Education, Office, Retail, Warehouse) have operating hours found in section 4.5.10 (Lighting Controls). Two building types (Health, Unknown) have operating hours found in the large table in section 4.5 (Lighting End Use, pages 756-757).

[24] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0. Volume 2: Commercial and Industrial Measures, p 756 - 757
IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf (ilsag.info)

Hours of operation for the single UES was based on operating hours details in the TRM, weighted against the percent prevalence of that building type category in the AIC territory. The resulting weighted hours of operation is detailed in 7.

Table 7. Weighted Operating Hours for LLLCs in AIC Territory

Building Type	Hours[25]	Building Prevalence	Weighted Hours
Education	4231	12%	508
Office	4453	15%	668
Retail	6936	15%	1040
Warehouse	5116	31%	1586
Health	7036	7%	493
Unknown	3379	20%	676
			4970

Energy Savings Factor

The TRM prescribes the Energy Savings Factor (ESF) of "Interior Networked Luminaire-Level Lighting Controls as 61%. It also notes that the ESF of the baseline should be 0 if there are no lighting controls or "prior existence of lighting controls [are] unknown." Therefore, the Energy Savings Factor is determined as 00.61-0 = **0.61**.

Waste Heat Factor

The TRM prescribes Waste Heat Factor (WHF) by building type in the large table in Section 4.5 (Lighting End Use). As with the other parts of the equation, the values were weighted by the prevalence of each building type in AIC territory.

Table 8. Weighted WHF of LLLCs in AIC Territory

Building Type	WHF[26]	Building Prevalence	Weighted WHF
Education	1.10	12%	0.13
Office	1.12	15%	0.17

[25] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0. Volume 2: Commercial and Industrial Measures, p 757
IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf (ilsag.info)
[26] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0. Volume 2: Commercial and Industrial Measures, p 683 - 684
IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf (ilsag.info)

Retail	1.08	15%	0.16
Warehouse	1.02	31%	0.32
Health	1.15	7%	0.08
Unknown	1.08	20%	0.22
			1.07

4.4 Total Unit Energy Savings

Using the AIC territory-based weighted values calculated in this section, and highlighted in yellow, the TRM-prescribed calculation for LLLC energy savings can be calculated as detailed in Equation 8, resulting in a weighted annual energy savings from any single LLLC installed in AIC service territory of 207.8 kWh.

Equation 8. Actual Unit Savings per LLLC in AIC Territory

$$207.8\ kWh = 0.06406\ kW * 4970\ Hours * 0.61 * 1.07$$

4.5 Luminaire Sales in AIC Territory

Both the market share and the market uplift from MT are grounded in market share percentage, defined as:

Equation 9. Market Share Percentage

$$\frac{\%\ all\ luminaires\ sold\ with\ LLLCs(t)}{\%\ all\ luminaires\ sold\ (t)}$$

After defining the LLLC market share, the value was multiplied by the total lighting sales in AIC's service territory in each year to derive the total annual number of LLLCs sold in the service area. Since historical data for total lighting sales was not available, a methodology was developed to estimate total sales. The methodology for calculating total sales was corroborated with an alternative utility publication to ensure confidence in the value. Total luminaire sales can be used in Equation 10 to identify the total number of LLLC sales for any given year.

Equation 10. Calculation of Number of LLLCs in AIC Territory

$$Number\ of\ LLLCs(t) = LLLC\ Market\ Share\ \%(t) * Total\ luminaire\ sales(t)$$

Methodology for Calculating Total LLLC Sales

The methodology for deriving total luminaire sales per year values for the following four variables:

1. Total commercial square footage in AIC territory for each year of the forecast
2. Commercial and new construction and renovation/replacement rates
3. Average sqft per luminaire
4. The total number of fixtures sold in each year.

Total Commercial Square Footage in AIC's Service Area (1)

AIC's commercial market is characterized in the 2020 AIC Potential Study.[27] The study found that AIC's total commercial floor space in 2020 was 1,124,900,000 sqft. The Commercial Buildings Energy Consumption Survey (CBECS)[28] from the US Energy Information Administration (EIA) shows national trends in commercial space over the last 40 years. The study shows that total commercial floor space increased from around 51 billion sqft in 1979 to over 96 billion sqft by 2018. Using the EIA data, a linear forecast was created from 1979 to 2050 (the end of the LLLC NMB range) to determine the average annual growth rate of 0.86%. The forecast used all CBECS data points normalized over time. The growth rate was applied to AIC's known square footage to create a square footage forecast through 2030, as shown in Table 9.

Table 9. Estimated Commercial Floorspace in AIC Territory

Year	Total Sqft
2022	1,144,331,478
2023	1,154,172,728
2024	1,164,098,614
2025	1,174,109,862
2026	1,184,207,207
2027	1,194,391,389
2028	1,204,663,155
2029	1,215,023,258
2030	1,225,472,458

[27] AIC Illinois Market Potential Study Preliminary Potential Estimates. https://www.ilsag.info/wp-content/uploads/AIC-MPS_Prelim.-Electricity-Potential-for-SAG_09-02-2020.pdf
[28] 2018 Commercial Buildings Energy Consumption Survey. Building Characteristics Highlights. https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf

New Construction and Renovation/Replacement Square Footage (2)

The number of LLLC-eligible luminaires per year is contingent on the total number of luminaires added to or replaced in AIC's service area per year which, in turn, is contingent on the annual square footage of commercial new construction and the annual square footage of commercial space undergoing renovation/replacement.

New construction square footage in each year (time "t") is calculated as:

Equation 11. New Construction Square Footage Area

$$New\ Construction\ sqft(t) = Commercial\ sqft(t) - Commercial\ sqft(t-1)$$

Renovation and replacement areas by year are calculated using the industry-accepted assumptions that: (1) equipment is replaced at the end of its useful life, and (2) equipment turn-over is evenly paced (i.e., that 1/N widgets are replaced each year, where N = the deemed useful life of the widget), we estimated renovation/replacement square footage in each year (time "t") as:

Equation 12. Renovation and Replacement Square Footage for Luminaires

$$Renovation/Replacement\ sqft(t) = Commercial\ sqft(t)/13$$

where 13 = average deemed useful life of commercial luminaires.[29]

Table 10 details estimated annual new construction and renovation/replacement values over time. Notably, the methodology employed is similar to the approach DOE used in its Energy Savings Forecast for SSL.[30]

[29] 2024 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 12.0, Volume 2: Commercial and Industrial Measures, IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf (ilsag.info) Nonresidential luminaires have deemed lives depend on operating hours and generally range from 12 to 15 years.

