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Bringing Efficiency to Light℠

Why Leave Savings on the Table? C&I Lighting Lifetime and Peak Demand Savings Analysis

November 18, 2019

Presenters

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Agenda

Introduction

Rick Tempchin, *Alliance to Save Energy*
Christina Halfpenny, *DesignLights Consortium*

Research Overview

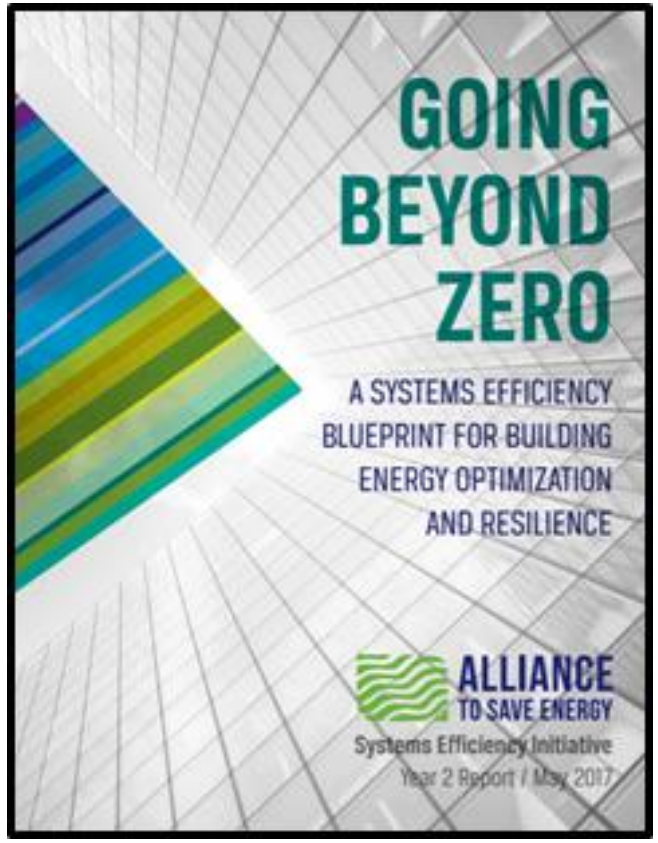
Dan Mellinger, *Energy Futures Group*

- Background Research
- Lifetime Savings Potential
- Peak Demand Savings
- Cost Effectiveness

Questions and Answers

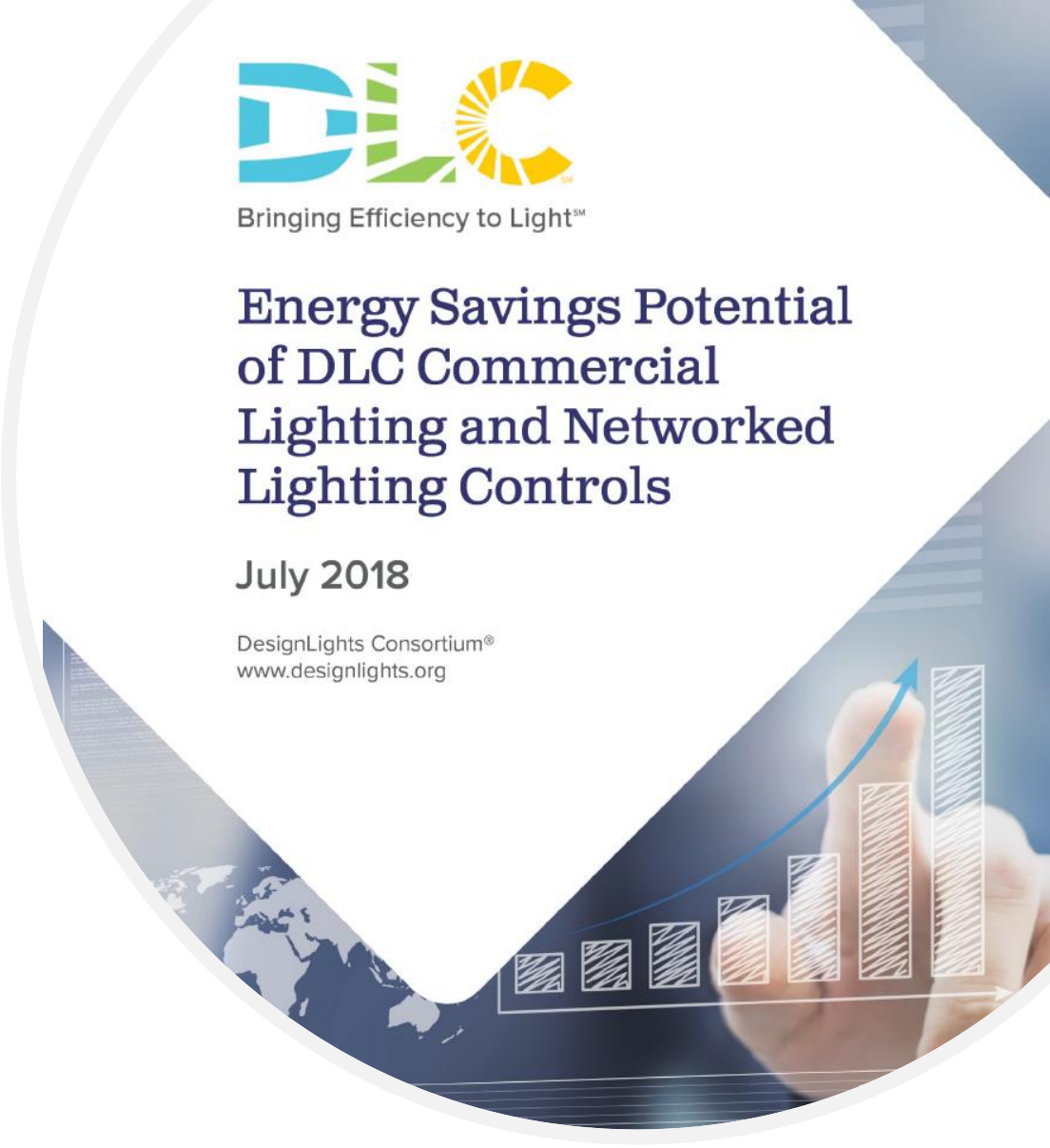
Alliance to Save Energy: Systems Efficiency Resource Hub

- Repository of documents and tools to promote building systems efficiency
  - Promote implementation of Systems Efficiency Initiative (SEI) recommendations
- Focus on utility-led systems efficiency programs
  - Documenting successes and lessons learned from utility EE programs
  - Utility-ESCO consultations
    - Dec 2018 congressional briefing
    - Oct 2019 Utility-ESCO dialogue
  - Commercial & Industrial Lighting Lifetime and Peak Demand Savings Analysis



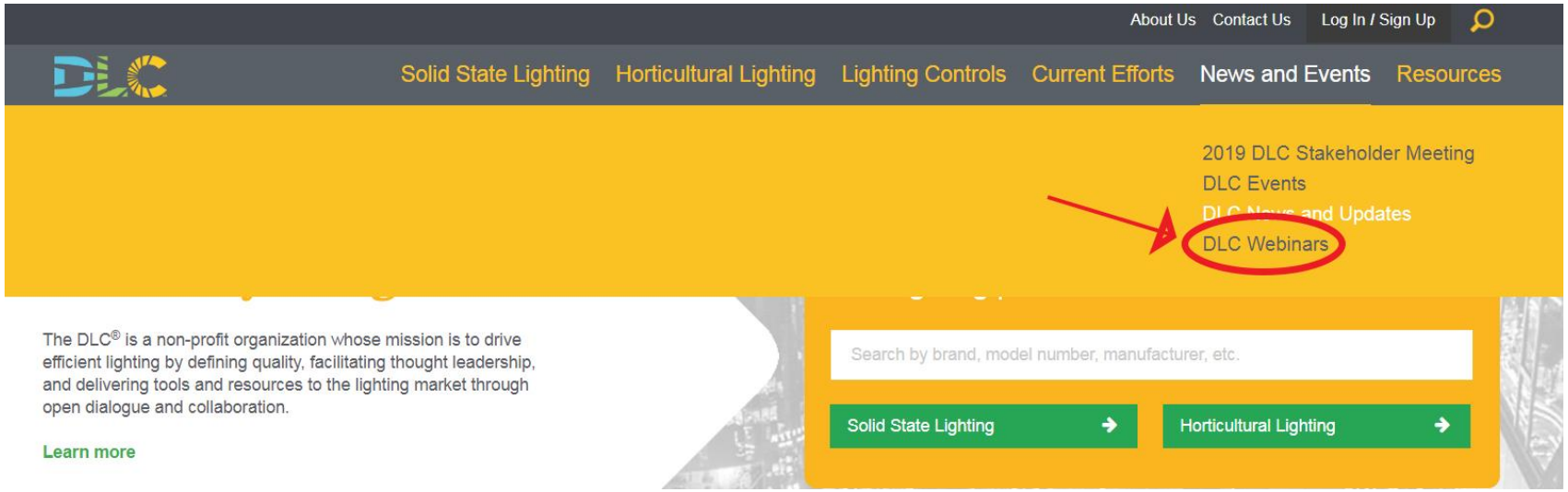
Networked Lighting

- Added savings and value with NLC
- Risk of lost opportunity without networking
- A path exists to maintain C&I lighting portfolios at or above current levels until at least 2028



Webinar Logistics

- Recording will be posted on the DLC website following the webinar
- Please submit questions through the Question Pane during the webinar – Q+A will be held at the end

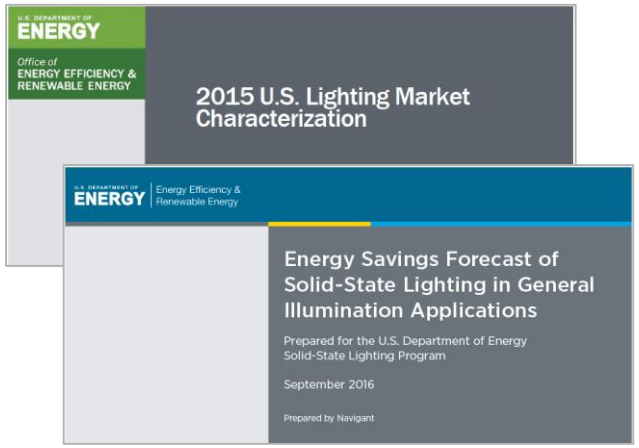


Research Overview

Research Objectives

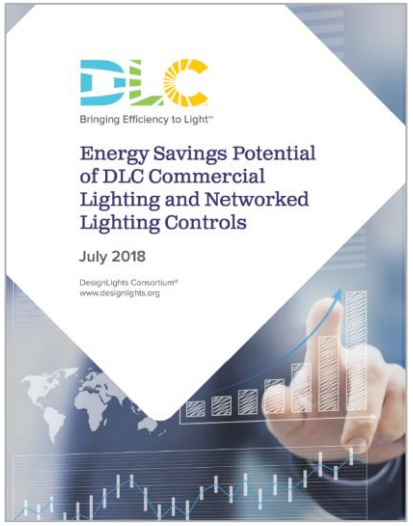
- Identify energy efficiency (EE) program **measure assumptions for LED and NLC**
- Quantify the ***lifetime*** **savings potential** for C&I lighting product types
- Determine the extent that C&I lighting technologies contribute to **peak demand savings**
- Evaluate the **cost-effectiveness implications** when considering lifetime savings for LED and NLC as a system

