TUESDAY, DECEMBER 16, 2025

Technology feature: advanced and networked lighting controls

Ed Rubinstein
BSc, MSc & CEM

ieso
Connecting Today.
Powering Tomorrow.

SAVE ON ENERGY
POWER WHAT'S NEXT

A podcast by Save on Energy: The Energy Manager's Playbook

Presented by IESO's Save on Energy training and support team:

- ❑ Features real-world stories from Ontario's energy management community
- ❑ Covers the industrial, institutional, commercial and municipal sectors
- ❑ Focused on challenges, successes and practical insights
- ❑ Bite-sized episodes for quick and impactful learning
- ❑ A resource for energy professionals and decision-makers

Questions or feedback?
trainingandsupport@ieso.ca

Tune in on your preferred platform:
saveonenergy.ca/training-and-support/podcast

ieso Connecting Today. Powering Tomorrow.

SAVE ON ENERGY POWER WHAT'S NEXT

Agenda

1. Lighting basics
2. Introduction to advanced/networked lighting controls
3. Lighting control system design
4. Lighting control strategies
5. Case studies

Objectives

- Define and explore the core technologies and relative benefits of advanced networked and luminaire lighting controls and explain their roles in enhancing building energy efficiency, occupant comfort, safety and performance
- Identify and describe major lighting control strategies
- Analyze case studies and practical examples of buildings using advanced lighting controls, highlighting measurable benefits

01 – Lighting basics

What are lighting controls?

- Lighting controls are a collection of devices that allow us to control when and how lights are operated.
- Lighting controls range from a sophisticated network of sensors, devices and algorithms to a simple toggle switch on a wall.

Why do we use lighting controls?

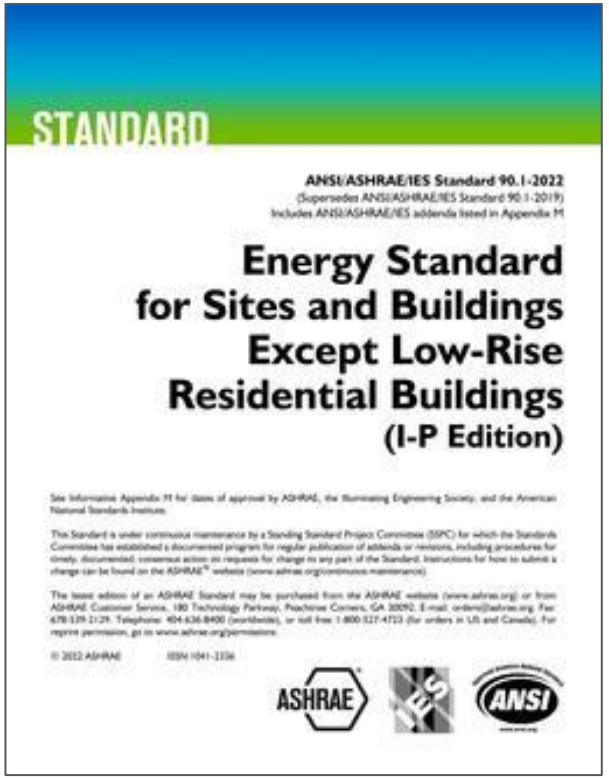
- The goal of lighting control systems is to deliver the right quantity of light of the appropriate quality at the right place during the right time.

Lighting quantity

- **Illuminance** tells you how brightly a surface is lit (i.e. how much light falls on a surface, not how bright the light source is):
  - 1 lux = 1 lumen per square meter
  - 1 footcandle = 1 lumen per square foot

Lighting quantity cont'd

- **Lighting power density (LPD)** is the amount of electrical power used for lighting per unit area, usually measured in watts per square meter or square foot.

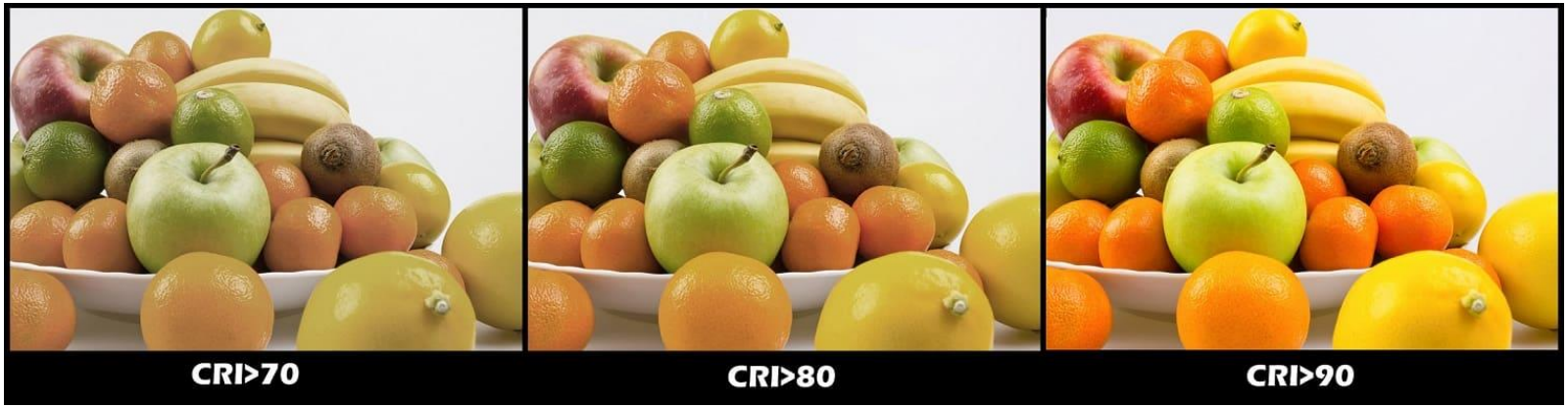


Lighting quality - 1

- **Correlated colour temperature (CCT)** is a measure of the colour appearance of light, expressed in kelvin (K), that describes whether light looks warm (yellow/red) or cool (blue).