[30] Energy Savings Forecast of Solid State Lighting in General Illumination Applications. December 2019. https://www.energy.gov/sites/default/files/2020/02/f72/2019_ssl-energy-savings-forecast.pdf

Table 10. Estimated Changing Commercial Floorspace in AIC Territory by Type

Year	New Construction (Sqft)	Renovation/Replacement (Sqft)
2022	9,757,338	85,048,840
2023	9,841,251	85,786,605
2024	9,925,885	86,530,769
2025	10,011,248	87,274,934
2026	10,097,345	88,025,498
2027	10,184,182	88,782,518
2028	10,271,766	89,546,047
2029	10,360,103	90,316,143
2030	10,449,200	91,092,862

Average Square Foot per Luminaire (3)

The next step in this analysis was to determine the square footage covered per luminaire. The area will be the same regardless of whether the luminaire is equipped with an LLLC. As with the UES analysis described above, the AIC-specific building-type prevalence weightings were used to ensure the results would be tailored to AIC's service area.

Steve Mesh (Principal, Lighting Education and Design) created sample lighting designs for multiple building types, and developed small (10,000 sqft), medium (20,000 sqft), and large (30,000 sqft) designs for each building type. When sqft/fixture differed between sizes, the average values were used across the building type.

Figure 8. Example Warehouse Lighting Design Developed by Steve Mesh

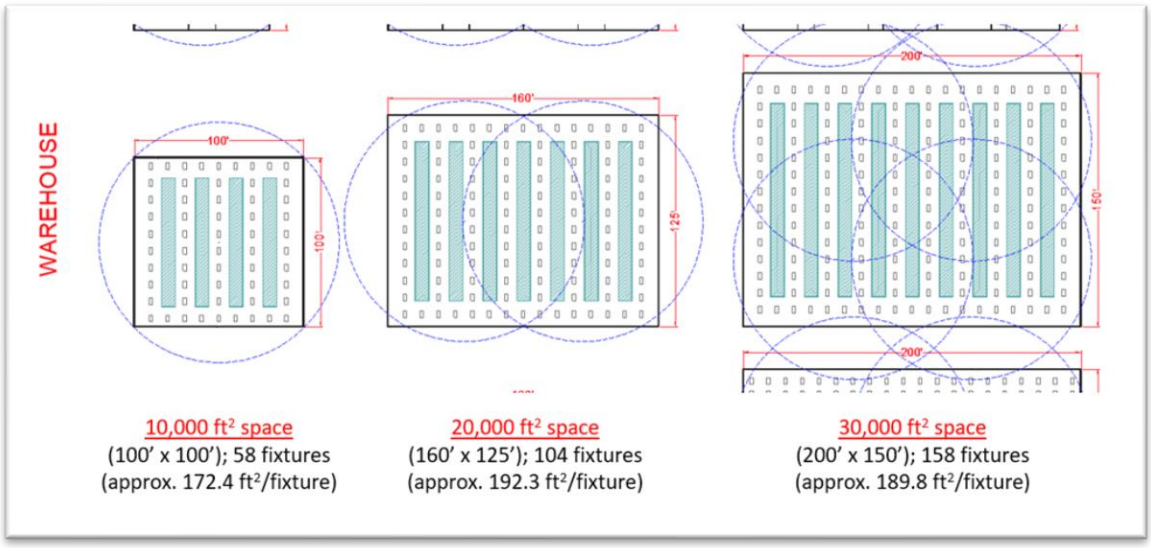


Table 11. Weighted Square Footage per Luminaire Fixture

Building Type	Sqft/fixture	Building Prevalence	Weighted Sqft/fixture
Education	113	12%	13.6
Office	83	15%	12.5
Retail	120	15%	18.0
Warehouse	185	31%	57.4
Health	73	7%	5.1
Unknown	150	20%	30.0
			136

Total Fixtures Sold (4)

Once the total square footage for both new construction and renovation/replacement were determined, as well as the average sqft/luminaire, a calculation of the total number of luminaires sold in AIC's service area in each forecast year can be made where:

Equation 13. Total Luminaire Sales

$$Total\ luminare\ sales(t) = New\ construction\ luminaire\ sales\ (t) + Renovation\ and\ Replacement\ luminaire\ sales\ (t)$$

Table 12. Estimated Total Luminaires Sold in AIC Territory

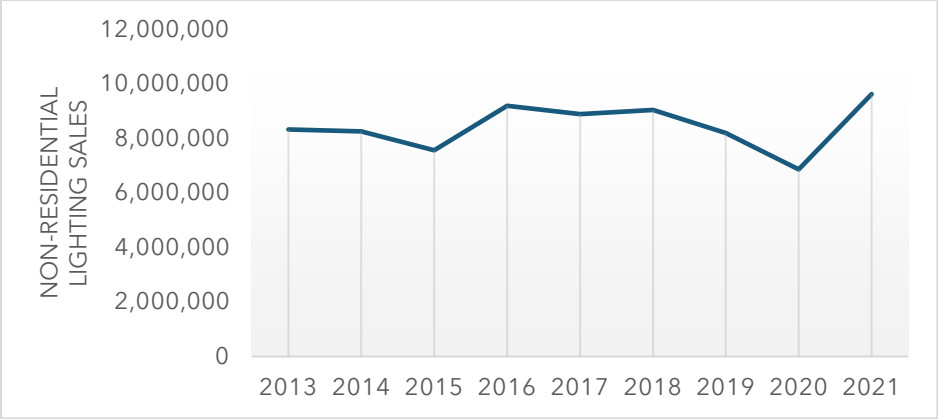
Year	# of Luminaires Sold
2022	718,991
2023	725,175
2024	731,411
2025	737,701
2026	744,046
2027	750,444
2028	756,898
2029	763,408
2030	769,973