DOE Market Characterization and SSL Forecast (2015-17)



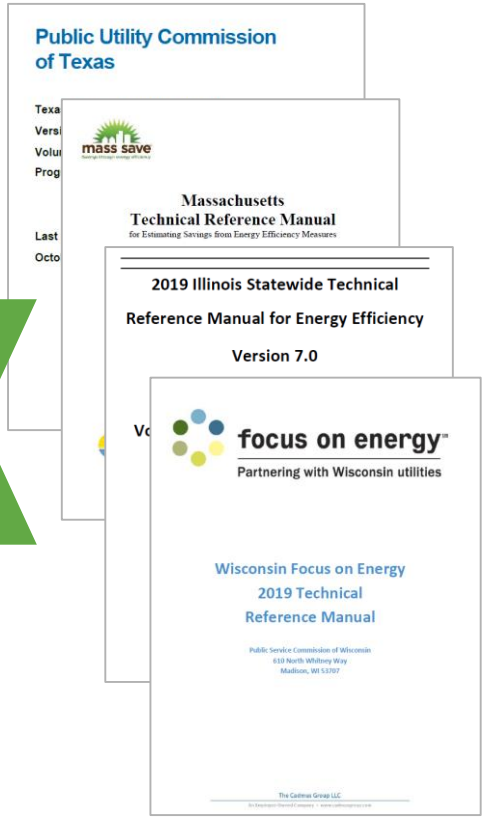
DLC NLC Energy Savings (2017)

DLC Energy Savings Potential Report (2018)



ASE/DLC Lighting Lifetime and Peak Demand Savings Analysis (2019)

Technical Reference Manual Assumptions from 12 States



Technical Reference Manual (TRM) Research

- Technical Reference Manuals are a **document/database for common products and technologies**
- Provides the algorithms and assumptions necessary to **calculate energy savings and evaluate measure cost-effectiveness**

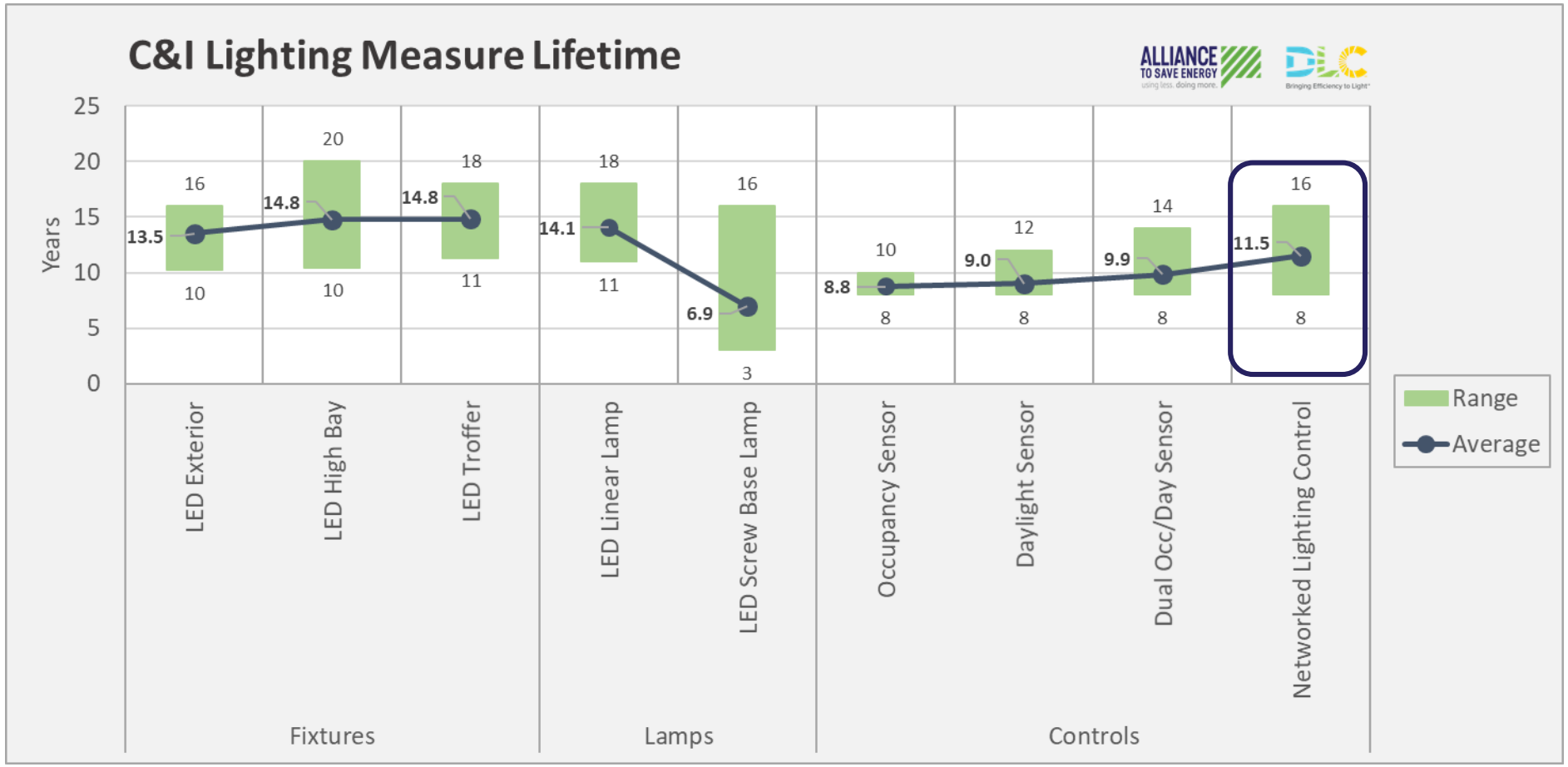
States/Jurisdictions Reviewed (12 total)
• **Northeast (3)** Massachusetts, Mid-Atlantic, Vermont • **Midwest (4)** Illinois, Michigan, Minnesota, Wisconsin • **South (3)** Arkansas, Texas, Tennessee • **West (2)** California, New Mexico

Measure Values Collected for ASE/DLC Research
• Effective Date • Product Type and Measure Name • **Measure Lifetime** (absolute and/or calculated) • Operating Hours • Control Savings Factor • **Summer Coincidence Factor** • Summer Peak Timeframe • Measure cost (high and low)

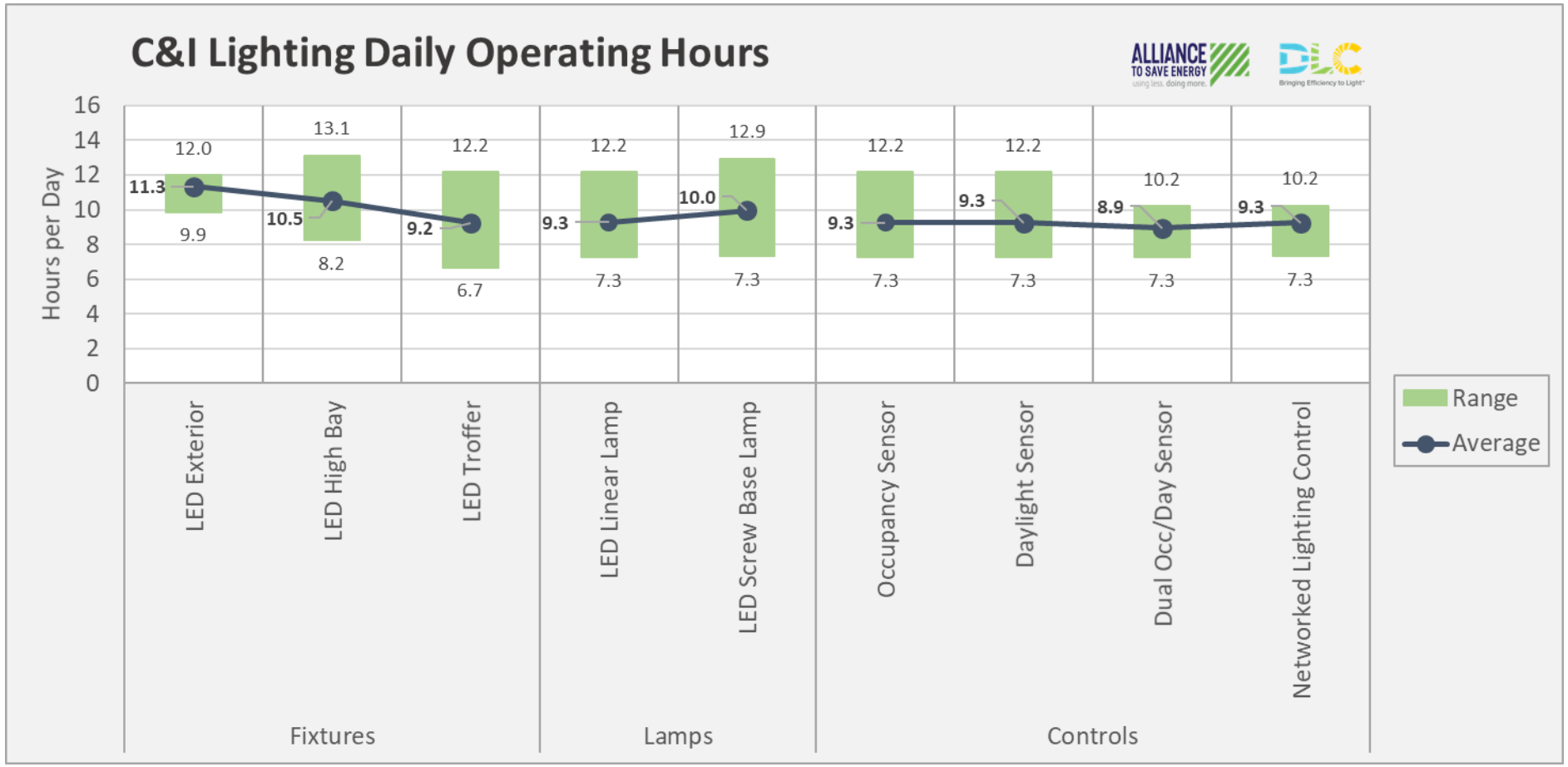
TRM Lighting Measure Prevalence

Region	State	Version	Fixtures			Lamps		Controls			
			LED Exterior	LED High Bay	LED Troffer	LED Linear Lamp	LED Screw Base Lamp	Occupancy Sensor	Daylight Sensor	Dual Occ/Day Sensor	Networked Lighting Control
Northeast	Massachusetts	2019	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Mid-Atlantic	2018	✓	✓	✓	✓	✓	✓	✓		
	Vermont	2017	✓	✓	✓	✓	✓	✓	✓	✓	
Midwest	Illinois	2019	✓	✓	✓	✓	✓	✓	✓	✓	
	Michigan	2019	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Minnesota	2019	✓	✓	✓	✓	✓	✓	✓		
	Wisconsin	2019	✓	✓	✓	✓	✓	✓	✓	✓	✓
South	Arkansas	2017	✓	✓	✓	✓	✓	✓	✓	✓	
	Tennessee	2017				✓	✓	✓	✓	✓	
	Texas	2018	✓	✓	✓	✓	✓	✓	✓		✓
West	California	2017	✓	✓	✓	✓	✓	✓	✓	✓	
	New Mexico	2016	✓				✓	✓	✓		
Count of States			11	10	10	11	12	12	12	8	4
% of States (out of 12)			92%	83%	83%	92%	100%	100%	100%	67%	33%