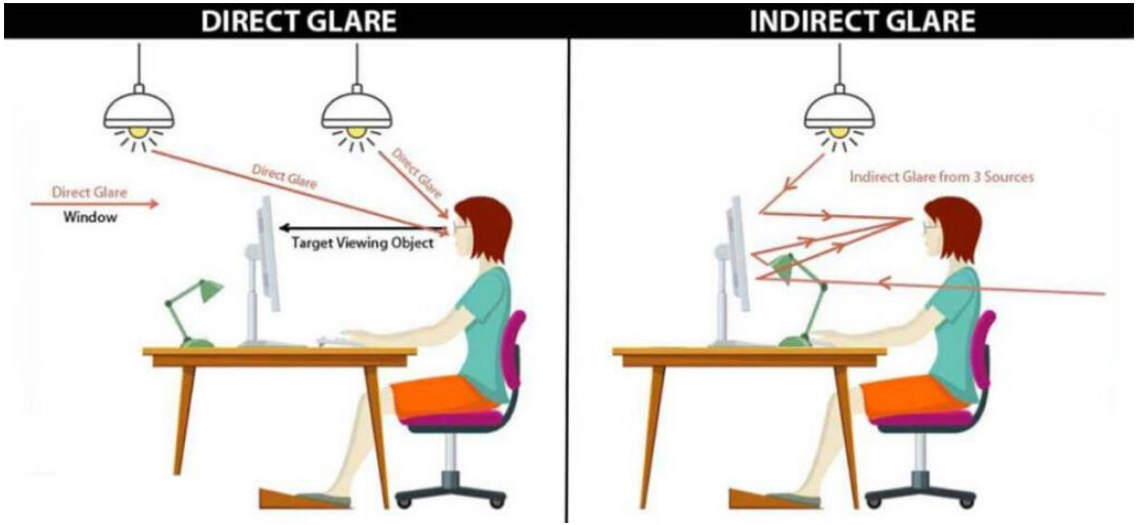
Lighting quality - 2

- **The Colour rendering index (CRI)** is a measure of how accurately a light source shows the true colours of objects compared to natural light.



Lighting quality - 3

- **Lighting glare** is visual discomfort or reduced visibility caused by overly bright light or strong contrast in a person's field of view.



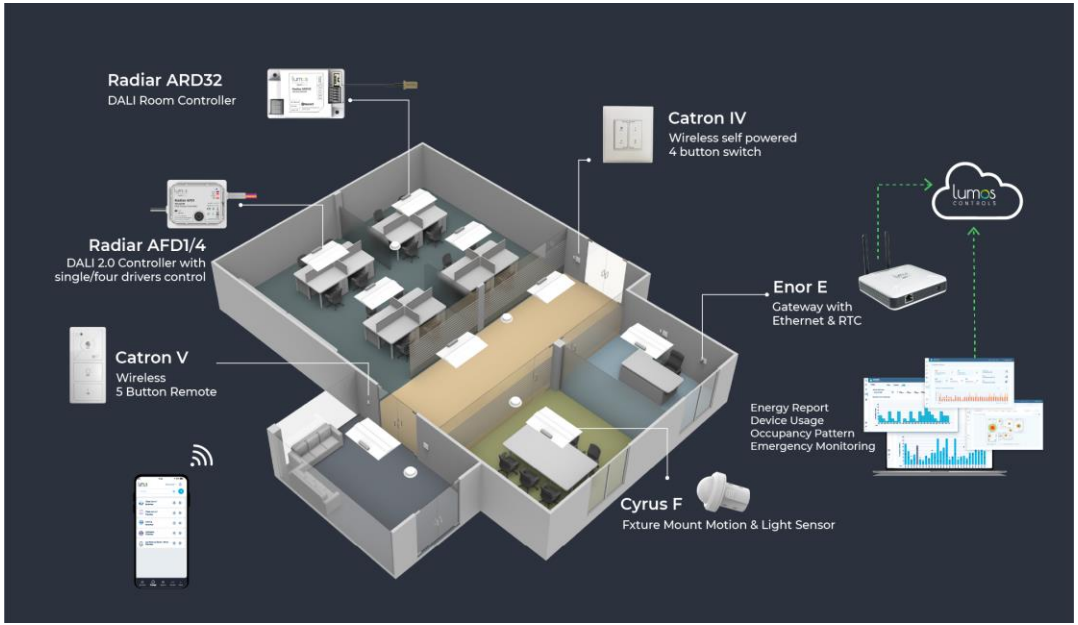
02 - Introduction to advanced and networked lighting controls

What are advanced and networked lighting controls?

- **Advanced lighting controls (ALCs)** are systems that automate lighting based on occupancy, daylight, schedules and user preferences that go beyond basic switches and dimmers.

What are advanced and networked lighting controls? cont'd

- **Networked lighting controls (NLCs)** are a subset of advanced lighting controls (ALCs) whereby devices communicate via digital networks (wired or wireless) for centralized or distributed control across buildings or campuses.