Corroboration of Calculated Total LLLC Sales

The nonresidential distributor luminaire sales data from Bonneville Power Authority in the Pacific Northwest was used to corroborate the above calculated total sales values. BPA nonresidential luminaire sales data from regional distributors that is available for the 2013-2021 time period were used. Figure 9 illustrates nonresidential luminaire sales in the Pacific Northwest.[31]

[31] *BPA. Lighting Market Research. https://www.bpa.gov/energy-and-services/efficiency/market-research-and-momentum-savings/lighting-market-research*

Figure 9. Original BPA Sales Figures

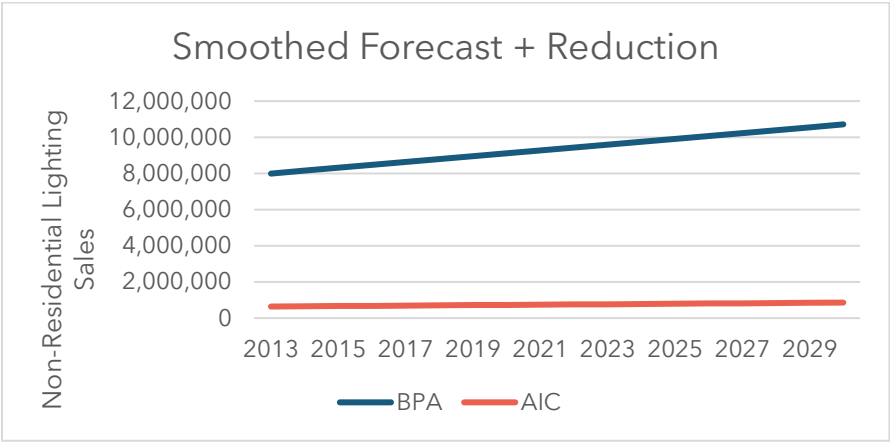


BPA. Lighting Market Research. https://www.bpa.gov/energy-and-services/efficiency/market-research-and-momentum-savings/lighting-market-research

The BPA distributor data show actual sales trends that include exogenous economic realities such as supply chain shortages caused by the COVID-19 global pandemic. Because the pertinent AIC territory forecast will not include such highly unusual influences on expected sales, the BPA's 2013-2030 sales data was normalized so that the forecast developed a projection that does not include "blips" due to the pandemic (see Figure 10).

Since AIC's service territory is much smaller than the entire Pacific Northwest service area that the BPA distributor sales data represents, it is necessary to scale BPA's sales data to AIC's territory. Comparing commercial sector energy (MWh) sales for AIC to commercial energy sales for Pacific Northwest utilities, AIC is approximately 8% of the size of the Pacific Northwest. Figure 8 illustrates the resulting luminaire sales estimates for BPA and AIC.

Figure 10. Smoothed Forecast and Reduction



When comparing the estimated total luminaire sales in AIC's service territory derived using the first methodology (as shown in Table 12) to those shown above (in Figure 10) over the 2013 to 2030 timeframe, the estimates varied by only 1% - 11%. Applying both evaluations to the calculation increases the degree of confidence in the AIC sales projections.

4.6 Natural Market Baseline Savings Forecast

To estimate the number of LLLCs attributable to the natural market baseline, the total number of luminaires sold in each year can be multiplied by the estimated NMB LLLC market share in that year (Table 3):

Equation 14. Total Number of LLLC Sales in AIC Territory Accounted for in the NMB

$$Number\ of\ NMB\ LLLCs(t) = NMB\ Market\ Share\ \%(t) * Total\ luminaire\ sales(t)$$

The UES can be applied to the total NMB LLLC sales to determine the expected baseline savings within AIC's service territory from LLLCs installed without utility intervention. This establishes the baseline that will be subtracted from total market sales (or savings) to derive sales (or savings) attributable to the AIC LLLC MTI.

Table 13. NMB Market Share, Number of LLLCs, and Energy Savings Estimates

Year	NMB Market Share	# LLLCs	kWh Savings
2022	0.36%	2,588	537,801
2023	0.49%	3,553	738,333
2024	0.66%	4,827	1,003,077
2025	0.90%	6,639	1,379,620
2026	1.23%	9,152	1,901,835
2027	1.66%	12,457	2,588,633
2028	2.24%	16,955	3,523,341
2029	3.00%	22,902	4,759,160
2030	4.00%	30,799	6,400,200

4.7 Market Transformation Savings Forecast

Similar to the approach used to estimate the number of LLLCs attributable to the baseline, the number of LLLC attributable to the LLLC MTI was estimated by multiplying the total

number of luminaires sold in each year by the estimated "uplift" attributable to AIC's MTI activities. The following equation can be applied:

Equation 15. Total Number of LLLC Sales in AIC Territory Attributed to the LLLC MTI

$$Number\ of\ MT\ LLLCs(t) = MT\ Uplift\ \%(t) * Total\ luminaire\ sales(t)$$

The "market uplift" attributable to MT activities was forecasted using a combination of findings from AIC's 2023 LLLC baseline survey, lighting distributor and installer participation at AIC-sponsored LLLC training events in 2022 and 2023, diffusion, and other industry sources.[32] The MT market uplift calculations relied on the following three variables:

A. Percent of trade allies who are familiar with LLLCs
B. Percent of additional projects where trade allies, who are familiar with LLLCs, will recommend LLLCs to customers (recommendations occur as a result of AIC-sponsored LLLC training and other MTI outreach and educational activities)
C. Percent of customers who would be willing to buy/install LLLCs

The uplift attributable to MT is calculated as the summation of percent values of the three market variables A, B, and C.

