

Ameren Illinois Energy Efficiency Program

Power Lunch

June 8, 2022

Networked Lighting Controls

WELCOME
— WE ARE —

OPEN

— PLEASE COME IN —

Steve Mesh professional affiliations

Illuminating Engineering Society

Northeast Regional Vice President, 2007-2008

Energy Management Committee member for 25 years

Former Quality of the Visual Environment Committee member

IES/New York section Education Committee chairperson, 1999-2001

International Association of Lighting Designers

Former IALD Corporate Member

1997 Intern Program administrator

American Institute of Architects

AIA Registered Provider, 2003-2008

- **Invited speaker:**

- LightFair (1992, 2007-2013, 2016, 2017, 2020)
- Lux Pacifica (New Delhi, India – 2002)

LC:

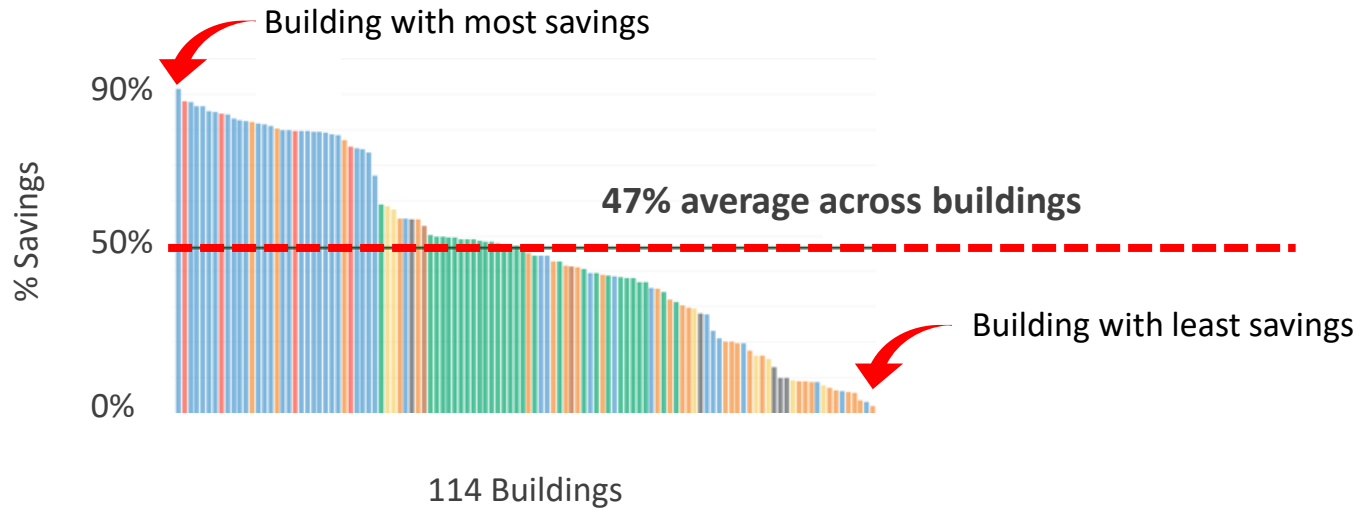
- “Lighting Certified”
- “Item Writer”

Young Eagles pilot



DLC (DesignLights Consortium) study

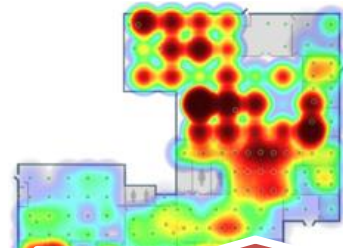
- Average savings in lighting energy from lighting controls – **47%**
- Data was from voluntary contributions
- Individual buildings: lighting control savings ranged from **2%-90%**
- Search “DLC Energy Savings Report” online to download the full report and webinar
- Other utility auditing groups are beginning to confirm similar values to this report’s averages



Non-energy benefits of LLC systems



Asset Tracking



Space Utilization



Indoor Positioning



Diagnose and Report



Conference Room Scheduling



Security



Energy Tracking



Integrate with BMS/HVAC

A close-up, shallow depth-of-field photograph of hands typing on a laptop keyboard. The lighting is cool and blue-toned. A white rectangular box with a thin border is centered over the keyboard, containing the word "Definitions".