Benefits of advanced and networked lighting controls I

- **Reduced energy consumption** by automatically adjusting lighting levels (off/on, dimming) based on occupancy, daylight, schedules and user needs, reducing unnecessary usage:

Control strategy	Average lighting energy savings
Occupancy/vacancy sensors	25–30%
Daylight harvesting	20–40%
Time scheduling	10–25%
Task tuning	10–20%
Personal controls	10–20%
Combined strategies	Up to 40% or more
Networked lighting controls	Often exceed 50% savings

(https://inside.lighting/news/23-11/economic-benefits-advanced-lighting-controls)

Benefits of advanced and networked lighting controls II

- Potential to **enhance lighting quality and experience** by adjusting lighting levels and colours to meet user needs

Benefits of advanced and networked lighting controls III

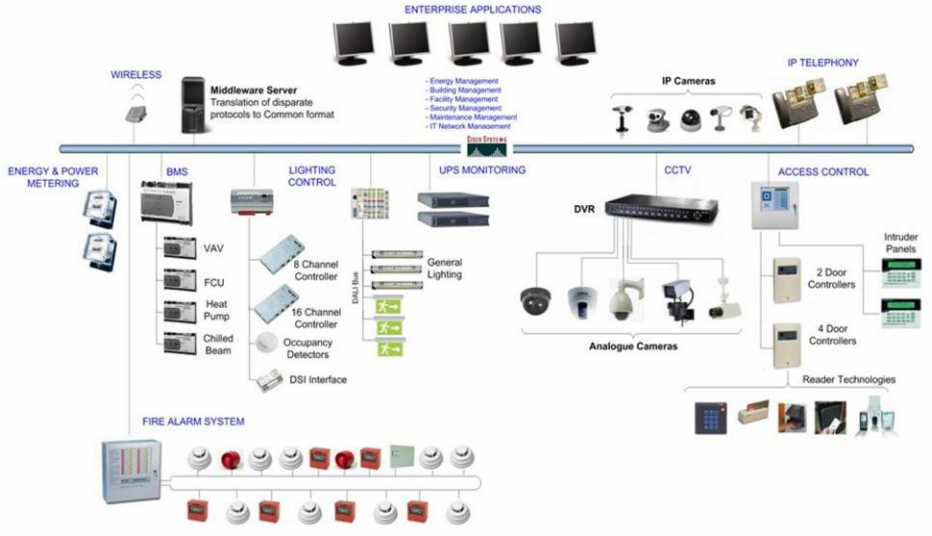
- Networked lighting controls enable real-time **remote monitoring** to support lighting maintenance (reactive and predictive), collection of data for analytics (e.g. occupancy, energy use, etc.) and security.

Benefits of advanced and networked lighting controls IV

- In addition to remote monitoring and integration with security systems, advanced lighting controls have the potential to **enhance safety and security** by:
  - Providing building occupants with cues for other or unexpected occupancy
  - Simulating building occupancy
  - Using scene-based lighting as part of emergency response

Benefits of advanced and networked lighting controls V

- Networked lighting controls can be integrated with other building systems to improve overall building operations, efficiency, etc.:
  - HVAC
  - Building automation systems
  - Maintenance management
  - Security
  - Building access
  - Event calendars



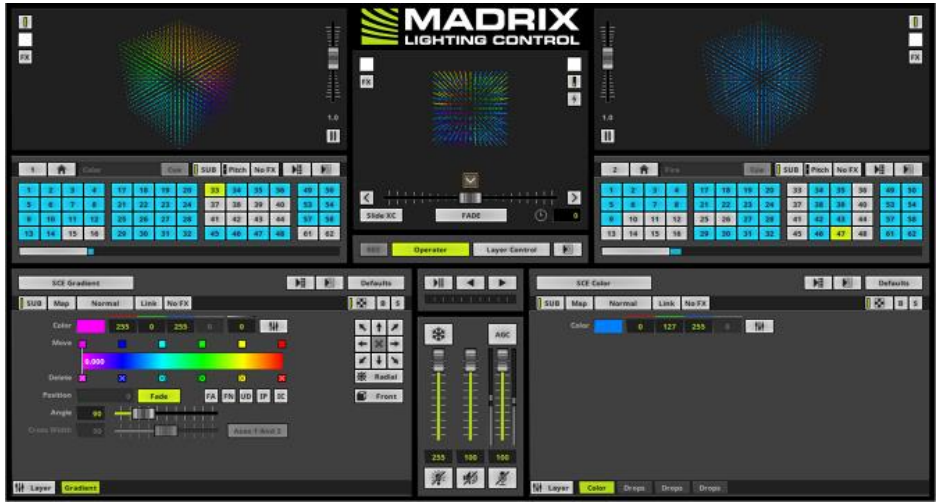
03 – Lighting control system design

Lighting control system components - 1

- **Hardware:** provides data to controls and adjusts lighting based on control strategies:
  - Sensors (occupancy, daylight)
  - Timers
  - Controllers
  - Wall switches
  - Wiring (information, power)
  - Wireless transmitters and receivers
  - Gateways
  - Luminaires