Drawing on a combination of findings from the baseline study and an analysis of regional trade ally representation at AIC trainings, it was determined that just over 4% of trade allies are familiar with LLLCs. Recognizing that AIC anticipates continuing its in-person and online trade ally training, develop and disseminate additional program collateral, and enhance engagement with distributors and manufacturers in coming years, it is expected that increasing percentages of area trade allies will become familiar with LLLCs in the coming years. The initial trade ally familiarity percentage was increased by 2.5% - 5.0% per year, based on AIC's anticipated future LLLC MTI activities, and an estimated 12% of trade allies in the region will be very familiar with LLLCs by 2030.[33]

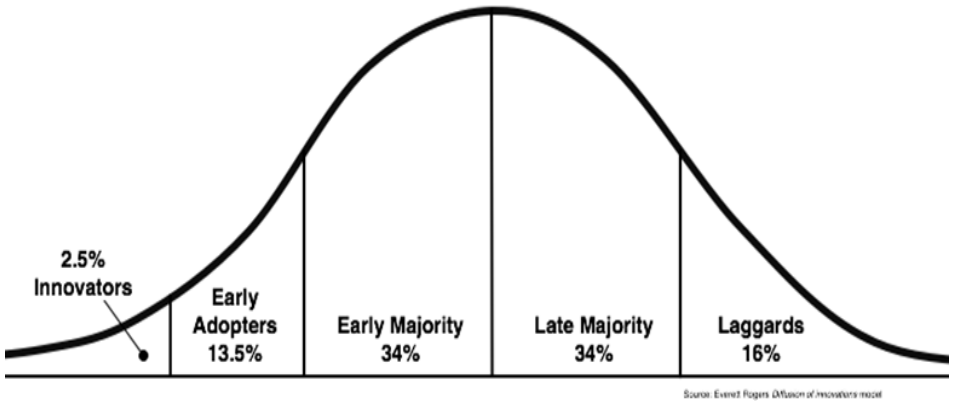
The analysis of AIC's 2022 post-LLLC trade ally training survey concluded that trade allies recommended LLLCs to customers 21% more often than they did before the training, and this value was used for 2022.[34] In other market transformation research, NEEA estimated

[32] Opinion Dynamics. "2023 Luminaire Level Lighting Controls Pilot, Customer and Trade Ally Baseline Survey Findings." Prepared for Ameren Illinois Company. September 7, 2023.
[33] Note that AIC's LLLC MT activities for 2024 and beyond are currently under development. As a result, the estimated affect that AIC's market efforts will have on LLLC uptake are subject to change based on AIC's future LLLC MT activities.
[34] The RI team acknowledges that the number of respondents to the 2022 post-training survey was extremely small and certainly not statistically significant. We will update this value and the subsequent analysis once additional data become available.

that training resulted in (trained) trade allies recommending an efficient technology 40% more often after five years of market intervention than they had prior to the intervention.[35] It is assumed that 40% of lighting trade allies will be recommending LLLCs by 2027 (five years after AIC began trade ally trainings). For the years between 2022 and 2027 the percentage of (trained) trade allies who will recommend LLLCs was straight-lined; for 2028 to 2030, the Excel forecasting function was used to estimate the appropriate percentage of trade allies, ending with just over 51% of (trained) trade allies in 2030.

Finally, diffusion theory was applied to estimate the percentage of customers (of those who will learn about them through trained trade allies and other means) who will be willing to adopt LLLCs in each year. As depicted in Figure 11, diffusion theory deems 2.5% of the market as "innovators" who are the earliest adopters of new technologies. It was estimated that 2.5% of customers would be willing to install LLLCs in 2022. Diffusion theory deems another 13.5% of the market as "early adopters" of new technologies. Since the NMB analysis concluded that LLLCs will begin to experience hypergrowth starting in 2030, it is anticipated that 16% of customers (=2.5% + 13.5%) will be willing to install LLLCs by 2030. A straight-line approach was used to estimate the percentage of customers willing to install LLLCs in the years between 2022 and 2030.

Figure 11. Diffusion Theory Technology Adopter Categories



Combining these variables, the estimated market uplift from AIC's LLLC initiative from 2022 to 2030 is shown in Table 14.

[35] Northwest Energy Efficiency Alliance. *Northwest Heat Pump Water Heater Initiative Market Progress Evaluation Report #5.* Prepared by NMR Group. November 4, 2019.

Table 14. Estimated % MT Uplift

Year	% Market Uplift	# LLLCs	kWh Savings
2022	0.09%	629	130,731
2023	0.17%	1,212	251,777
2024	0.27%	1,989	413,235
2025	0.53%	3,941	819,031
2026	0.81%	6,033	1,253,669
2027	1.24%	9,301	1,932,850
2028	1.92%	14,549	3,023,241
2029	3.43%	26,154	5,434,751
2030	6.03%	46,411	9,644,212

4.8 Savings Summary

Figure 12 and Figure 13 illustrate the forecasts of NMB and MT units sold and savings respectively, through 2030. As expected for any MT initiative, where the aim is to fundamentally alter the existing market by investing resources (largely upstream) early on while recognizing that such investments will yield substantial results in later years, the savings attributable to AIC's LLLC MTI is relatively modest through 2030.