Definitions

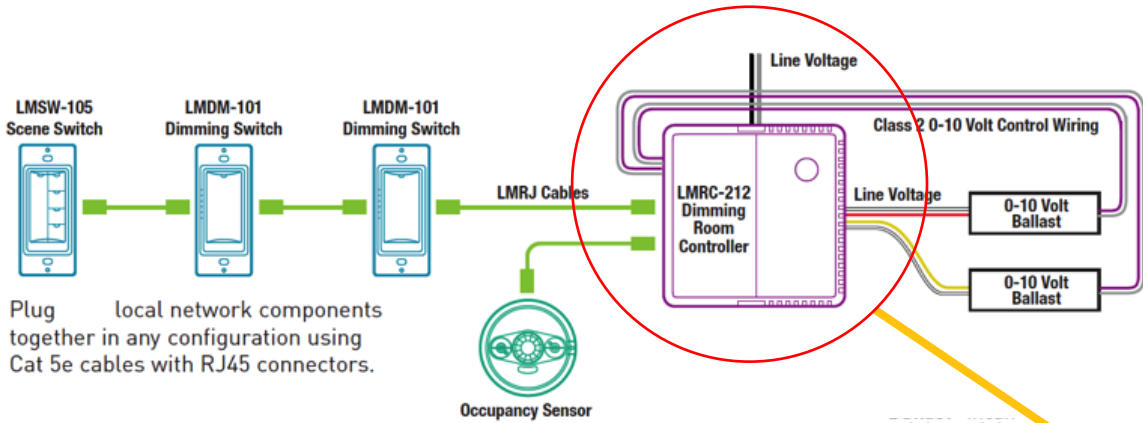
What are Room-Based Systems?

As defined by the DesignLights Consortium ...



“A “room-based system” is defined as follows: A system that is designed to control lighting in a **single room or space**, and where the control, configuration, and management of the system is **contained within the room or space** illuminated by the system. In order to interact with the system, (for instance, to change any settings or to download any data), a **user must be physically present** in, or in close proximity to, the room or space illuminated by the system.”