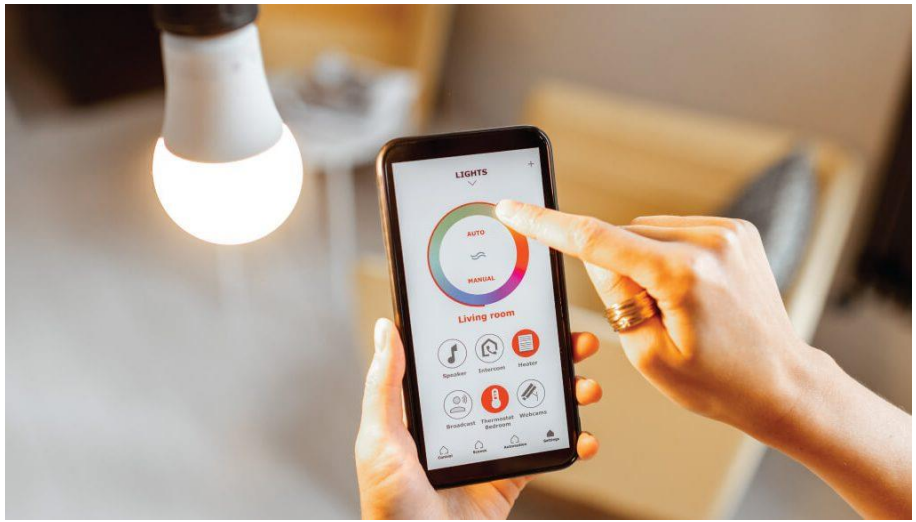
Lighting control system components - 2

- **Software (known as the lighting control brain):** enables users to configure, automate, monitor and optimize lighting performance across a building or network:
  - Can be pre-set or user programmable
  - Can be open source or proprietary
  - Often requires licensing fee; potential for software as a service (SaaS)



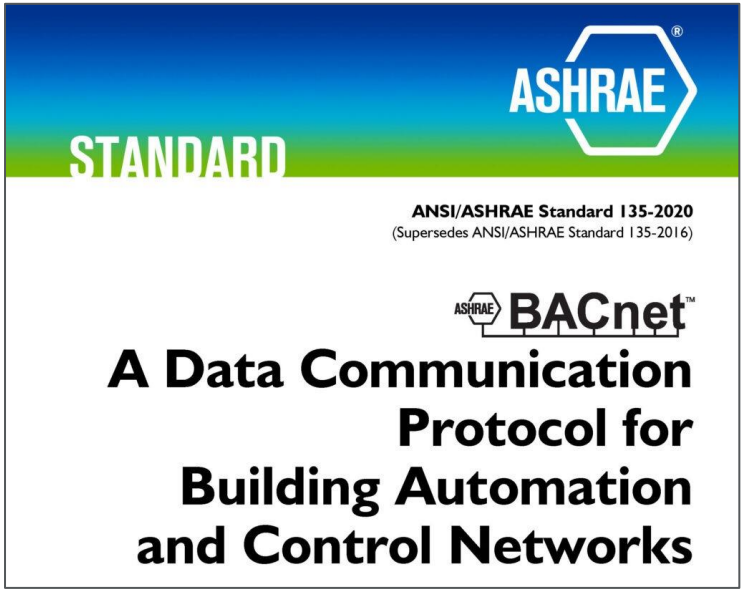
Lighting control system components - 3

- **User interfaces** allow people to interact with, monitor and manage the control system:
  - Wall-mounted switches and panels
  - Mobile apps
  - Dashboards



Lighting control system components - 4

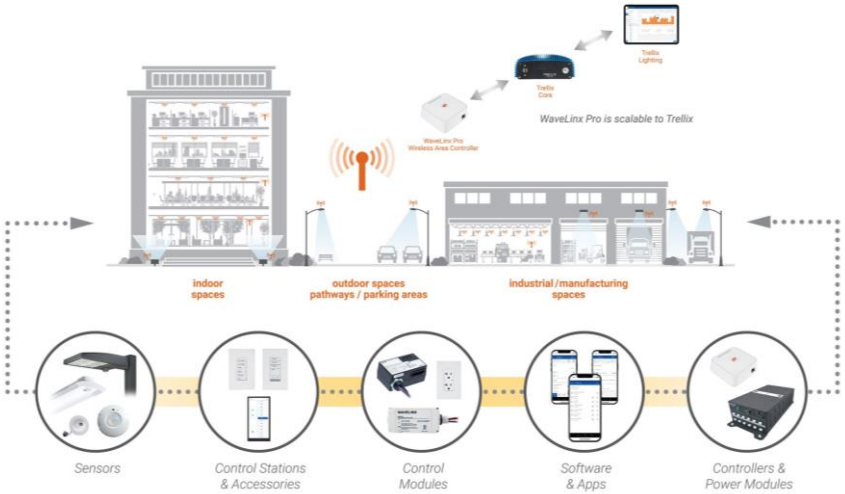
- **Communication protocols:** the language used to send data to and commands from lighting controllers:
  - Open source and standardized (e.g. BACnet): allows use of lighting control components from various manufacturers as well as potential for integration with other building systems
  - Proprietary: may limit choice of lighting control components to a single manufacturer



Approaches to lighting control system design - 1

- **Centralized control** systems have all system components connected to a single, central controller.

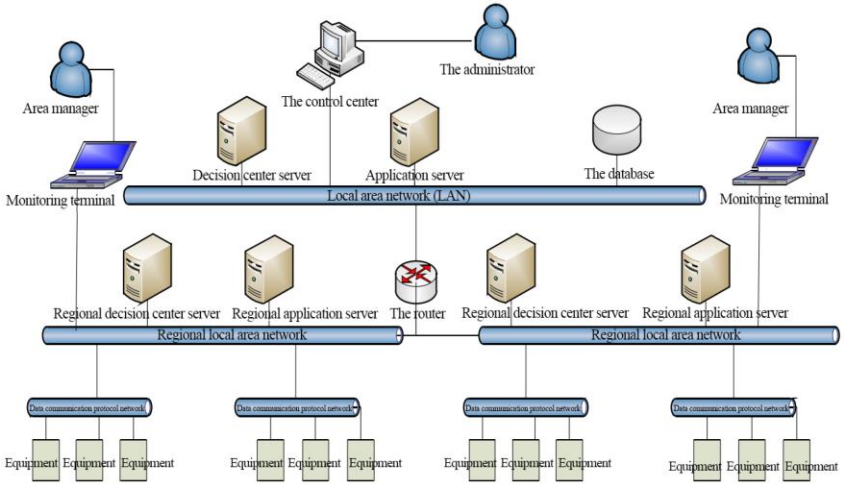
Pros	Cons
• Allows lighting control from a single location • Facilitates high level of integration with other building systems	• Often requires long cable runs • Potential for single point of failure



Approaches to lighting control system design - 2

- **Distributed control** systems use multiple controllers to manage lighting at the zone or floor level.