Figure 12. LLLC MT Program Forecast: Units Sold

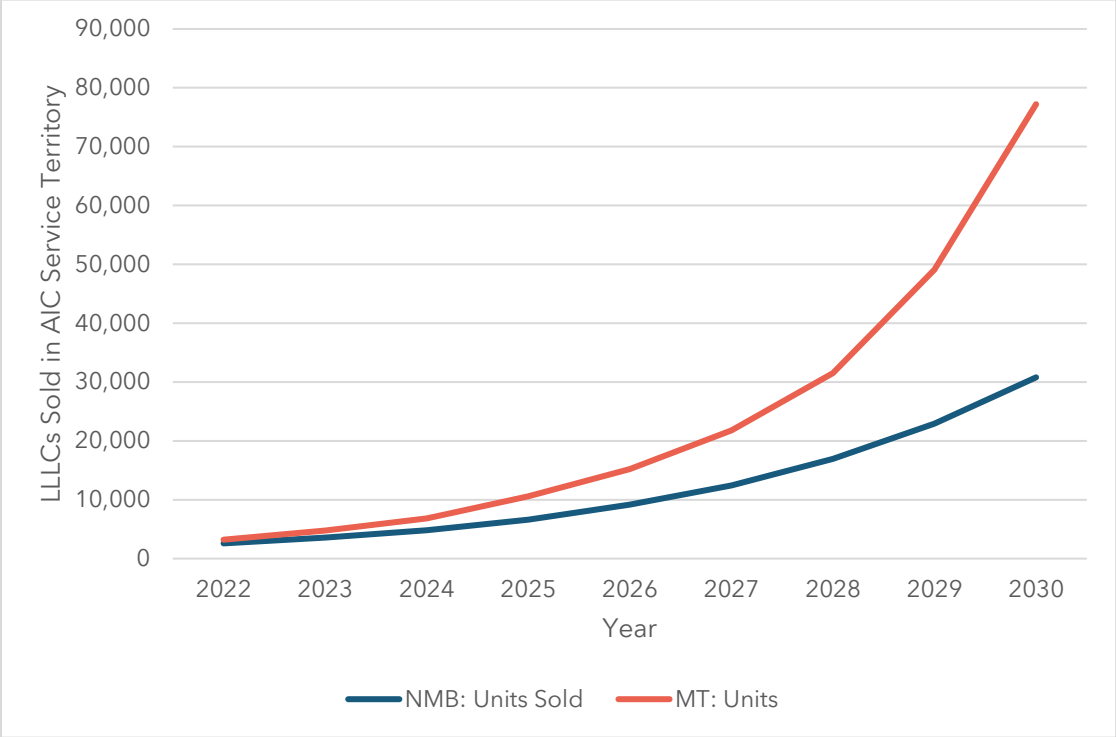
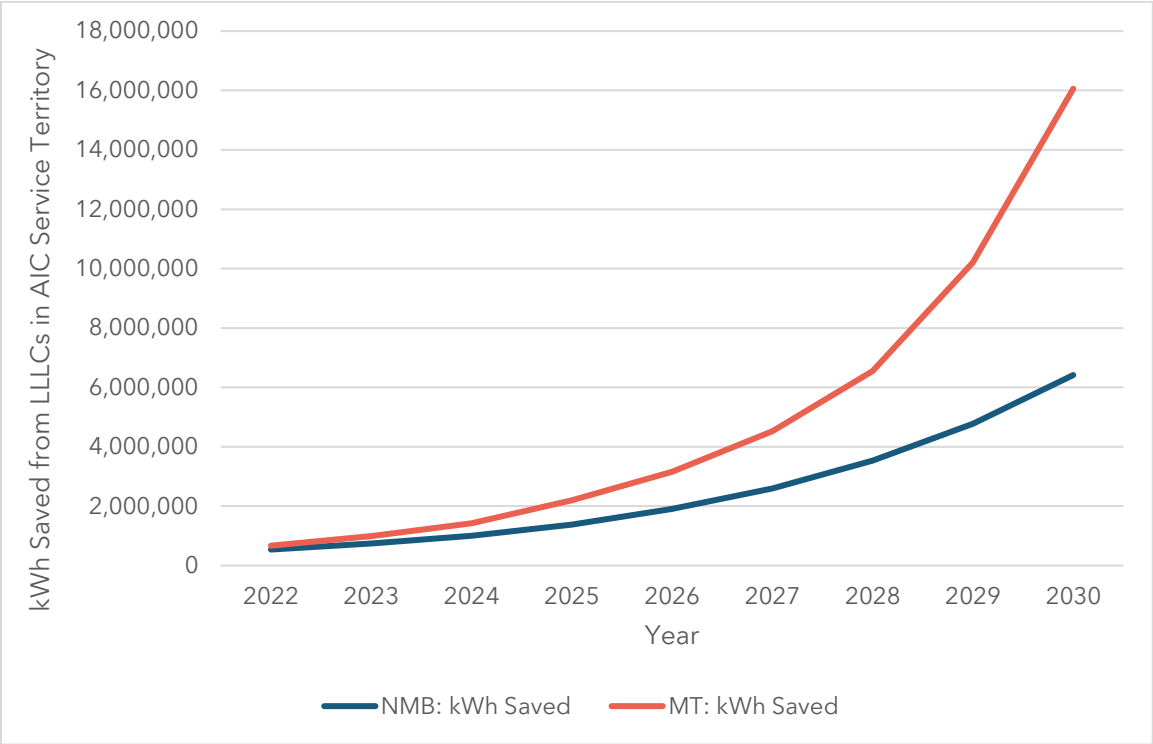


Figure 13. LLLC MT Program Forecast: kWh Saved



5 Evaluation Plan

Evaluation is necessary for measuring the progress and impact of any MTI. Based on the LM, ODC developed an evaluation plan that includes surveys among the target market to assess progress per the MPIs.

5.1 Key Research Objectives

AIC's annual evaluations will include both process and impact components. Each evaluation will address the following key objectives:

- Describe how the pilot was implemented.
- Explore areas for pilot improvement, including increasing its overall effectiveness and ease of implementation.
- Measure the amount of knowledge gained from the LLLC training and determine if an increase in recommendations of LLLCs to clients occurred.

- Assess annual levels of awareness and understanding of LLLCs among market actors.
- Measure how the market share of LLLCs shifted over the evaluation period.
- Estimate energy savings associated with the LLLC market transformation initiative.

5.2 Evaluation Tasks

Table 15 summarizes the evaluation activities planned for the Pilot over the three-year evaluation plan period.

Table 15. LLLC Pilot Evaluation Activities – 2024-2026

Activity	2024	2025	2026
Pilot Materials Review	✓	✓	✓
Pre- and Post-Training Assessments with Program Allies	✓	✓	✓
Market Actor Surveys (Market-Level Measurement)	✓	✓	✓
MPI Assessments	✓	✓	✓
Monitor Lighting Market	✓	✓	✓
Revisit NMB and Assumptions			✓
NLC and LLLC Sales Data Analysis	✓	✓	✓
Mid-Year Data Analytics	✓	✓	✓
Estimation of Market Transformation Savings	✓	✓	✓

The rationale for these activities is as follows:

- 2024: In the third year of the LLLC Pilot, evaluation will complete a number of core activities designed to begin measuring any progress towards market transformation goals. As such, evaluation will begin to provide assessments on the short-term MPIs specified in the program theory and LM, collect total market unit data, and calculate total market savings under the current NMB assumptions.