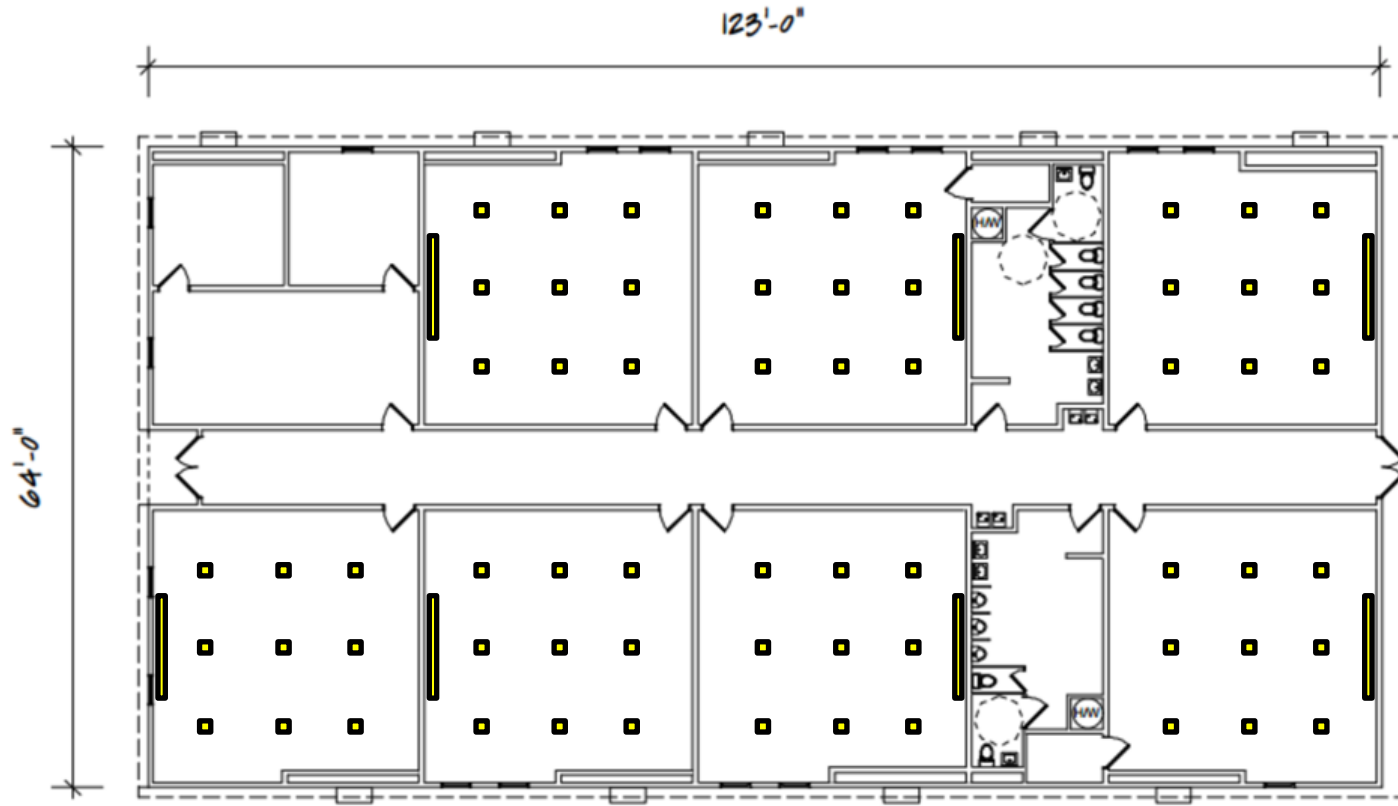
Room-Based System Topology



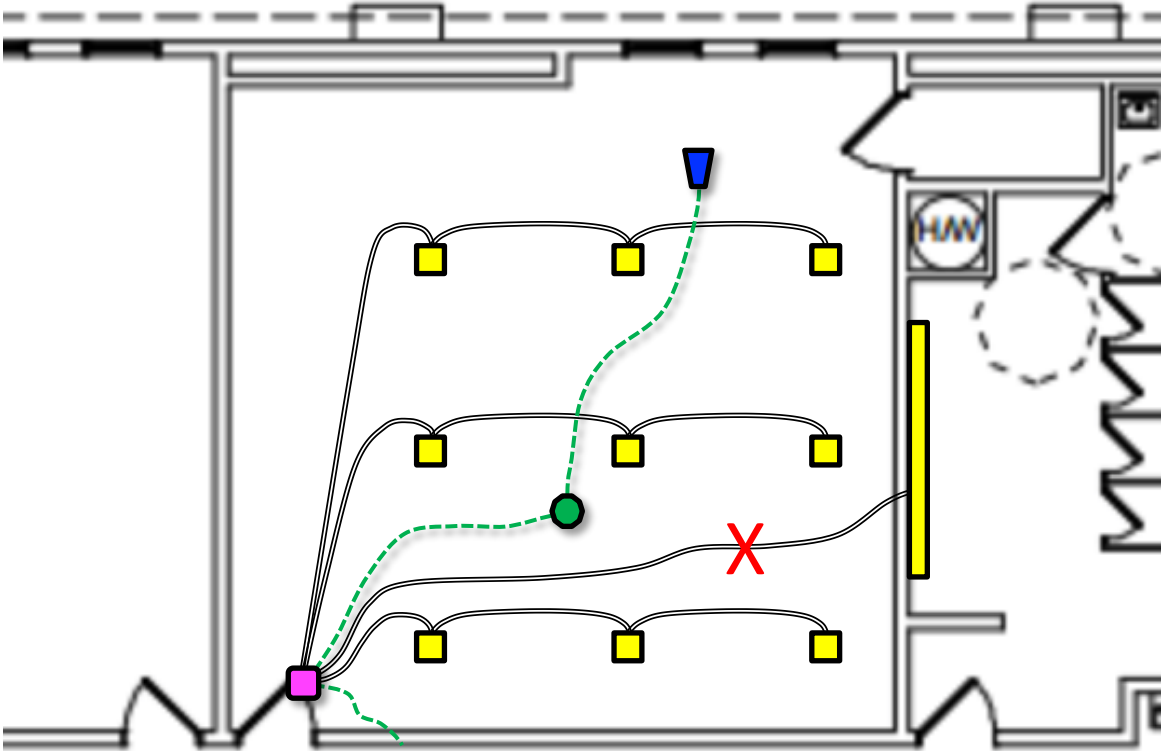
Plug local network components together in any configuration using Cat 5e cables with RJ45 connectors.