Pros	Cons
• Avoids potential for single point of failure • May be less expensive than centralized control • Can offer greater user customization	• May not offer "single seat" monitoring and control



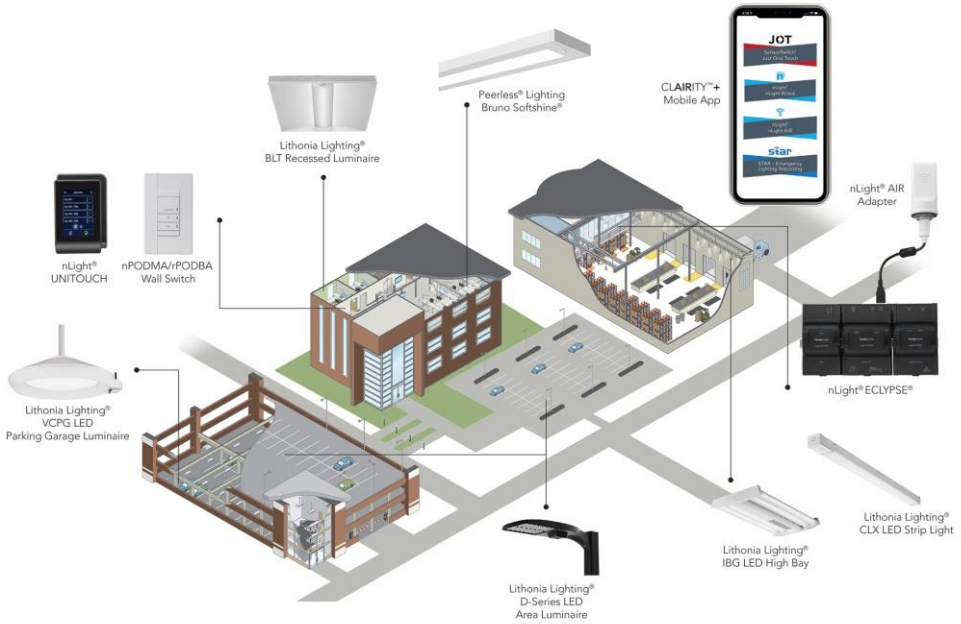
Approaches to lighting control system design - 3

- **Luminaire level lighting controls (LLLCs)** use sensors and controllers embedded directly into each light fixture.

Pros	Cons
• Allows maximum/granular user customization • Easier to retrofit and expand systems • Less expensive to install	• Typically doesn't offer "single seat" monitoring and control • Unable to implement sophisticated control strategies

Approaches to lighting control system design - 4

- **Hybrid control** systems incorporate centralized, distributed and/or luminaire level lighting control throughout a building based on space utilization, lighting requirements, occupancy, installation and maintenance costs, etc.



Approaches to lighting control system design - 5

	Centralized control systems	Distributed control systems	Luminaire level lighting controls (LLLCs)
Control logic location	Singled centralized controller	Multiple control modules near the spaces they serve	Sensors and controllers, integrated directly into each light fixture
Wiring	Low-voltage wiring from fixtures and sensors to the central panel	Localized wiring with potential for wireless communication	Minimal wiring required
Scalability and flexibility	Changes require reprogramming at the central controller; additional wiring needed to scale	Highly scalable and easy to expand or rezone without rewiring	Extremely flexible
Initial cost	Potential higher costs due to central controller and wiring	Generally low costs, especially for small spaces or retrofits	Often cost-effective due to lower labour/material costs
Maintenance	Requires expert knowledge for setup and maintenance	Easier for electricians to work with normal wiring; maintenance is more distributed	Maintenance is simplified and often contained to individual units

Approaches to lighting control system design - 6

- **Centralized systems** may be better suited for new construction (where pre-wiring is easier) and a high degree of unified and sophisticated scene setting is desired.

- **Distributed systems** (including LLLCs) excel in flexibility, scalability and ease of installation (especially for retrofits) and may be best suited for areas that require robust, localized control.

04 – Lighting control strategies

Lighting control strategies - 1

- **Occupancy/vacancy sensing**
  - **Occupancy sensors** turn lights on/off automatically and provide convenience in high-traffic areas (e.g. hallways, laundry rooms, etc.).
  - **Vacancy sensors** require manual switching to turn lights on, but they turn lights off automatically and can provide greater savings in areas where occupancy does not always require lighting (e.g. closets, rooms where people pop in for short periods).

Lighting control strategies - 2

- **Active sensors** detect motion via ultrasonic sound waves.
- **Passive sensors** use infrared to detect heat changes.
- **Dual-mode sensors:**
  - Require both ultrasound and passive infrared to detect occupancy simultaneously to turn lights on; ensure lights are not accidently turned on (e.g. by air currents, activity outside of the room, etc.)
  - Require one of the modes to continue to detect occupancy to keep the lights on; reduce chance of lights turning off while space is still occupied

Lighting control strategies - 3

- **Daylight harvesting** uses photoelectric sensors to modulate artificial lighting based on available daylight.