TRM Lighting Measure Lifetime

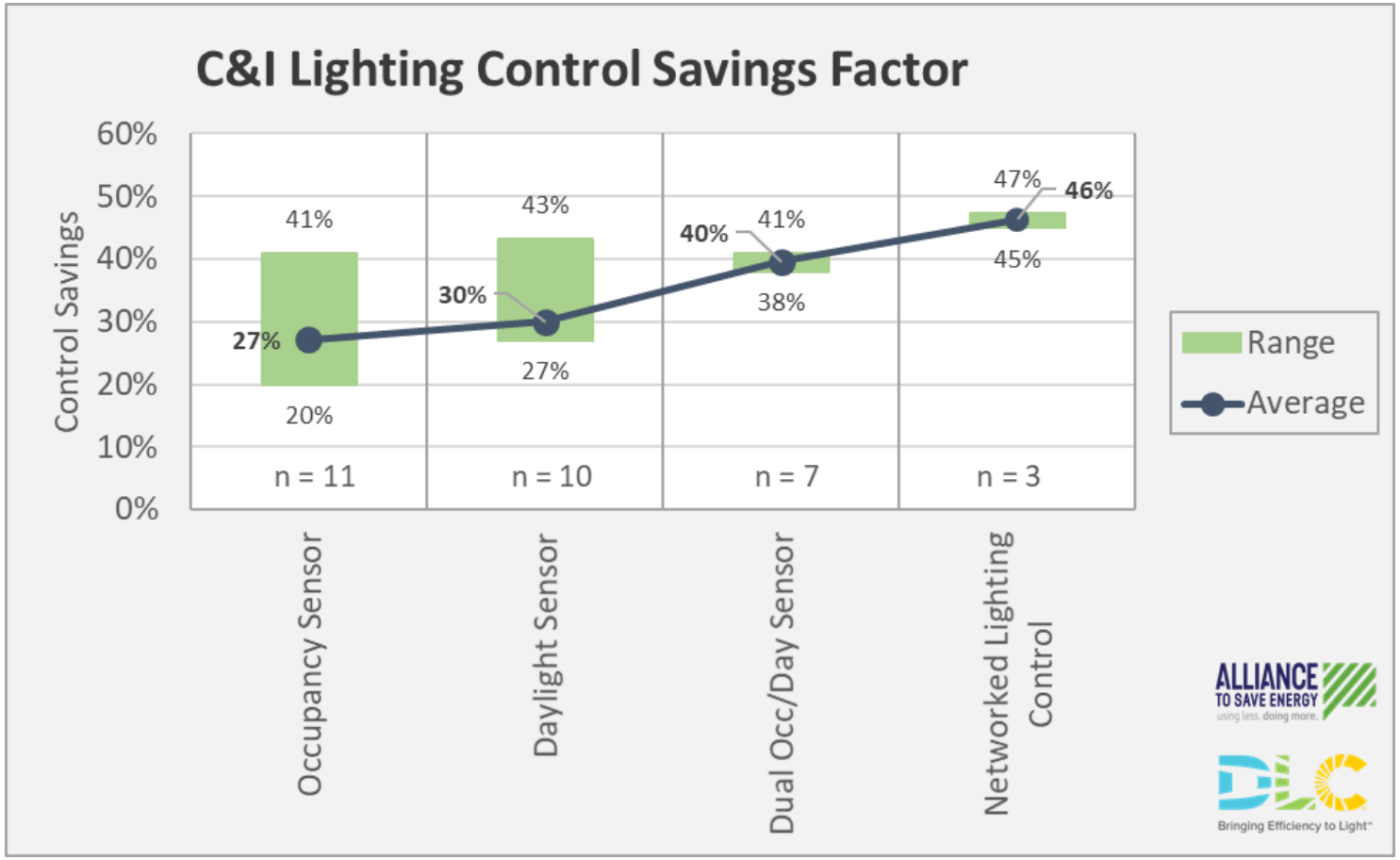


TRM Lighting Operating Hours



TRM Lighting Control Savings Factor

- A lighting control savings factor is used in TRMs to calculate savings
- Represents savings from reduced operating hours, reduced power, or both



TRM Research Findings

EE program TRMs are not keeping pace with lighting control technology

Networked lighting controls are absent in a majority of TRMs reviewed

All TRMs reviewed treat **LEDs and NLCs as separate stand-alone measures**

Lighting control measure lifetimes are notably lower than the associated LED lighting

Lifetime Savings Potential

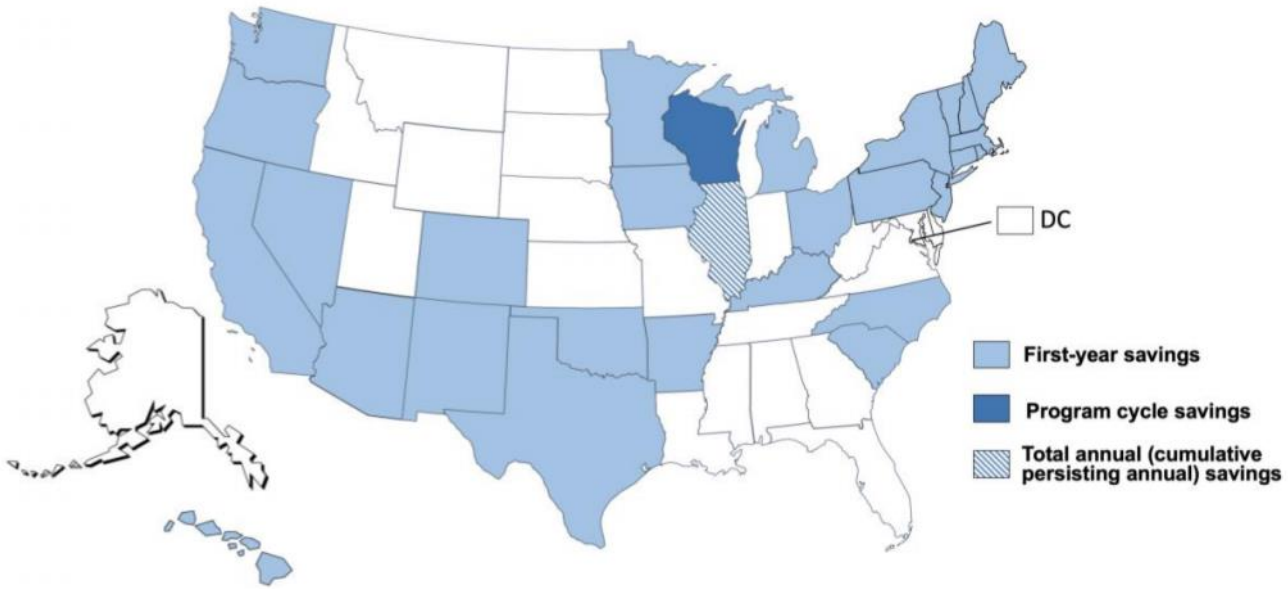
Annual vs. Lifetime Energy Savings

Annual (1st Year) Savings	Lifetime Savings
The 12-month savings total expected by a new measure in the first year of implementation	The sum of a measure's annual savings over its expected useful life (EUL)

- Most utility EE programs track progress in terms of annual (first-year) energy savings
- An annual savings focus can inadvertently direct incentives toward measures with a lower lifetime benefit
- **Lifetime savings more adequately represents the energy and economic potential of a measure**

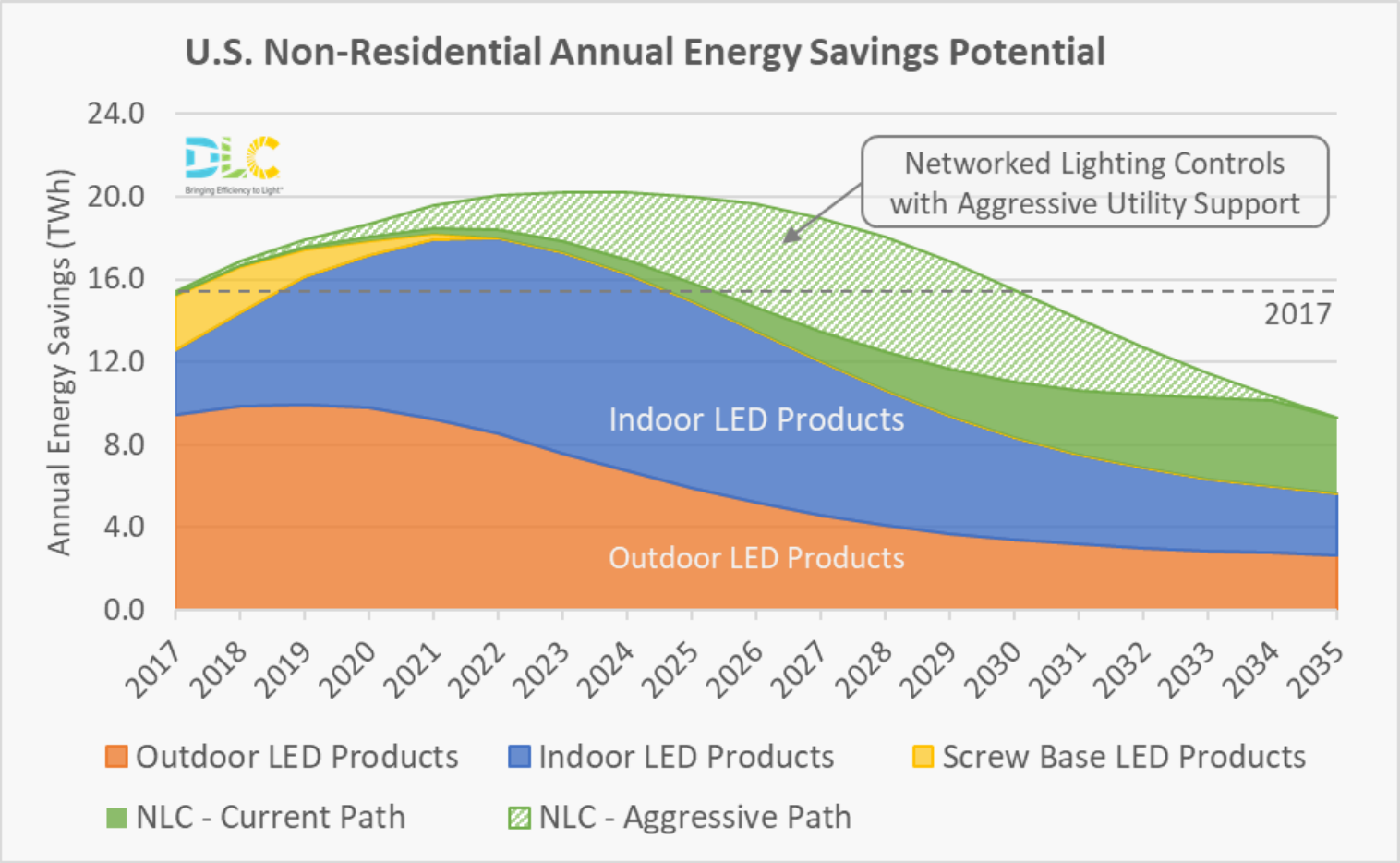
Why do EE Programs Rely on First-Year Savings?