Room-Based System Topology (school example)



Room-Based System Topology



What are NLCs?

NLC = Networked Lighting Control system

As defined by the DesignLights Consortium ...

“Networked lighting control (NLC) systems: NLC systems are lighting systems with a combination of sensors, network interfaces, and controllers that effect lighting changes in luminaires, retrofit kits, or lamps.”

What are LLLCs?



LLLC = Luminaire Level Lighting Controls

As defined in the 2018 version of the Illinois Energy Conservation Code (based on IECC 2018 <International Energy Conservation Code>) ...

“LUMINAIRE-LEVEL LIGHTING CONTROLS. A lighting system consisting of one or more luminaires with embedded lighting control logic, occupancy and ambient light sensors, wireless networking capabilities and local override switching capability, where required.”

In plain English, **LLLC** means that fixtures must have:

Controller (to switch and dim)

Occupancy sensor

Photosensor

Wireless connection to network ([only according to code ... see next page for clarification](#))

What are LLLCs?



LLLCs are a type of **NLC** (Networked Lighting Control) system.

However, not all NLC systems use LLLCs (*as defined by the code*):

Some NLC systems with fixture-integrated controllers and sensors are **wired**.

Wired NLC systems that have fixture-integrated controllers and sensors **can still be used** in a project (even if it doesn't meet the "official" code designation of an LLLC system).

You can still get **Ameren Illinois incentives** for using these systems.

Some NLC systems – whether they are wired or wireless – do **not** use fixture-integrated sensors (or controllers).

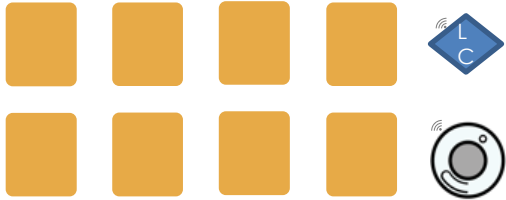
They use **zone-based** sensors and/or controllers.

Most important takeaway: regardless of whether a system uses a wired or wireless connection to the network – if it has fixture-integrated controllers and sensors, then it is considered an LLLC system by Ameren and eligible for financial incentives.

What is actually contained in each fixture?

NLC Configuration

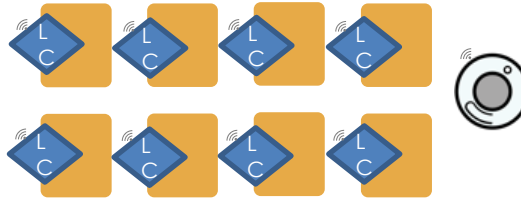
1 sensor : many fixtures



1 load controller : many fixtures

Individually Addressable

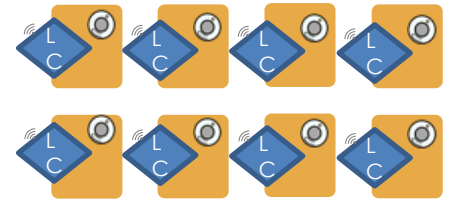
1 sensor: many fixtures



1 load controller : 1 fixtures


LLC (also individually addressable)