Lighting control strategies - 4

- **Time scheduling** operates lights on pre-set schedules based on expected occupancy and/or available daylight and includes astronomical timers that adjust schedules according to changes in sunrise/sunset times with the seasons.

Lighting control strategies - 5

- **Colour tuning** adjusts the correlated colour temperature (CCT) to support circadian rhythms, mood special themes, etc.

Lighting control strategies - 6

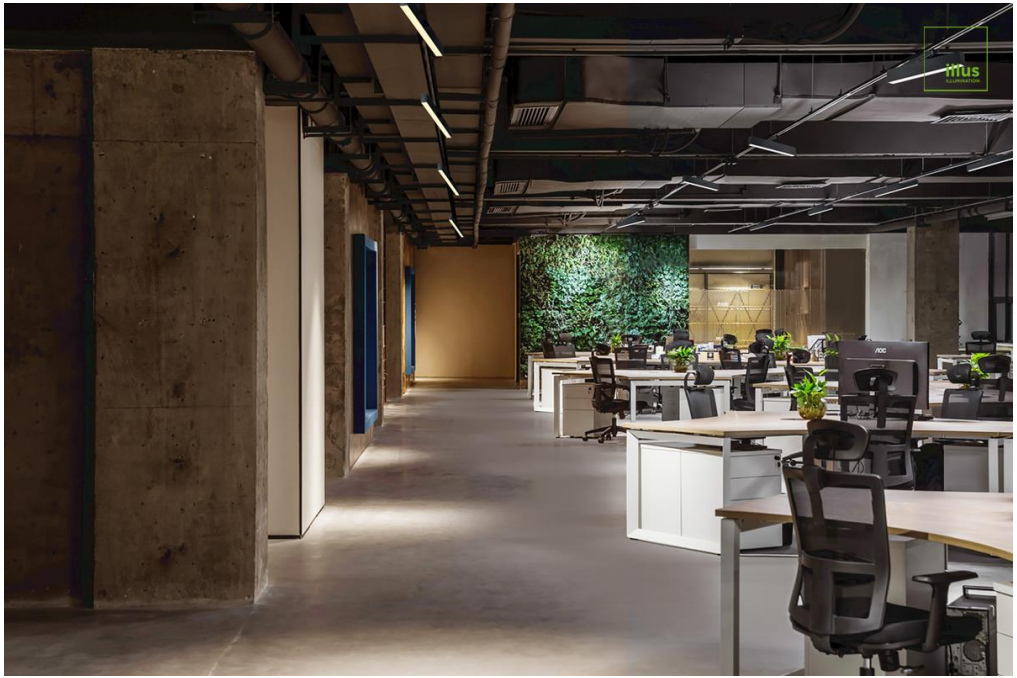
- **Task tuning/high-end trim** adjusts lighting levels to meet changing requirements and/or caps light output (e.g. at 70–80% of maximum) to reduce energy use while maintaining safety and comfort.

Lighting control strategies - 7

- **Demand response** lowers lighting levels in response to grid signals (e.g. price, peak demand, etc.) to reduce lighting energy costs.

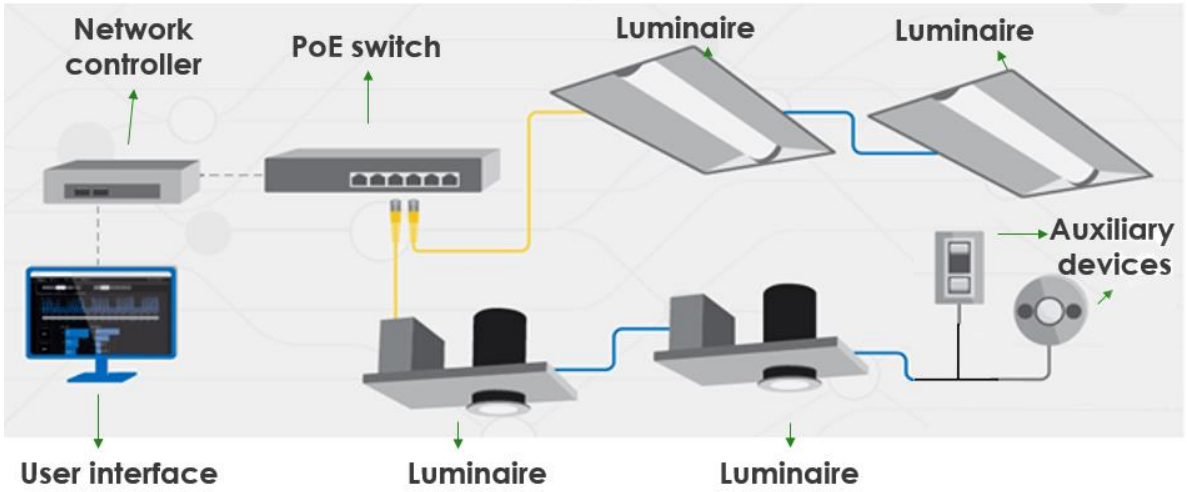
Lighting control strategies - 8

- **Personal control zones** allow occupants to control individual fixtures or small zones in their specific area.