- 2025 through 2026: Evaluation will continue to conduct core research to support annual impact and process evaluations. However, as the pilot matures, broader shifts are expected in the lighting controls market. As such, evaluation will focus more activities on estimating the pilot's market transformation impacts. In 2025 evaluation will revisit the NMB to determine whether the forecast and trends developed in 2023 are still accurate and appropriate for savings calculations.

The tasks for the evaluation are detailed below.

5.3 Pilot Materials Review

Evaluation will include an annual, comprehensive review of all pilot materials. Materials include implementation plans, LM, MPIs, marketing plans, materials provided to participating trade allies, as well as mass marketing materials. Evaluation will work closely with the implementation team to request all related materials as they become available throughout the year. Review of these materials will inform the process evaluation, allowing the evaluation team to document the design and implementation of the LLLC Pilot each year, and to assess how pilot activities may shift the lighting controls market in future years.

5.4 Training Assessments with Trade Allies

Evaluation will include annual surveys and interviews with program allies that enroll in the LLLC Pilot training sessions. There will be three rounds of assessments with training participants—that is, surveys/interviews before participating in the trainings, immediately after, and several months after the training sessions. The goals for each round are as follows:

- Pre-training assessments –Develop a baseline estimate for trade allies' understanding of the LLLC technology prior to participating in the training.

- Immediate post-training assessments – Assess trade allies' reactions to and satisfaction with the training. These surveys will also inform the assessment of MPI V (i.e., increased number of trained contractors/installers).

- Post-training assessments – Assess changes in behavior and activity around LLLCs several months after trade allies' participation in training. These surveys will provide valuable data points for the assessment of MPI III (i.e., increased recommendations of LLLC to customers from trade allies contacted by the pilot), and MPI IV (i.e., increased installations of LLLCs to customers among outreached trade allies).

Results from these post-training interviews will highlight if and how pilot activities may begin to shift the lighting controls market in future years.

5.5 Market Actor Surveys (Market-level Measurement)

Evaluation will include two separate annual surveys with samples of end users who did not receive incentives through the LLLC Pilot and trade allies who did not participate in any of the trainings nor receive incentives for selling LLLCs to end users. Findings from these

surveys will enable the development of current estimates of awareness and familiarity with LLLC technology among key populations (MPI I and MPI II), savings potential of LLLCs, and non-energy benefits among nonresidential building owners, property managers, decision-makers, lighting sellers, and lighting installers. Findings from surveys will facilitate developing estimates of recommendation/installation prevalence (MP IIII and MPI IV).

These surveys will be repeated annually over the course of the program to build a base of evidence for shifts in the lighting controls market that may be attributable to the LLLC Pilot. Each year, the surveys will use a random sampling approach. Evaluation will target a sample of trade allies using stratified random sampling; stratifying by whether the contact is considered a distributor or installer.

Evaluation includes designing a sample from the population of end users and trade allies to target a total of 350 completes from end users and 50 completes from trade allies. This approach allows the separation of each population into two groups; evaluation will avoid reaching out to the exact same sample every year to encourage higher response rates.

5.6 MPI Assessments

Each year, the evaluation will analyze the pre- and post-training assessments and the market actor surveys to provide directional evidence of attributable efforts from and compare the MPI estimates to targets set by RI and AIC.

Through 2026, the evaluation activities will focus on the short- and mid-term MPIs (MPI I through MPI V). Beginning in 2027, there will be additional focus on MPI VI and MPI VII to begin measuring progress toward long-term goals.

5.7 Monitor Lighting Market

Each evaluation year, the evaluation activity will include secondary research to track LLLC market activity, both locally and nationally. This enables AIC to stay up to date on LLLC technology advancements, the inclusion of LLLCs in codes and standards, and the support of LLLCs from other entities that may influence the AIC market. This is valuable information that can be used to inform any attribution discussions, revisions to the NMB, or revisions to unit-level savings estimates. This research includes reviewing key assumptions that inform the NMB forecast.

5.8 Revisit NMB and Assumptions

In 2026, evaluation efforts will include revisiting the NMB and the related assumptions as the Illinois Technical Reference Manual (IL-TRM) Attachment C notes the importance of tracking the baseline forecast periodically to assess the progress of the program and the target market. As part of this effort, evaluation will include an expert panel review of the NMB.

Expert judgement panels, often referred to as Delphi panels, are based on the principle that structured responses from experts, informed by the responses of their peers, may lead to more accurate results than unstructured responses without the benefit of iterative feedback. As part of a detailed NMB review, the evaluation team will facilitate a Delphi panel to assess the accuracy of the key NMB inputs and assumptions that drive the NMB market adoption curve. These inputs include, but are not limited to, the following:

- Maximum market share for LLLCs
- Start of the hypergrowth period
- Ramp period length

As part of this process, evaluation efforts include developing a questionnaire and evidence packet for review by the panelists. The evidence packet will include relevant sales data, secondary research, and survey results for review by the panelists. The Delphi panel will include two separate rounds of questioning. In the first round, panelists will be asked to answer key questions about the NMB and program attribution. In the second round, panelists will be presented with the same questions and the anonymous responses of other panel members. Each panelist will be asked to review the responses, logic, and rationale of their fellow panel members and will then be asked to revise their initial responses. Panelists will not be required to revise their initial responses, but they will be given the opportunity to do so after considering the responses of others.

The evaluation team will work closely with AIC and RI to develop a list of potential panel participants. The goal will be to develop a well-rounded panel of local and national experts familiar with the commercial lighting market, LLLCs, and/or market transformation programs.