1 sensor : 1 fixtures



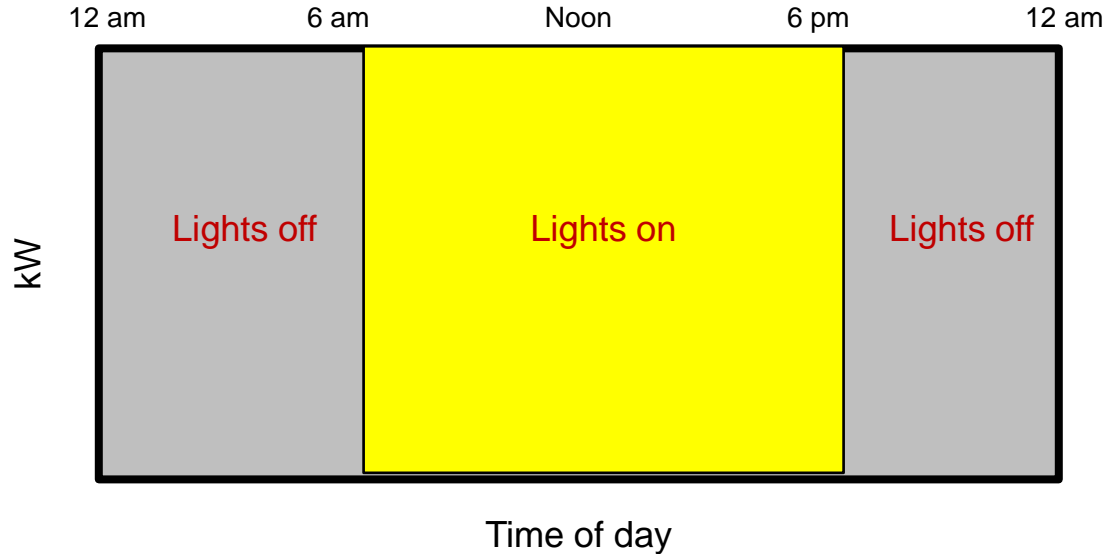
1 load controller : 1 fixtures

Courtesy of John Arthur Wilson



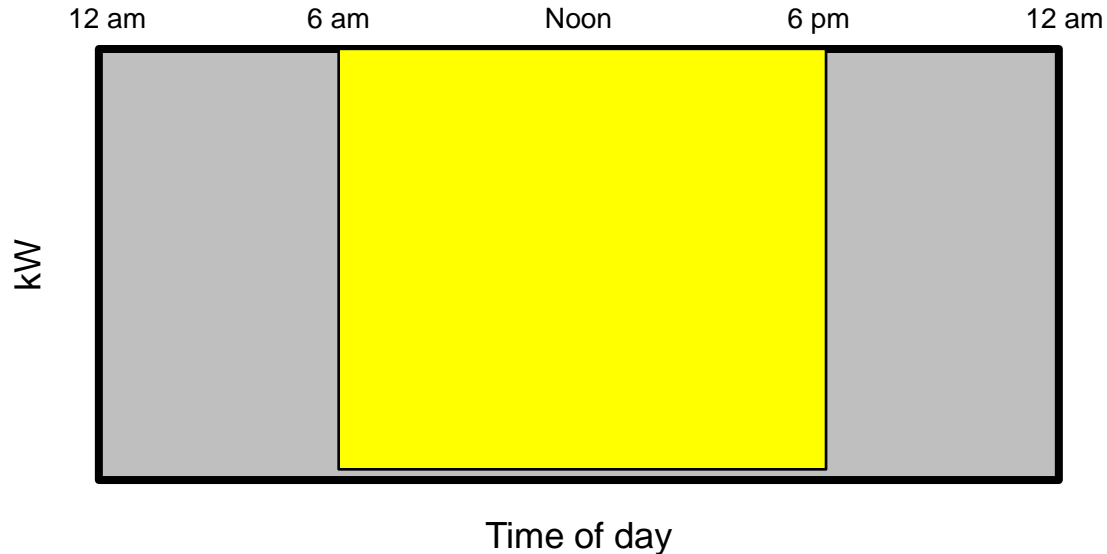
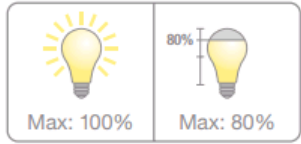
Control Strategies