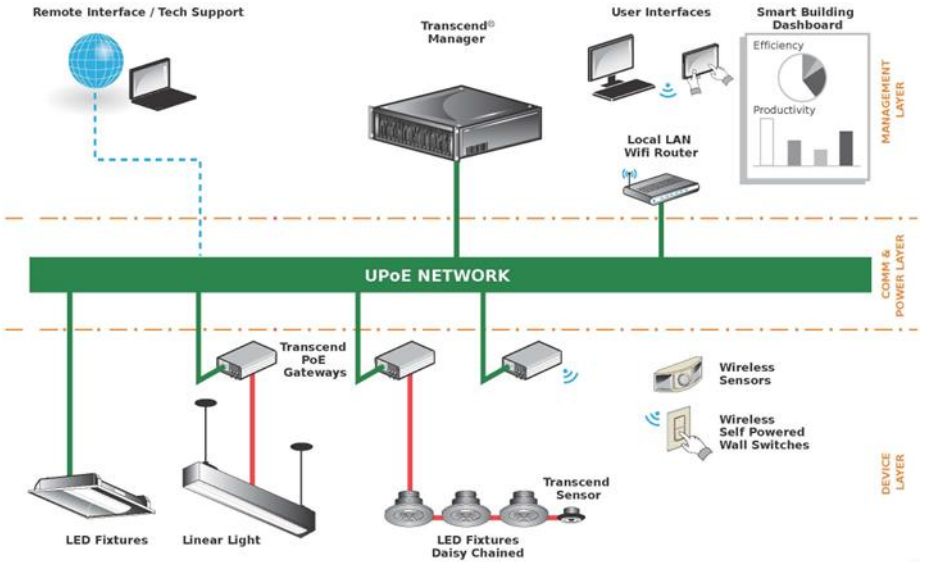
Power over ethernet (PoE) lighting

- **Power over ethernet (PoE)** lighting is a technology that delivers both electrical power and data to/from lighting control system components using standard Cat 5/6 ethernet cables, eliminating the need for separate wiring.



Power over Ethernet (PoE) lighting cont'd

- Allows for individual fixture control
- Eliminates high-voltage wiring
- Easy to reconfigure/add components
- Facilitates data collection and analytics
- Needs to take into account:
  - Cybersecurity
  - Cable distances
  - Maximum power load of switches
  - IT space and cooling requirements



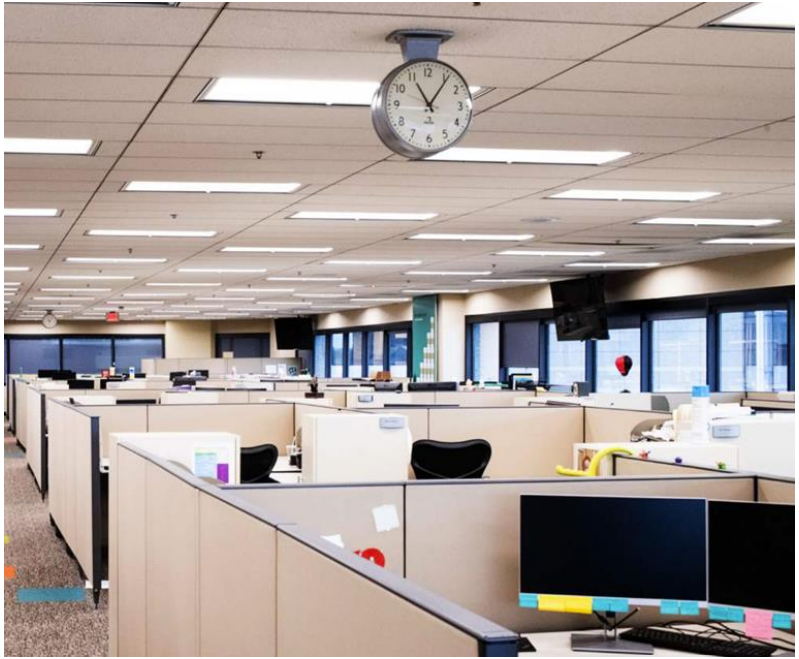
Practical considerations

- More sophisticated control systems allow the layering and combining of multiple strategies.
- The more sophisticated the control system, the higher the maintenance costs for sensors, controllers, software, etc.
- It is important to include "fail on" strategies so that lighting reverts to full output and normal colour in the event of component failure or loss of system communications.

05 – Case studies

Case study #1

- 17-storey, 470,317 ft^2 office tower
- 3,685 Bluetooth mesh lighting controllers integrated into each luminaire
- Occupancy/vacancy sensing, scheduling, manual control, high-end trim
- 75% lighting energy savings



https://designlights.org/wp-content/uploads/2024/12/silvair_emc_mw_connect_casestudy.pdf

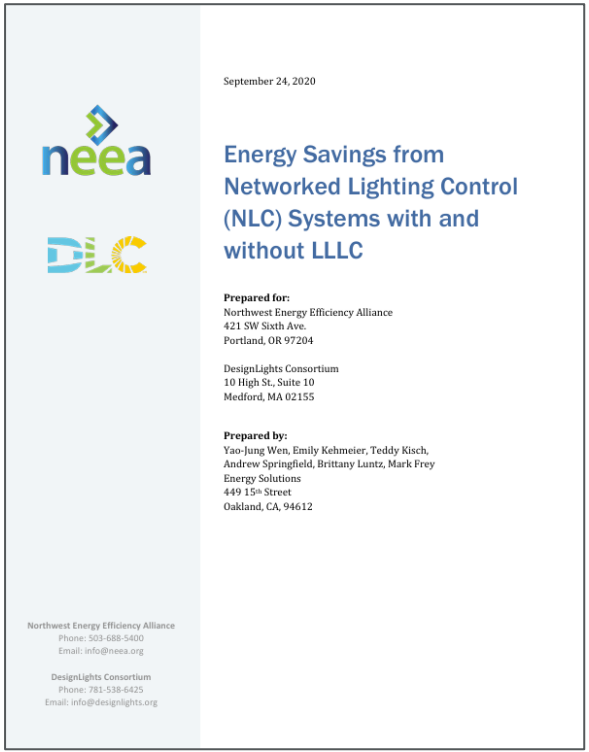
Case study #2

- Empire State Building
- Daylight and occupancy sensing, wireless communication, dimming ballasts
- 60% lighting energy savings
- Three-year simple payback period