5.9 NLC and LLLC Sales Data Analysis

Evaluation activities include using secondary data to analyze lighting market sales data annually, to calculate the total market units of LLLCs in Illinois.[36] Evaluation will also use the

[36] Advance Market Analytics. United States Commercial Lighting Market Data Set.

IL-TRM to determine LLLC Unit Energy Savings (UES). Equation 16 and Equation 17 provide the current IL-TRM algorithms for LLLCs.[37]

Equation 16. IL-TRM V11.0 LLLC Electric Energy Savings Algorithm

$$\Delta kWh = KW_{Controlled} * Hours * (ESF_{EE} - ESF_{Base}) * WHF_e$$

Equation 17. IL-TRM V11.0 LLLC Summer Coincident Peak Demand Savings Algorithm

$$\Delta kW = KW_{Controlled} * WHF_d * (CF_{baseline} - CF_{LC})$$

Where:

$KW_{Controlled}$ = Total lighting load connected to the control in kilowatts.

$Hours$ = Total operating hours of the controlled lighting circuit before the lighting controls are installed.

ESF_{EE} = Energy Savings Factor (represents the percentage reduction to the operating Hours from the non-controlled lighting system) from the new lighting controls installed.

ESF_{Base} = Energy Savings Factor of the lighting controls that existed before the new lighting controls were installed.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting.

WHF_d = Waste heat factor for demand to account for cooling energy savings from efficient lighting in cooled buildings.

$CF_{baseline}$ = Baseline Summer Peak Coincidence Factor for the lighting system without lighting controls installed.

CF_{LC} = Retrofit Summer Peak Coincidence Factor the lighting system with lighting controls installed is 0.15 regardless of building type.

[37] The IL-TRM is updated as part of a yearly process; each version of the IL-TRM corresponds to a specific program year. We will use the IL-TRM algorithm specific to each program year being evaluated throughout the course of our evaluation in alignment with Illinois requirements.

The evaluation team will conduct secondary research to develop estimations of total connected load per control, total operating hours of the controlled lighting, and the ESF of the lighting controls that existed before the new lighting controls were installed.

5.10 Estimation of Market Transformation Savings

Using lighting sales data, directional survey findings, and secondary research, the evaluation team will take the total market savings of LLLCs in Illinois and subtract the savings from the NMB estimate as shown in Equation 18.

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Equation 18. MT and Incentive Energy Savings

$$MT\ Energy\ Savings_{including\ RA} = UES\ x\ Number\ of\ MT\ Units\ (Units)$$

Where:

UES = UEC of baseline product/service – UEC of EE product

$Units$ = Total Market Units minus NMB Units.

To further avoid double counting with the program's RA incentives, the evaluation team will subtract all non-MT verified savings within the same market from the MT savings as shown in Equation 19.

Equation 19. MT Only Energy Savings

$$MT\ Energy\ Savings_{MT\ only} = MT\ Energy\ Savings_{including\ RA} - RA\ Incentive\ Savings$$

Where:

$RA\ Incentive\ Savings$ = savings from users who wouldn't have adopted LLLCs without the incentive, plus savings from LLLCs installed as spillover from those who received incentives, and minus savings from free riders.

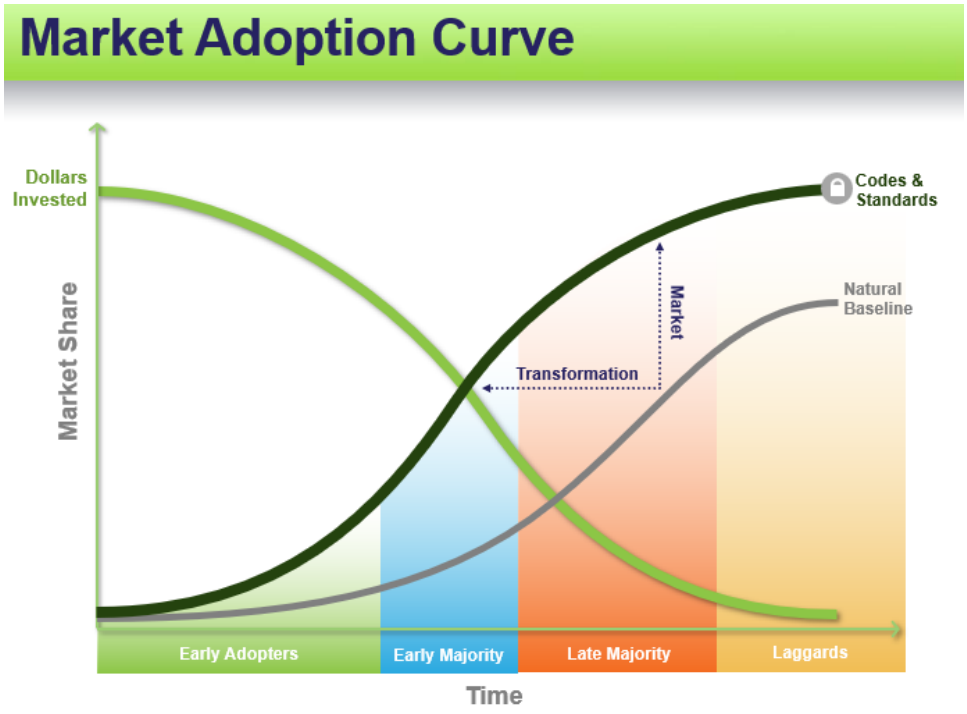
It should be noted that MTIs typically take time to generate meaningful savings. As a result, AIC anticipates relatively small savings in the early stages of the pilot.

6 Ameren Illinois Engagement

In theory, MT savings are small in the initial Pilot Phase, and are significant in later years as structural changes became permanent in the market. Investment in MT is high in the early phases to encourage initial adoption by the Innovators and Early Adopters, with market transformation becoming solidified as the Early Majority begins adopting the technology. Investment will gradually decrease as adoption increases due to a transformed market.

Figure 14 illustrates the interplay between investment, market adoption and the psychographic groups at different stages of the adoption process.

Figure 14. Market Adoption Curve



Stratton, Susan E. Northwest Energy Efficiency Alliance, July 6, 2015. Northwest Market Transformation [Slideshow].