- Simplicity and historical precedence
- Existing state policies (EERS)
- Some states have increased their focus on lifetime savings through goals or performance incentives tied to lifetime benefits
  - California, Connecticut, Illinois, Michigan, Oregon, and Rhode Island



Energy Efficiency Over Time: Measuring and Valuing Lifetime Energy Savings in Policy and Planning
https://aceee.org/sites/default/files/publications/researchreports/u1902.pdf

Prior DLC Research



Energy Savings Potential of DLC Commercial Lighting and Networked Lighting Controls

- Published in 2018
- Estimated the savings potential in terms of *first-year annual savings*.

https://www.designlights.org/resources/energy-savings-potential-of-dlc-commercial-lighting-and-networked-lighting-controls/

Lifetime Savings Potential Analysis

Installed lighting inventory, wattage, and operating hours per DOE U.S. Lighting Market Characterization

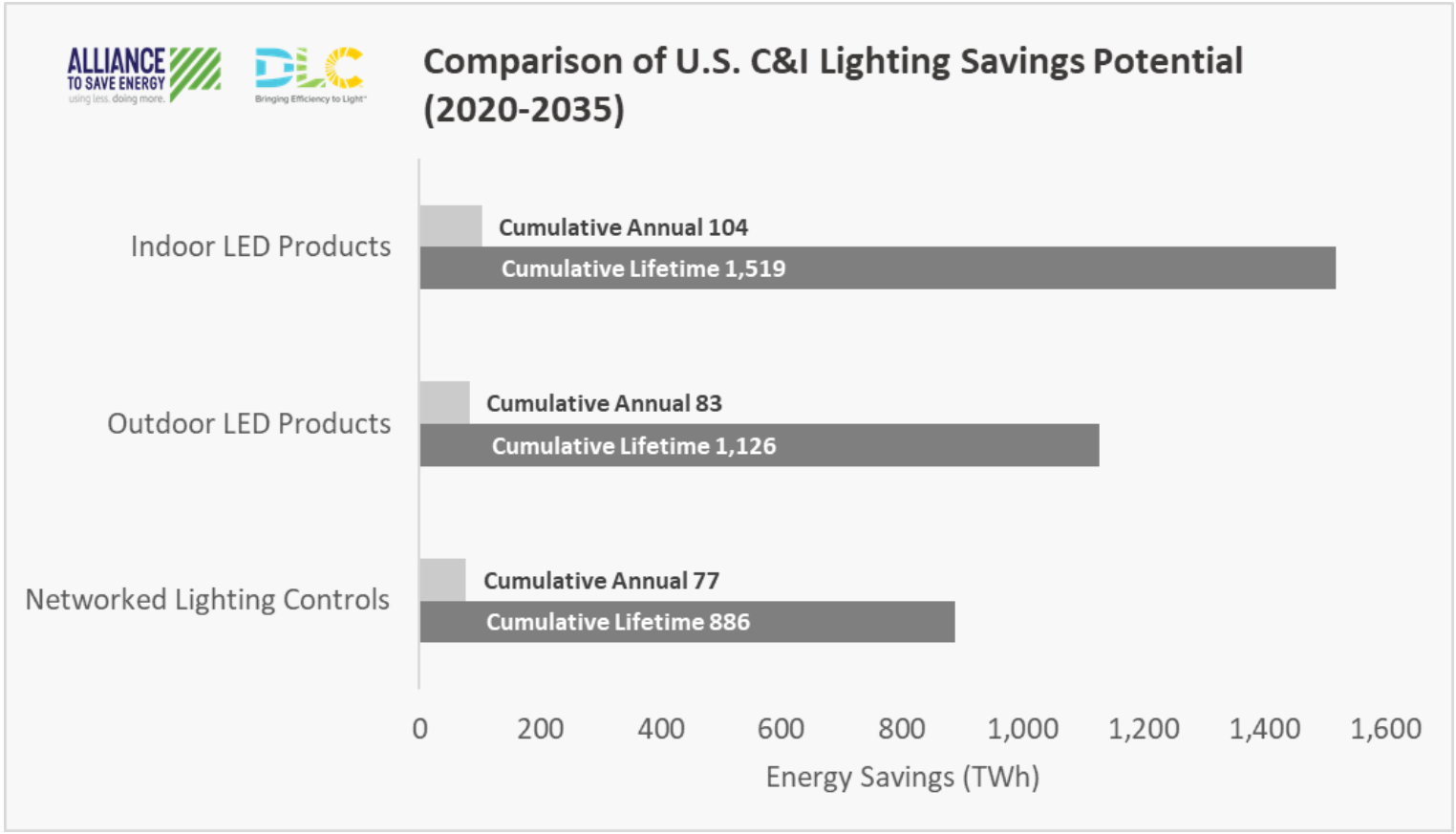
LED adoption and efficacy improvement according to DOE Energy Savings Forecast

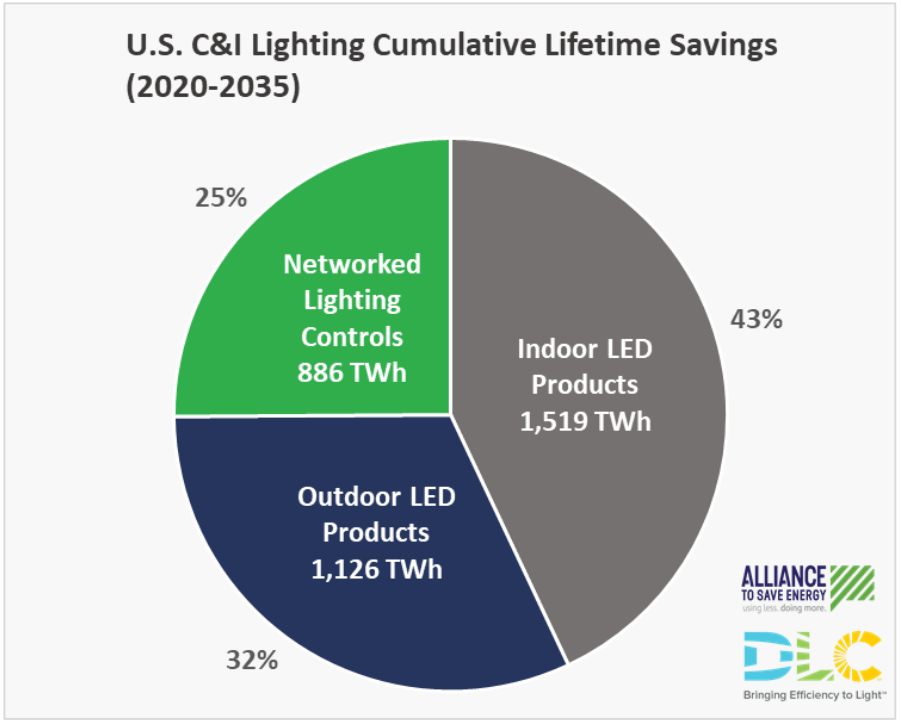
Continued levels of utility and industry promotion of **LED achieve adoption levels of 83% (indoor) and 90% (outdoor) by 2035**

Utilities and industry aggressively promote **NLC to achieve adoption levels of 58% (indoor) and 65% (outdoor) by 2035**