Time Scheduling



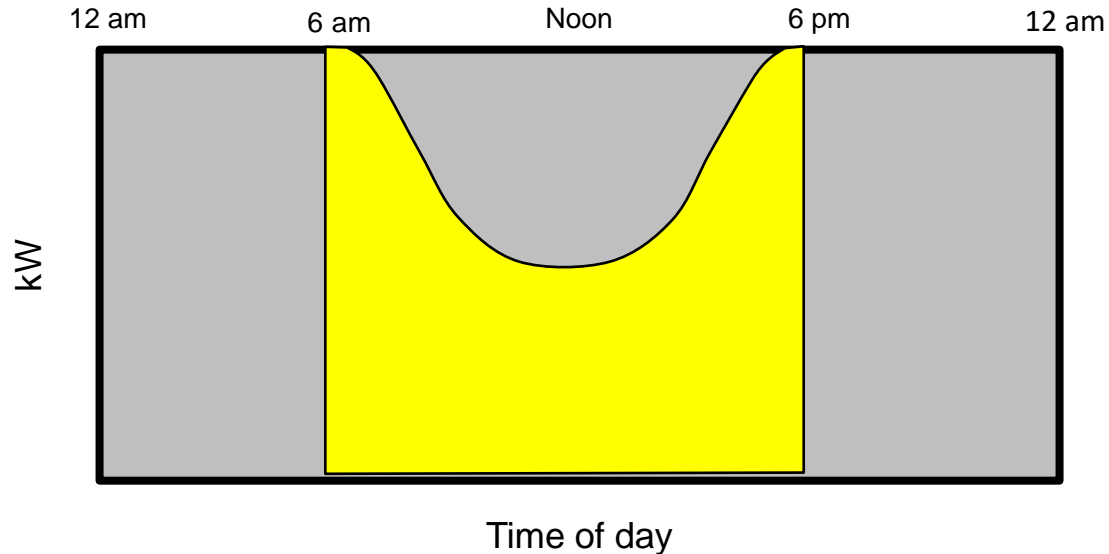
Turn off lights after hours or when a space is not normally used.