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-33859.pdf

Case study #3

- Meta study of almost 200 lighting control projects
- Average 49% lighting energy savings (range 10-75%)
- Two to five-year payback
- Systems with LLLCs demonstrated higher savings (more study needed)



September 24, 2020

Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC

Prepared for:
Northwest Energy Efficiency Alliance
421 SW Sixth Ave.
Portland, OR 97204

DesignLights Consortium
10 High St., Suite 10
Medford, MA 02155

Prepared by:
Yao-Jung Wen, Emily Kehmeier, Teddy Kisch, Andrew Springfield, Brittany Luntz, Mark Frey
Energy Solutions
449 15th Street
Oakland, CA, 94612

Northwest Energy Efficiency Alliance
Phone: 503-688-5400
Email: info@neea.org

DesignLights Consortium
Phone: 781-538-6425
Email: info@designlights.org

https://designlights.org/wp-content/uploads/2021/01/Energy-Savings-From-Networked-Lighting-Controls-with-and-without-LLLC_FINAL_09242020.pdf?utm_source=chatgpt.com

Questions?

Save on Energy's Capability Building Program

- Save on Energy's Capability Building program helps increase awareness of energy-efficiency opportunities, enhance knowledge and develop skills in organizations and communities across Ontario so they can undertake energy-efficiency actions and participate in Save on Energy programs.
- The program includes tools such as workshops, webinars, training courses, coaching, peer learning and information resources including guides and videos.

Learn more at
https://saveonenergy.ca/Training-and-Support
Register at
www.saveonenergytraining.ca

Training courses – incentives

Save on Energy offers incentives of up to 50% for ~20 training courses, plus certification exam fees, including:

- Achieving Net-Zero Buildings
- Energy Management and the ISO 50001 Standard
- HVAC Optimization for High Performance Sustainable Buildings
- Certified Energy Manager (CEM)
- Certified Measurement & Verification Professional® (CMVP)

Learn more at https://saveonenergy.ca/Training-and-Support/Training-Courses

Training courses – incentives for Enbridge customers

Enbridge customers are eligible for incentives of up to 75% for three courses:

- Dollars to $ense Workshops: up to $500 a day
- Certified Sustainable Building Operator® (CSBO): up to $2,250 of course fees
- Certified Energy Manager® (CEM): up to $2,500 of course fees

Stay connected with tools and resources

- Virtual one-on-one coaching: post-webinar support intake form for tailored support for organizations to manage energy resources effectively
- Monthly bulletin: sign up to receive monthly training updates on all Save on Energy training and support for new tools and resources
- Live training calendar: visit this page to easily register for upcoming events and workshops
- Training and support webpage: visit this page to access all training and support materials

Post-webinar support

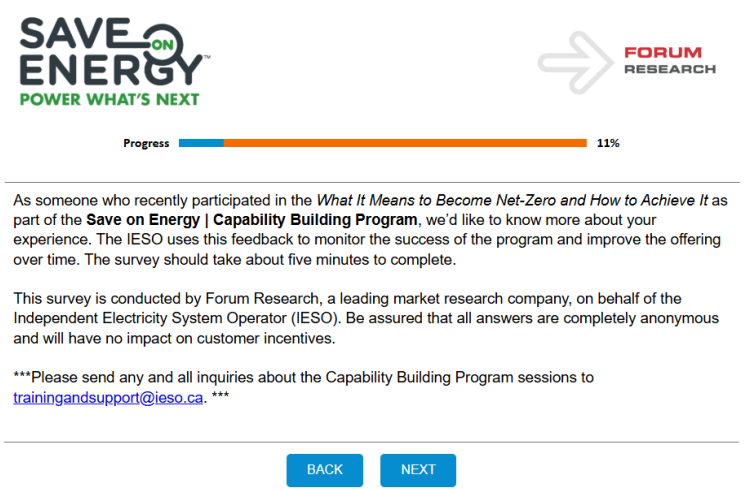
One-on-one coaching: tailored support for managing energy resources effectively

Post-webinar support intake form

Coaching sessions conducted virtually: phone, video calls and email

Designed for organizations, new or old, seeking guidance

Upcoming survey: we want your feedback!



Check your email! A survey is coming your way soon.

Why? Help us improve our training programs.

Who? Conducted by Forum Research on behalf of the IESO.

Time? Takes only five minutes to complete.

Confidentiality: Your responses are anonymous and won't impact participation or incentives.

The survey will be sent from:
surveyinfo@forumresearch.com

Thank you!

SaveOnEnergy.ca/Training-and-Support

trainingandsupport@ieso.ca

@SaveOnEnergyOnt

facebook.com/SaveOnEnergyOntario

linkedin.com/showcase/
SaveOnEnergy-Ontario

Sign up for Save on Energy's quarterly business newsletters for the latest program, resource and event updates

ieso
Connecting Today.
Powering Tomorrow.

SAVE ON ENERGY
POWER WHAT'S NEXT