Measure lifetimes identified during the TRM research

Lifetime Savings Estimate



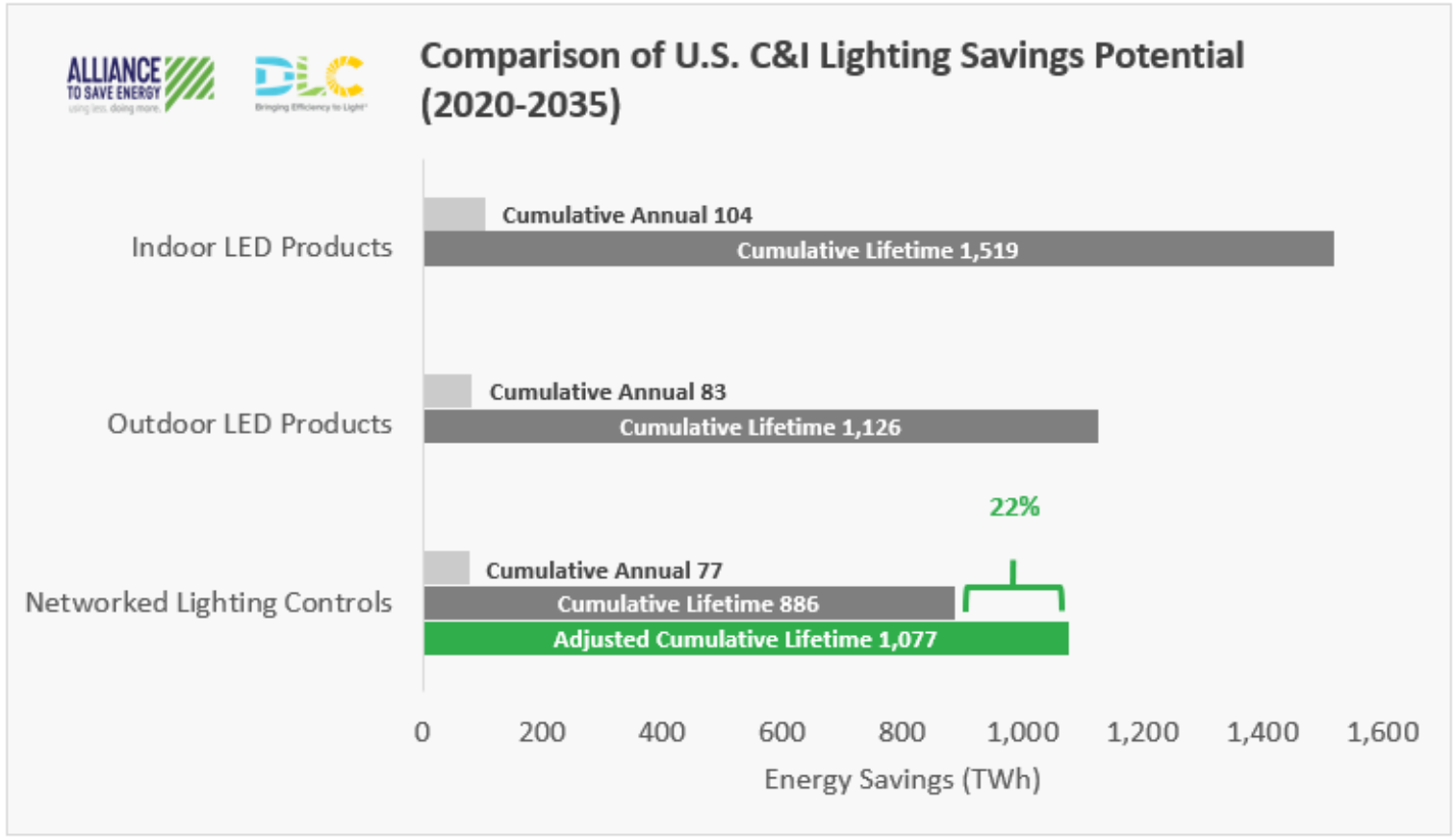


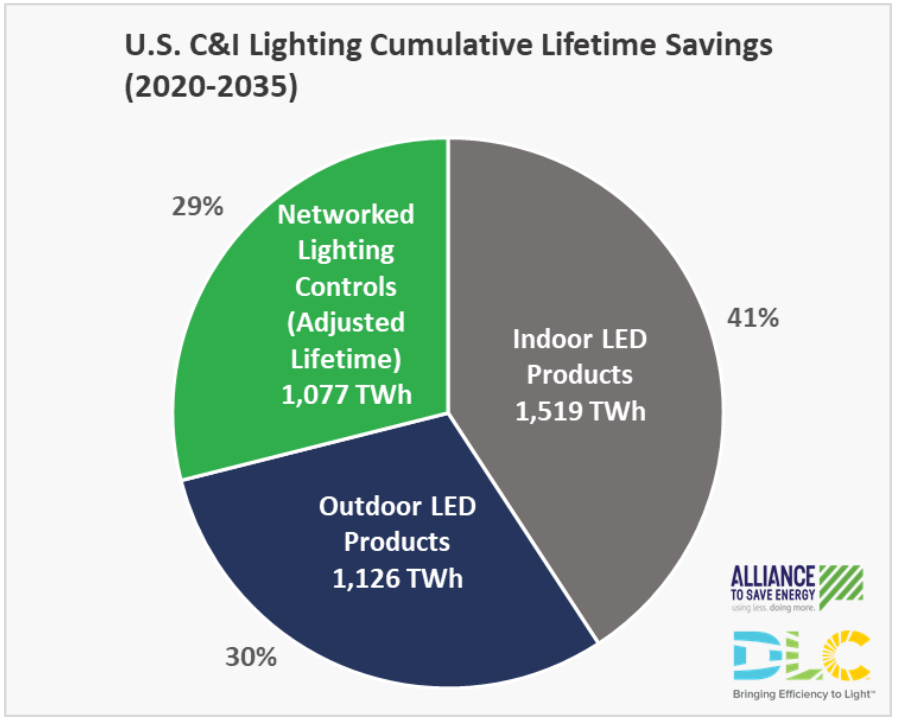
Adjusted NLC Measure Lifetime

Product Type	LED TRM Measure Life	NLC TRM Measure Life	Adjusted NLC TRM Measure Life
High/Low Bay	14.8	~~11.5~~	14.8
Linear Lamp/Fixture	14.5	~~11.5~~	14.5
Building Exterior	13.5	~~11.5~~	13.5
Street/Roadway	13.5	~~11.5~~	13.5
Parking Area/Garage	13.5	~~11.5~~	13.5

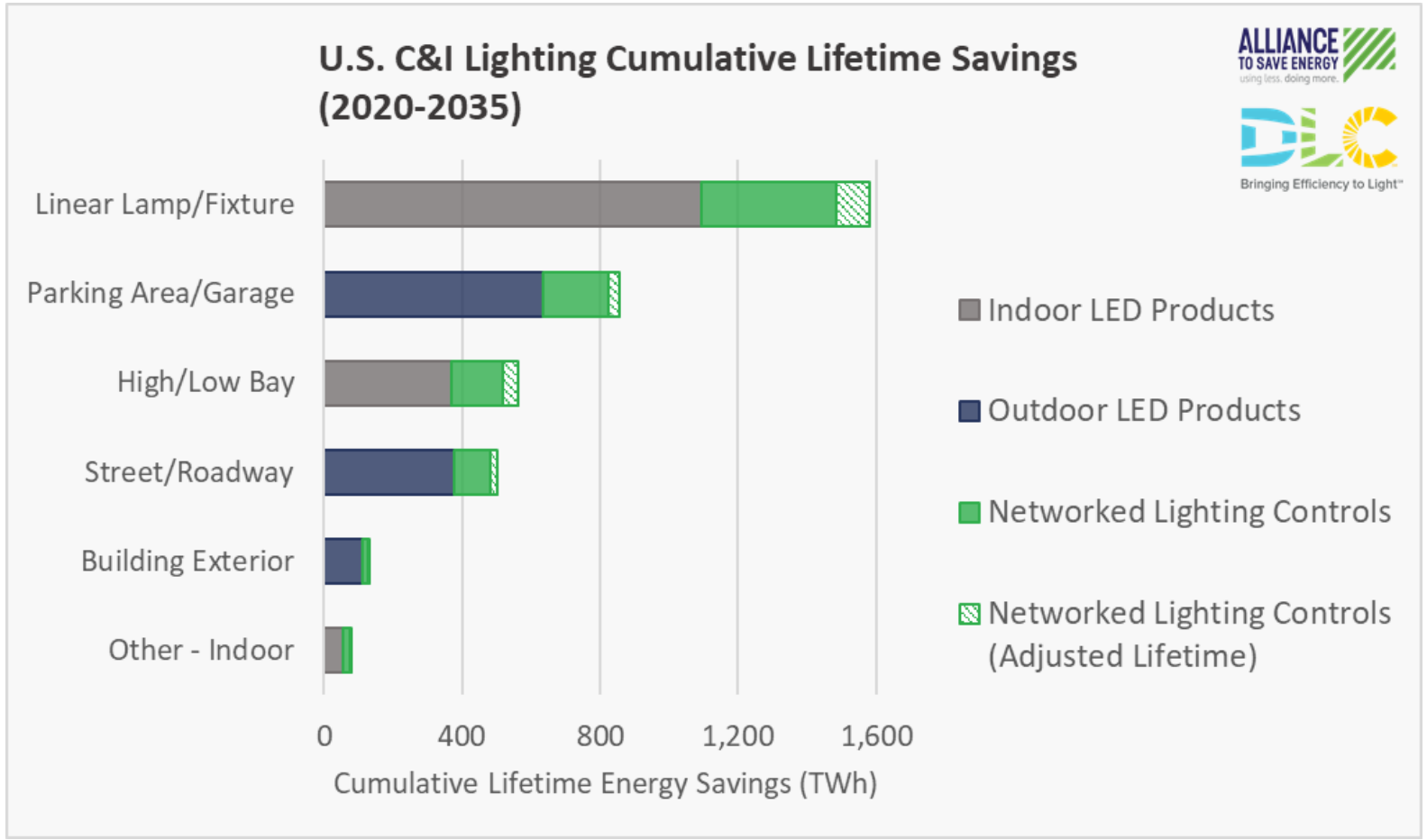
- LEDs and NLCs are dependent on each other to achieve the full savings potential
- **NLCs and LED fixtures increasingly operate as a system**, and in some cases are inseparable

Lifetime Savings Estimate with Adjusted NLC Life





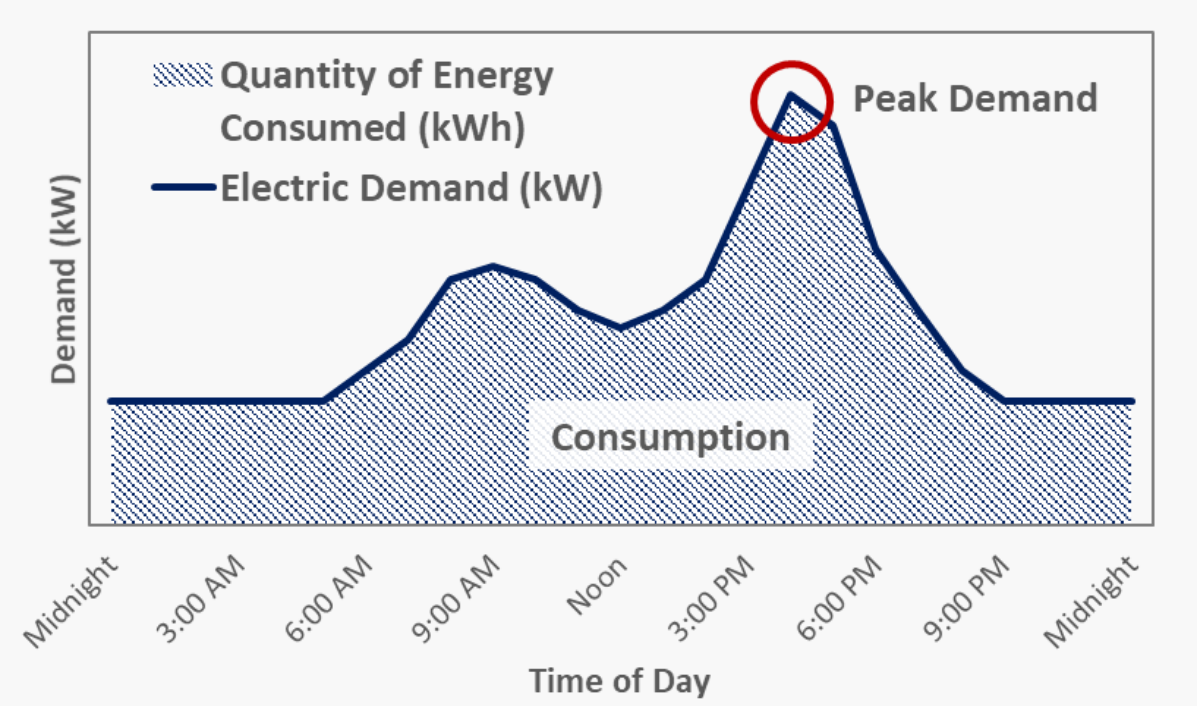
Lifetime Savings Estimate by Product Type



Peak Demand Savings

Peak Demand Definition

- **Electricity consumption** represents the power used over time (kWh)
- **Electricity demand** represents the instantaneous power required to meet the electrical loads of the utility (kW)
- **Peak demand** represents the highest electric power demand over a time period (month, year, summer, etc.)