High-End Trim / Task Tuning



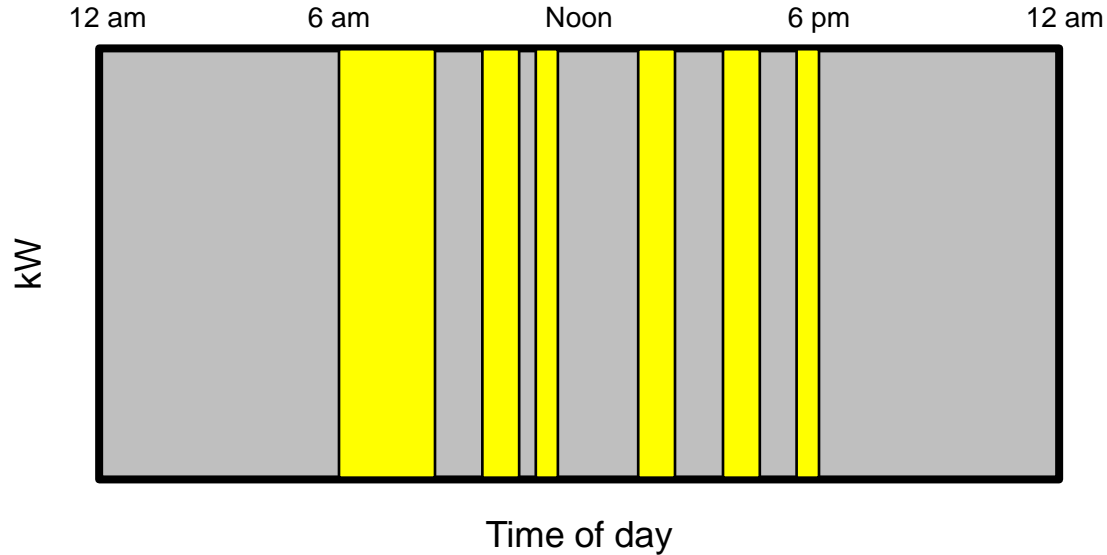
Reduce the maximum light level for an entire space or building during normal occupied hours.

Daylight Harvesting



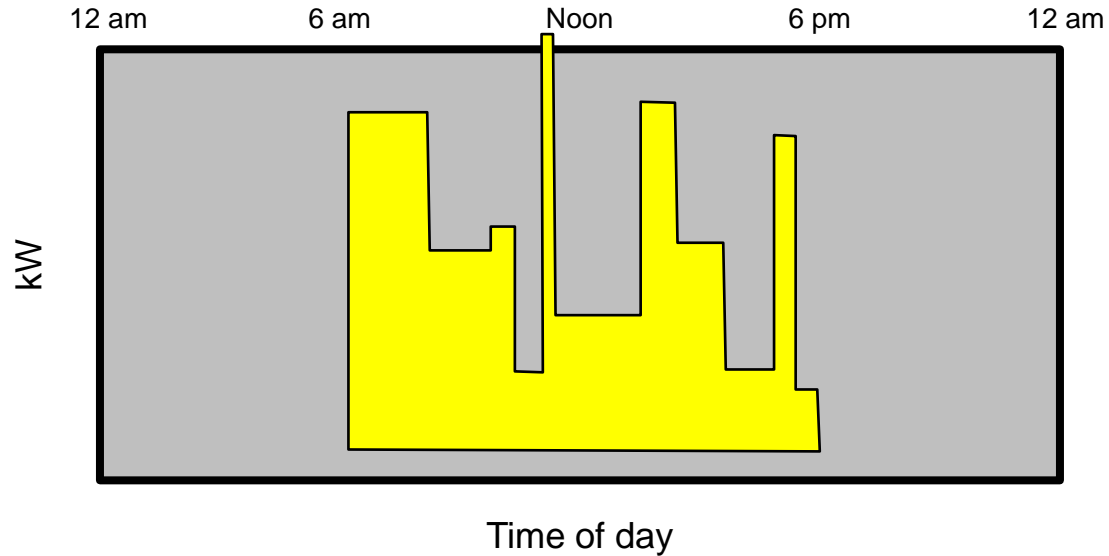
Dim or turn off lights based on available natural light.