Ameren Illinois has been engaged with the Target Market to proactively identify where LLLC adoption is within the market. Implementation activities have been designed, per the Logic Model to remove market barriers. Similarly, implementation activities have been designed and tested to measure efficacy and impact against identified market barriers.

In 2022 and 2023, AIC established the LM, NMB and MT Savings for the LLLC MTI. Implementation activities were largely focused on in-person Program Ally Training to better understand the barriers within that Target Market group. In 2022, AIC offered two-day in-person Program Ally training (PAT) events in three different locations, with one day dedicated to educating on the fundamentals of LLLC, and the second day being focused on commissioning LLLC.

In 2023, based on Program Ally attendees' feedback that dedicating two full days to training was challenging, AIC offered one-day classes in six different locations to increase accessibility to the events. AIC provided collateral to attendees to facilitate bidding on projects and educating their customers about the energy and non-energy benefits of LLLC.

In 2023, Ameren Illinois expanded the incentive availability in the traditional portfolio so that LLLCs were included as a measure in the Small Business Direct Install (SBDI) channel. Measure adoption and participation through the Standard channel and SBDI channel were increasing at a significant rate through the first half of the year, and so LLLC incentives were capped at a dollar rate per fixture. Further evaluation of incentive rate and channel availability will be continued throughout the LLLC MTI to ensure that the high-cost barrier is addressed while maintaining Program budget to meet the need for project participation.

Successful market transformation requires a wide audience to be exposed to the technology. While in-person training is necessary for new technology, AIC recognizes the limitations of that approach for accessibility and reach. AIC will design future activities to enable more Program Allies across AIC's service territory to be trained and more customers to be exposed to LLLC options. It is also important to ensure that there are local experts who can provide training and education to the Target Market. AIC plans to train the Energy Advisor team to be experts in lighting controls to serve in that capacity.

Table 16 provides summary information for implementation activities for the AIC LLLC MTI.

Table 16. Summary of AIC LLLC MTI Activities and Impacts

Program Year	Incentives	Utility Activities	Supporting Materials	Market Progress Indicators		
2021	Standard and Installer Pilot*					
2022	Standard and Installer Pilot	• In-Person Training of Installers • Webinar for Customers, Installers, and Distributors				
2023	Standard and SBDI	• In-Person Training of Installers and Distributors • Webinars for Installers and Distributors	Facts of LLLCs, DLC QPL**, and How to Bid LLLC Projects	Utility Personnel (Energy Advisor) and Distributor Expertise	General Contractor and Installer Expertise	Increased Awareness, Familiarity, Recommendations, and Installations made in the Target Market
2024		• In-Person Training of EE Personnel • Online and In-Person Training of Installers and Distributors • Webinars for Customers, Installers, and Distributors				
2025		• In-Person Training of EE Personnel • Online and In-Person Training of Installers and Distributors • Webinars for Customers, Installers, and Distributors	Facts of LLLCs, DLC QPL**, How to Bid LLLC Projects, Where to Install LLLCs, and DLC LLLC Online Tool***			
2026		• Online and In-Person Training of Installers and Distributors • Webinars for Customers, Installers, and Distributors				
2027		• Online and In-Person Training and Webinars for Customers, Installers, and Distributors				
2028		• Online and In-Person Support for Customers, Installers, and Distributors				
2029		• Online and In-Person Support for Customers, Installers, and Distributors				
2030		• Program Personnel Support Available				

*The Pilot Installer incentive was launched in 2021, but there was no participation in the Installer Pilot incentive in 2021.

**DesignLights Consortium Qualified Products List

***DesignLights Consortium is developing a web-based tool to aid installers with LLLC projects. AIC is supporting DLC efforts to develop the tool.

Based on the above planned activities and their impacts, AIC expects to increase Target Market engagement for a further three years and then reduce Target Market activities as LLLC familiarity increases while focusing more on upstream engagement.

7 Multi-year Budget

The Utility will use approved methodologies and market savings attribution forecasts in a final MTI Business Plan to determine what budgets are prudent for Market Transformation for LLLCs over the lifetime of the LLLC MTI. Four-year planning cycle savings and costs will need to be evaluated for cost effectiveness to determine budget allocation for LLLC MTI efforts. Initial forecast and budget estimates place this effort within the range of cost per kWh along with the traditional portfolio initiatives.

8 Estimate of Cost-Effectiveness

The Utility will use approved methodologies and market savings attribution forecasts in a final MTI Business Plan to determine what budgets are prudent for Market Transformation for LLLCs over the lifetime of the LLLC MTI. Four-year planning cycle savings and costs will need to be evaluated for cost effectiveness to determine budget allocation for market transformation efforts. Initial forecast and budget estimates place this effort within the range of cost per kWh along with the traditional portfolio initiatives. Further evaluation of total costs for LLLC installation projects will need to be evaluated in order to apply a TRC to this MTI.

9 Names of utilities most likely to be involved with operating this initiative

At this time, the component pieces of this LLLC MTI have been developed based on research and engagement relative to the Ameren Illinois service territory. Primary methodologies and base research are applicable to other service areas, but certain assumptions and data sets would need to be reviewed in order for an Energy Savings Framework to be applicable for additional utilities.

10 Description of interaction with other utility programs (if any) by utility

No interaction with other local utility programs has occurred thus far for this AIC LLLC MTI. Conversations and consultations have occurred with utilities outside of Illinois on development of market transformation frameworks and on practices to increase adoption of LLLC technology.

11 Description of Jobs or Disadvantaged Community Impacts

This Initiative leverages AIC's diverse vendor pool where applicable for diverse Program Allies, event coordination, trainings, and collateral development. AIC will continue to identify where and how disadvantaged communities can be included in MTI program activities.

12 Discussion of risks specific to this Initiative

One key risk is the inability to collect LLLC-specific sales data in AIC Illinois' service territory. While alternate methods have been established to quantify total sales in the area, future efforts should be spent developing a stronger market data source.

13 Date of Adoption and Date of Amendments (if any)

This Initiative is proposed for consideration and approval in November of 2023.