Peak Demand Reduction Through Energy Efficiency

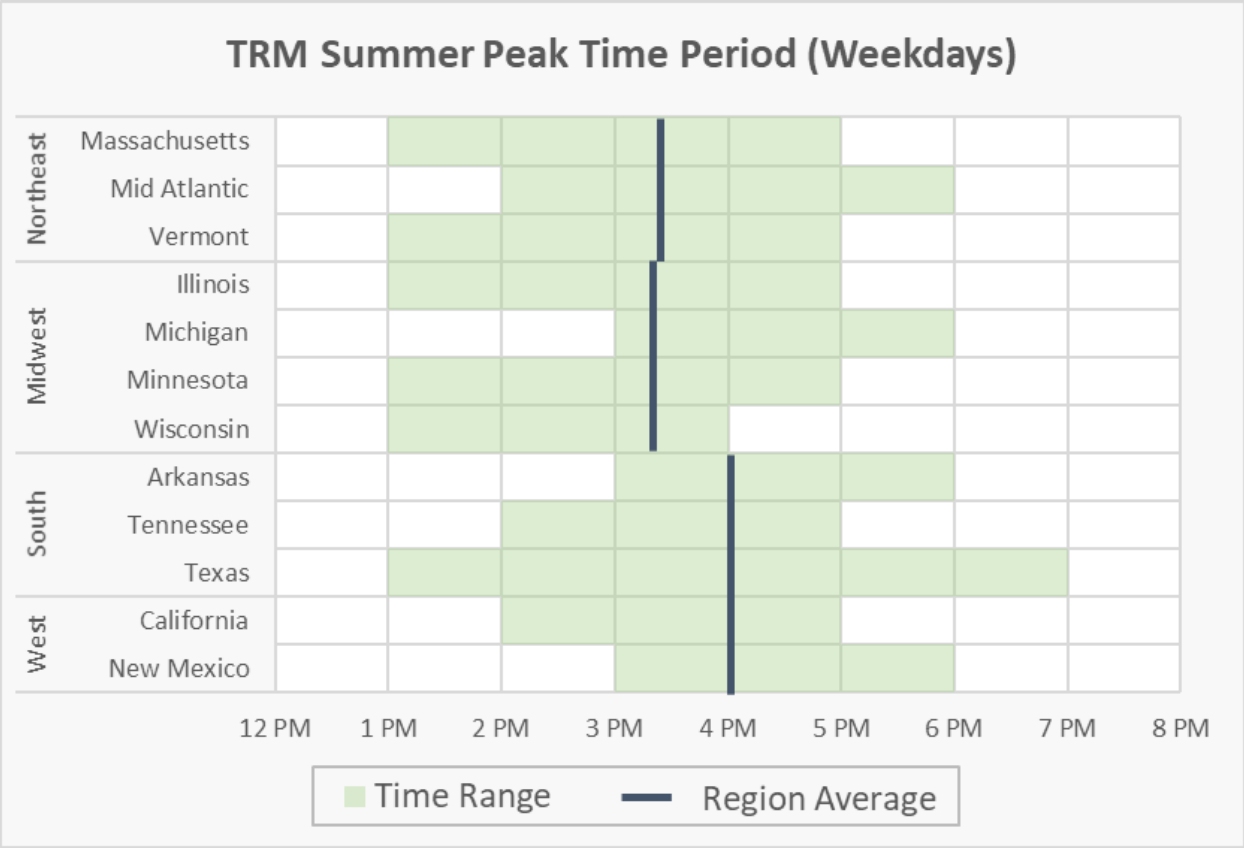
- Savings from an energy efficiency measure may not always overlap with the time of a system peak
- Overlap with a peak demand timeframe is called *coincidence*
- Coincidence factors are used to estimate the impact that a measure has on peak demand for the associated season

Example Coincidence Factors	Summer (Weekdays 1-5pm)	Winter (Weekdays 5-7pm)
Residential Indoor Lighting	55%	85%
Commercial Indoor Lighting	83%	65%
Commercial Outdoor Lighting	0%	100%
Industrial (24/7) Lighting	100%	100%

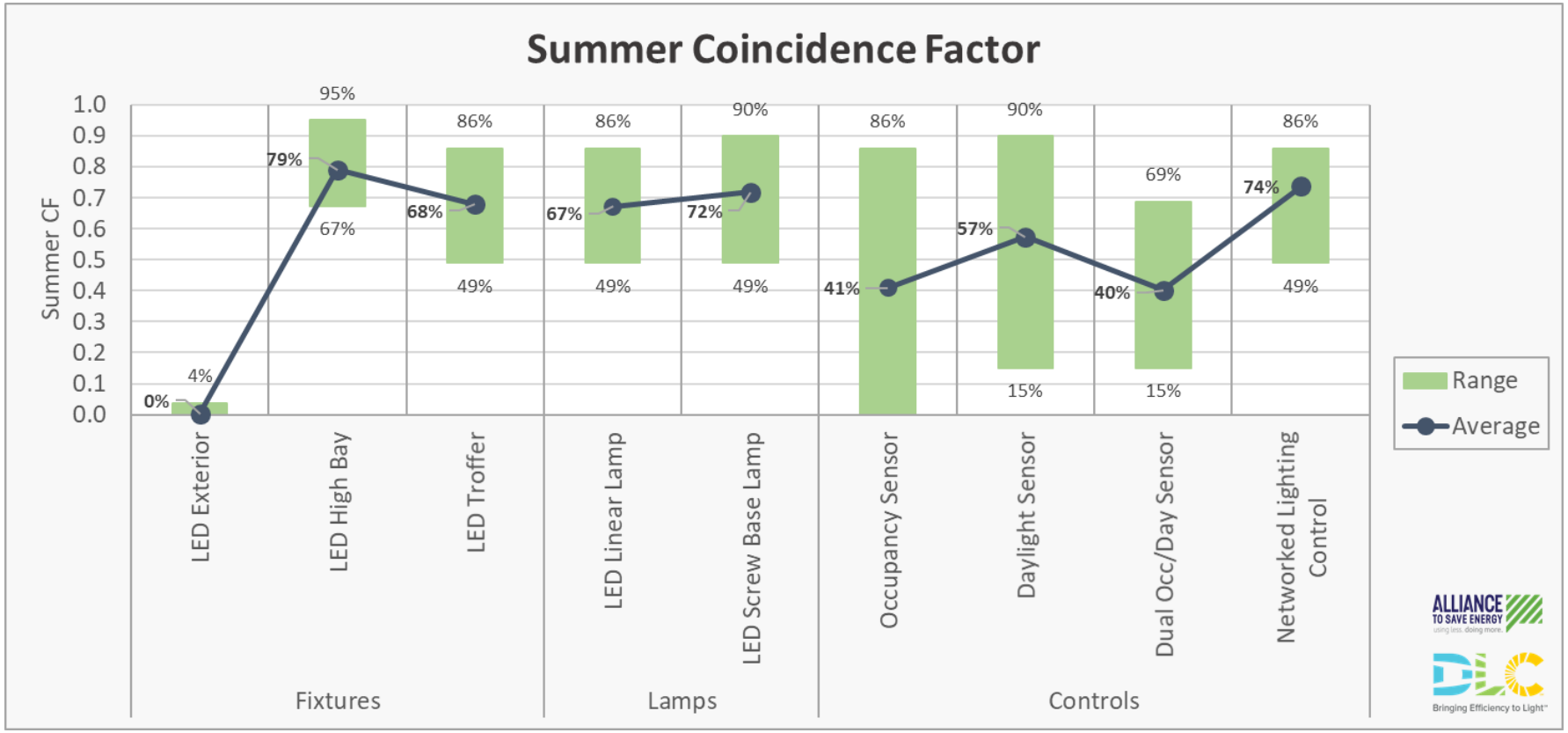
Example Summer Peak Lighting Coincidence Factors from Massachusetts TRM

Peak Demand Savings Analysis

- Summer peak was selected since most utilities face a greater capacity constraint during the summer months
- Most TRMs reviewed define summer peak time period as late afternoon weekdays June to August

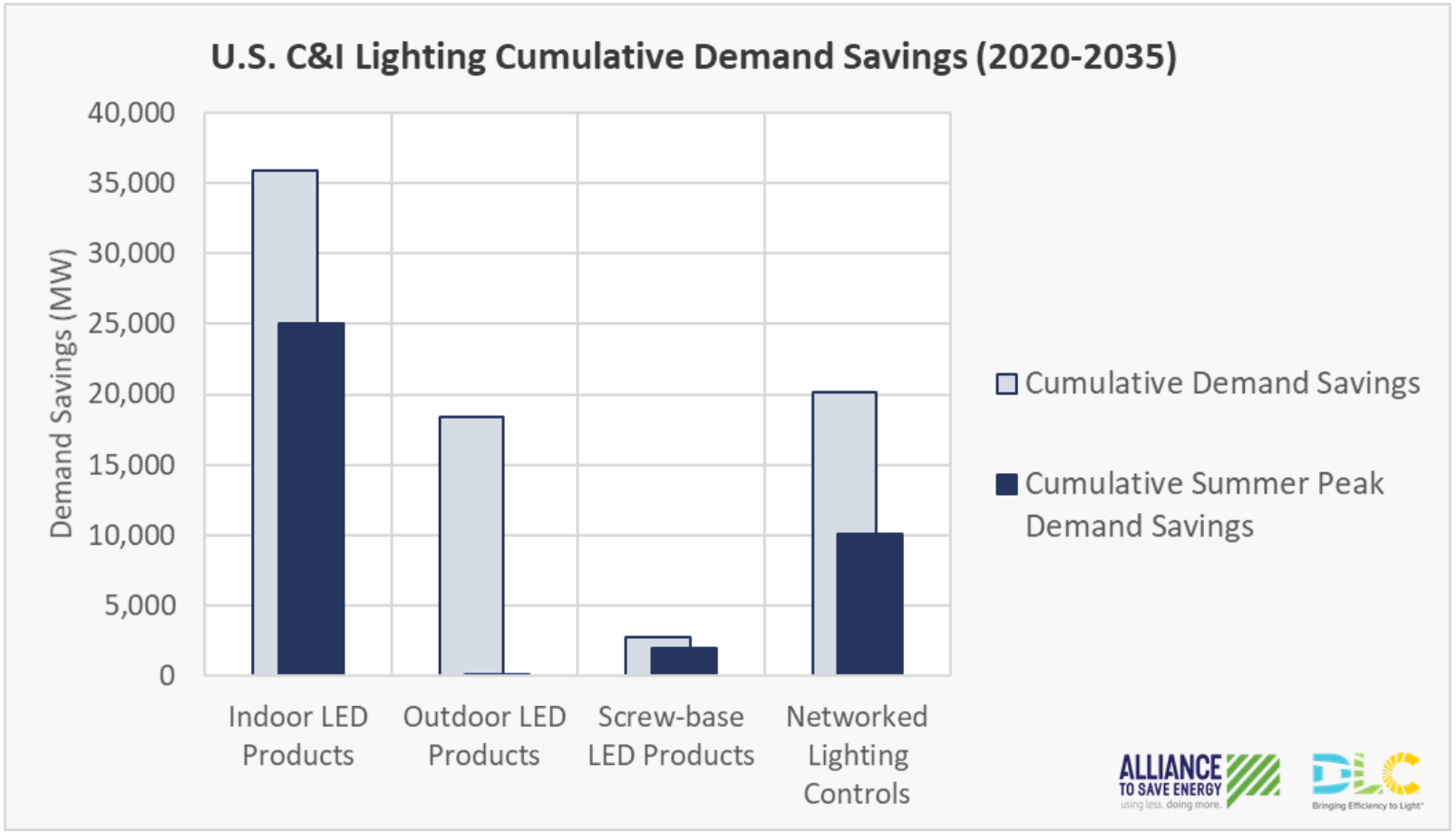


TRM Summer Coincidence Factor



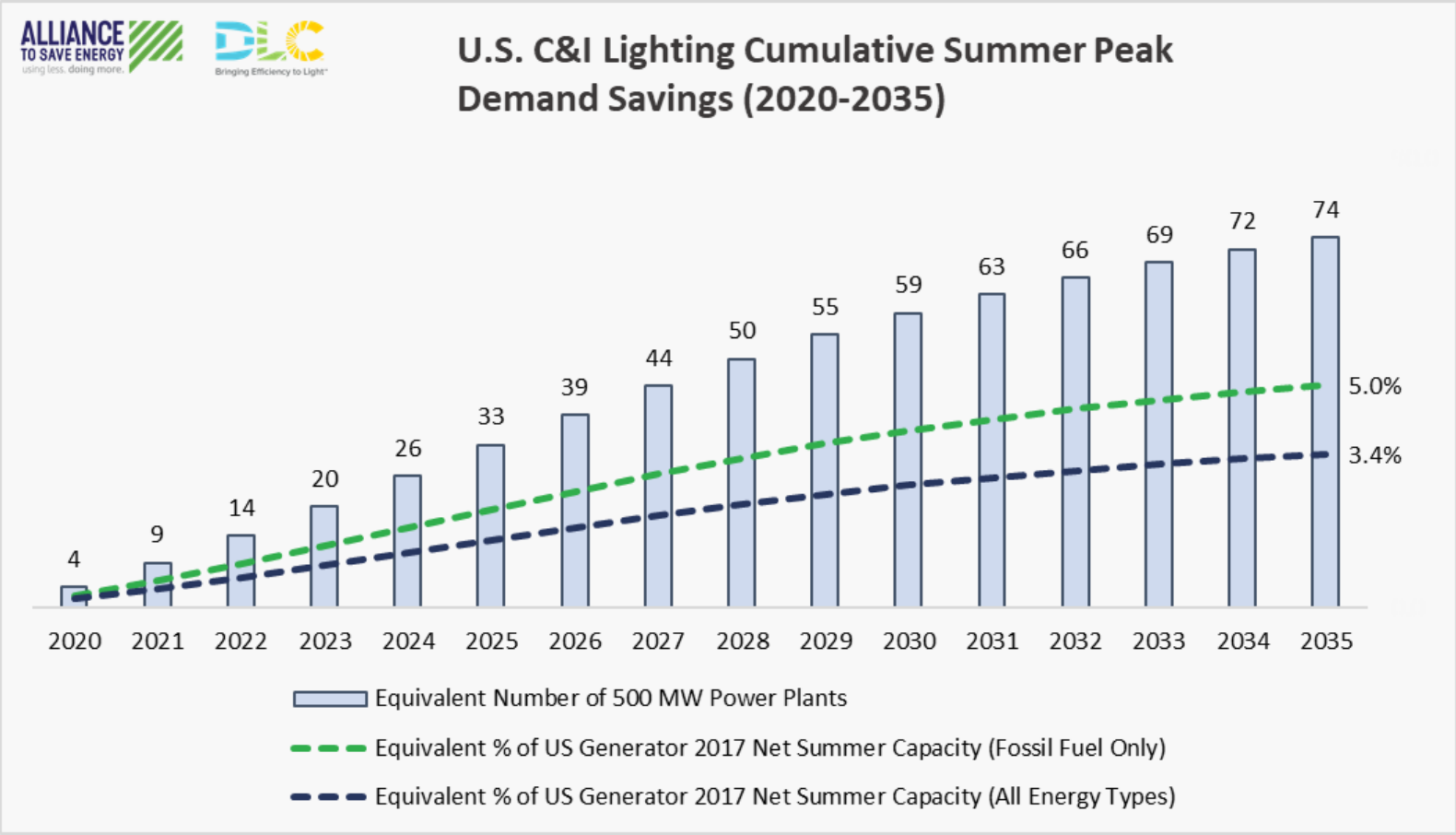
- Significant variation among lighting control coincidence factors
- The same lighting control measure will have drastically different assumed peak demand savings

C&I Lighting Summer Peak Demand Savings Potential



In the context of summer peak, indoor LED lighting and networked lighting controls are far and away the most important commercial lighting measures

C&I Lighting Peak Demand Savings Potential



- By 2035, the potential summer peak demand impact from indoor LED and networked lighting control is roughly equal to 5% of the generating capacity of the entire fleet of U.S fossil fuel power plants*

* 2017 net summer fossil fuel power plant capacity totaled 745,866 MW according to the Energy Information Administration (https://www.eia.gov/electricity/annual/html/epa_04_03.html)

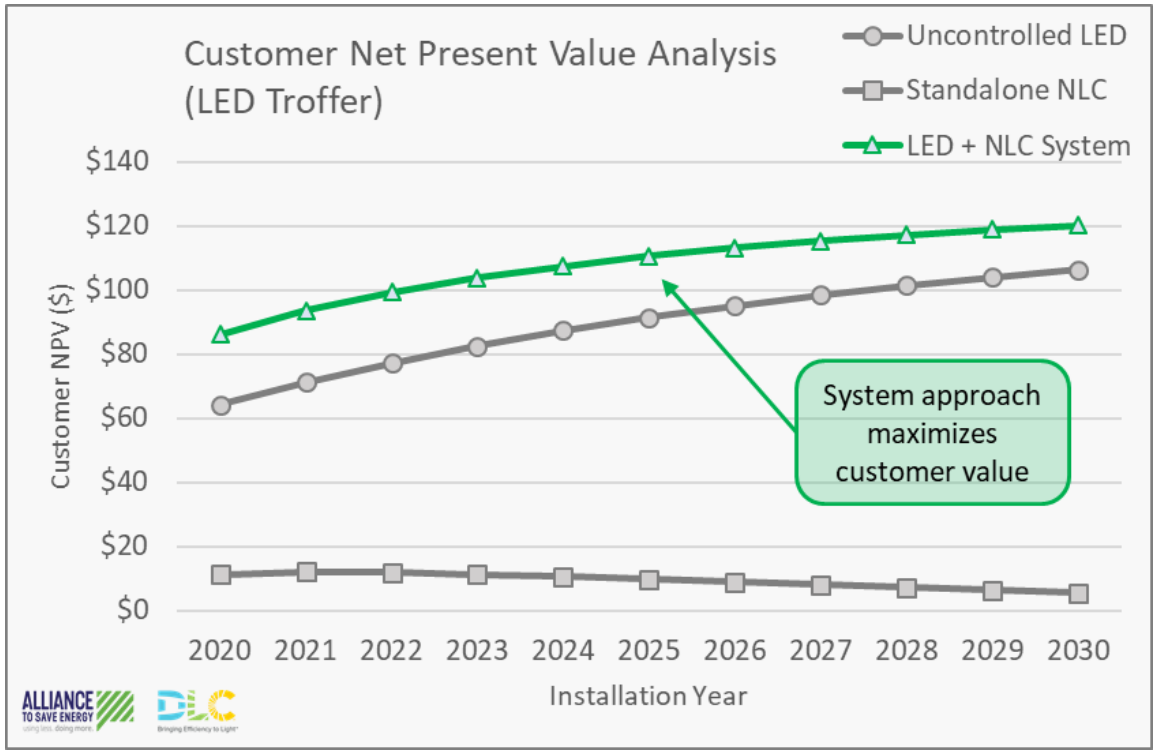
Cost Effectiveness

Cost Effectiveness Analysis

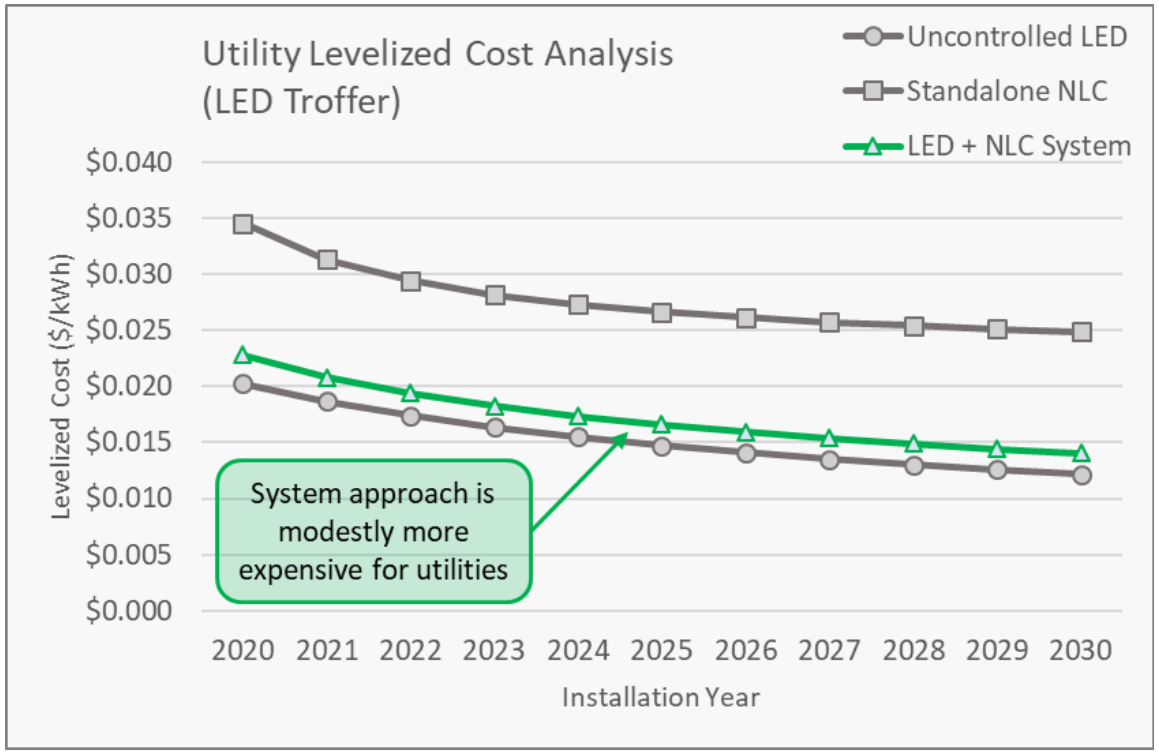
Cost-Effectiveness Measure	Scenarios Considered	Key Inputs
• Customer simple payback (years) • Customer net present value - NPV ($) • Customer internal rate of return - IRR (%) • EE program rebate cost ($/kWh) • EE program lifetime rebate cost ($/lifetime kWh) • EE program levelized cost of energy ($)	• Four LED product types (troffer, highbay, exterior small, and exterior larger) • LED measures alone using TRM lifetime • NLC measures alone using TRM lifetime • LED + NLC system measures using adjusted TRM lifetime	• Measure characterization (watts, hours) • Annual savings • Measure lifetime • Current and future measure costs • Utility incentive • Electric rate • Inflation • Discount rate

Cost Effectiveness Scenario for LED Troffer

Customer Economics (NPV):



Utility Incentive Economics (levelized cost):



Default input assumptions include electric rate ($0.105/kWh), annual operating hours (3375), baseline power (67.5 watts), LED power (33.5 watts), average annual efficacy change (2.7%), 2019 LED cost ($92), LED average annual cost change (-3.4%), LED utility incentive (30%), LED and NLC measure life (per TRM research), LED installation time (20 minutes), NLC type (luminaire integrated), NLC savings (47%), 2019 NLC cost ($50), NLC average annual cost change (-7.0%), NLC utility incentive (40%), NLC installation time (15 minutes), inflation (2.0%), discount rate (5.0%), labor rate ($75/hour).

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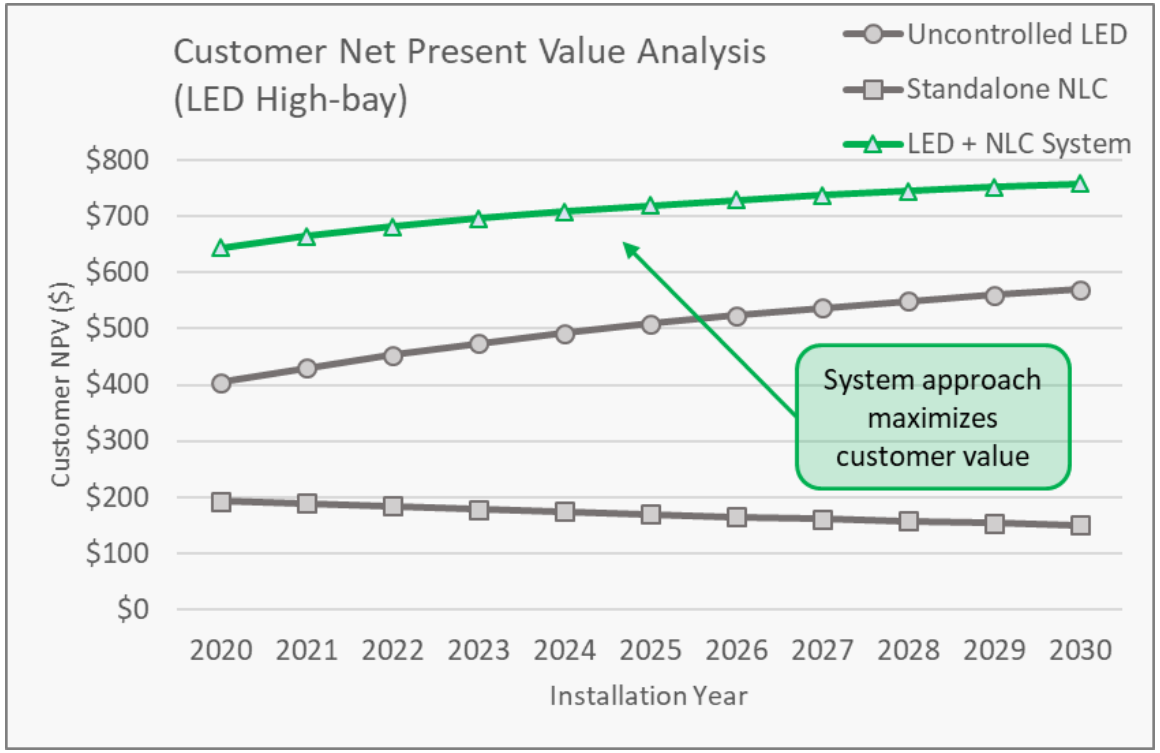
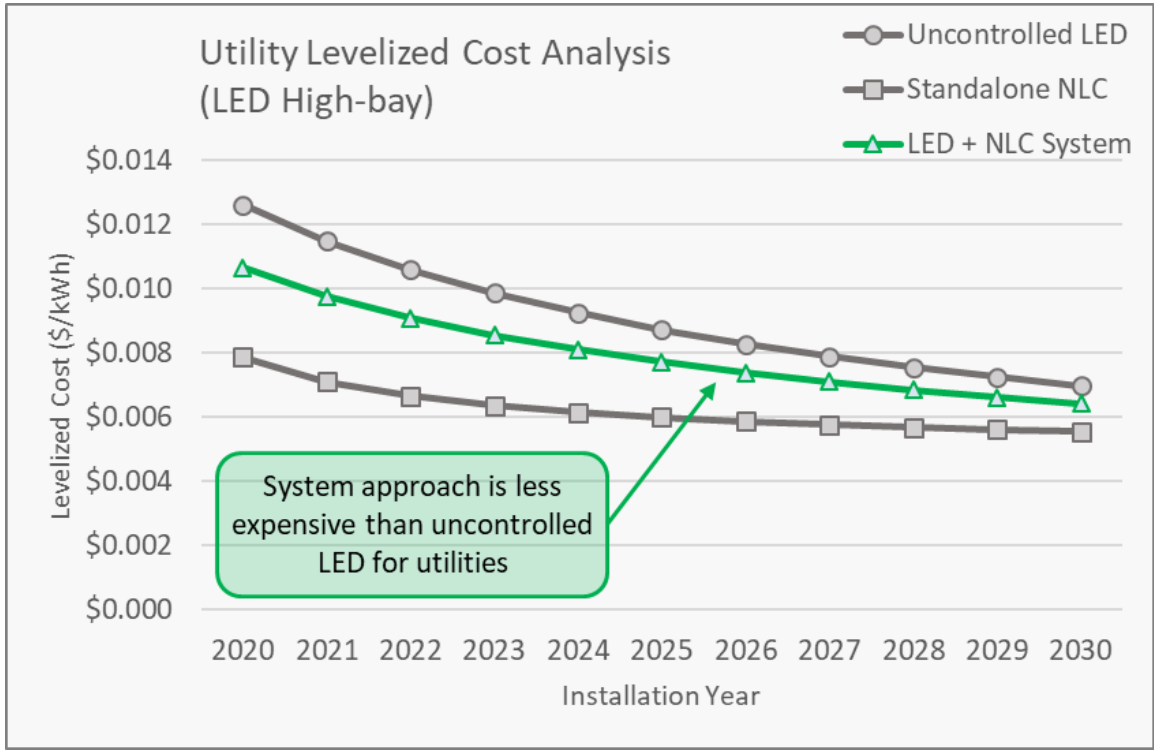
Cost Effectiveness Scenario for LED Higbay

Customer Economics (NPV):



Utility Incentive Economics (levelized cost):



Default input assumptions include electric rate ($0.105/kWh), annual operating hours (3834), baseline power (246.6 watts), LED power (128.7 watts), average annual efficacy change (2.7%), 2019 LED cost ($229), LED average annual cost change (-3.4%), LED utility incentive (30%), LED and NLC measure life (per TRM research), LED installation time (30 minutes), NLC type (luminaire integrated), NLC savings (47%), 2019 NLC cost ($50), NLC average annual cost change (-7.0%), NLC utility incentive (40%), NLC installation time (15 minutes), inflation (2.0%), discount rate (5.0%), labor rate ($75/hour).

Summary

TRM Measure Assumptions

- Many EE programs are underestimating benefits by using overly conservative assumptions for lighting control measure life and savings potential.
- Lost opportunity for significant energy savings can be avoided when networked lighting is combined with lighting projects in savings assumptions.

Lifetime Savings

- Focusing on annual (first-year) savings grossly underrepresents the true savings potential over the life of the measure.
- Annual (first-year) savings goals inadvertently encourage the promotion of short-lived measures.

System Approach

- Treating LED+NLC as a system can improve cost-effectiveness since the NLC lifetime savings increase by 22%.
- Combining LED+NLC encourages integration with other building systems (e.g. HVAC).
- EE programs treat NLC as an independent measure from LED, with shorter lifetime measures.

Peak Demand Reduction

- The potential peak demand savings from indoor LED combined with networked lighting controls is significant, since coincidence with summer peak is high in most areas.
- Summer peak savings could equal 5% of today's fossil fuel capacity by 2035.

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Research Recommendations

Lifetime Savings

- EE programs, regulators, and policy makers should **increase focus on lifetime savings**.

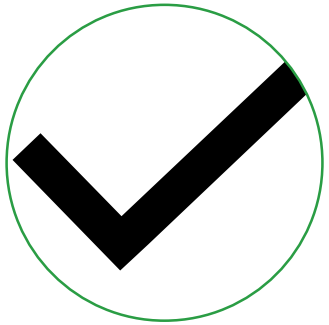
NLC Emphasis

- A measure characterization for **networked lighting controls is needed within all TRMs**.
- The measure lifetime for networked lighting control measures should be consistent with LED fixtures.

LED + NLC Systems Approach

- Networked lighting controls should be characterized as an **LED + NLC system measure** within TRMs.
- EE programs should evaluate program design opportunities and incentive **strategies that promote LED lighting and networked lighting controls as a system**.

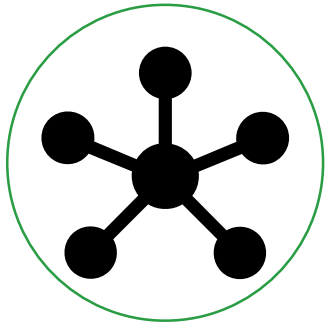
Desired Outcomes



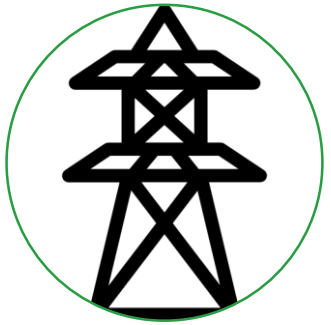
Better represent the impacts of policies and programs

Minimize cost-effectiveness challenges / maximize lifetime and peak savings

Limit stranded savings by increasing the adoption of NLCs



Enable integration with other building systems



Establish a foundation for grid-interactive efficient buildings (GEB)

C&I Lighting Lifetime and Peak Demand Savings Analysis

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