Occupancy / Vacancy Sensing



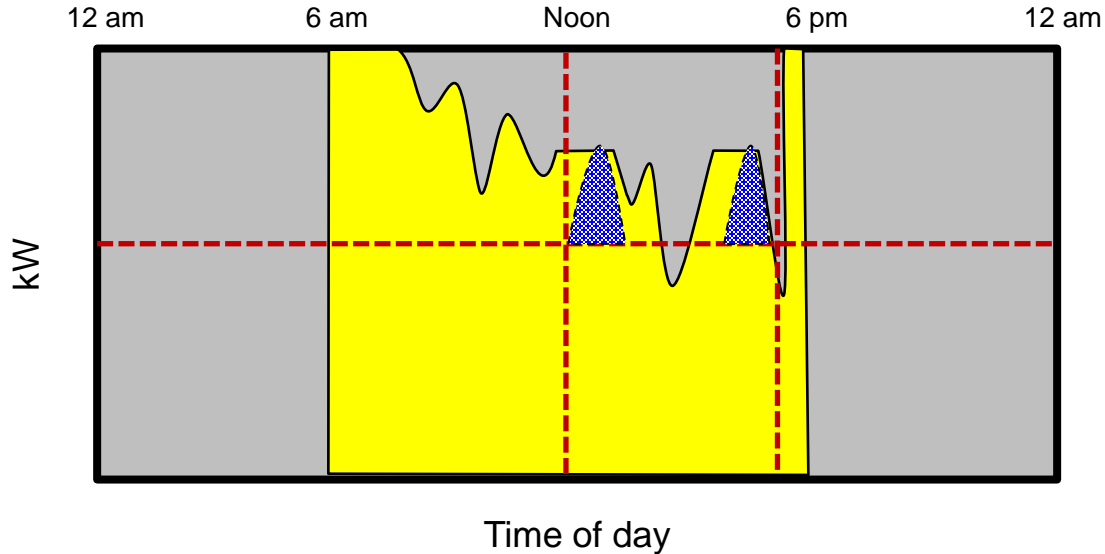
Turn off lights when the space is unoccupied (vacant).

Personal Control



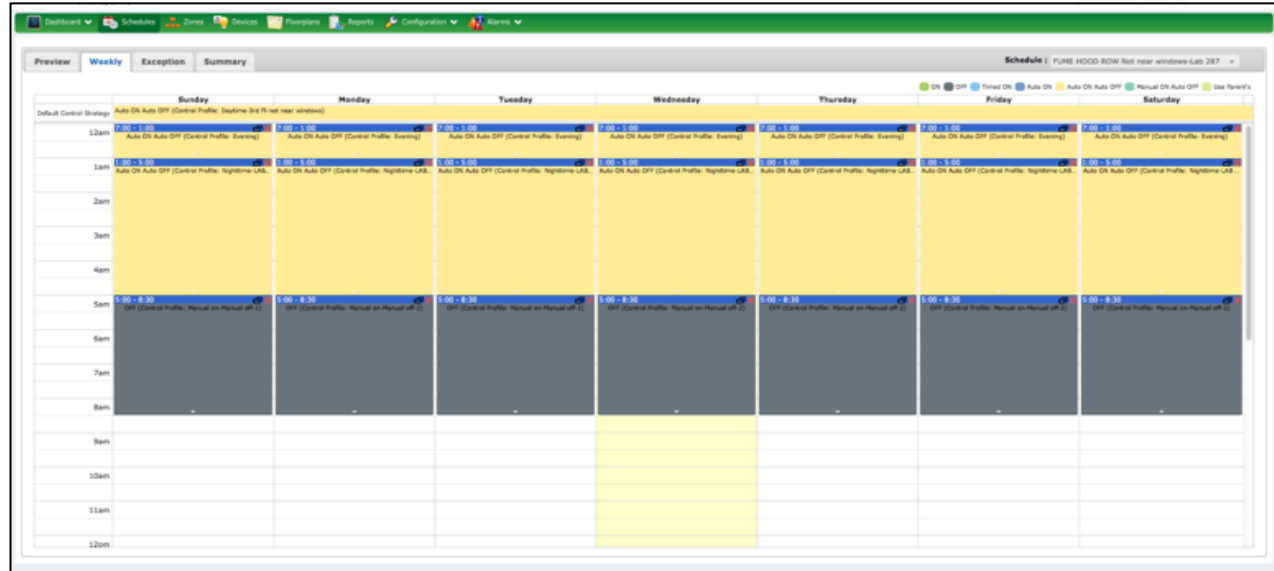
Dim or turn off lights based on personal preference or needs.

Variable Load Shedding (“Demand Response”)



Dim or turn off lights during periods of peak demand.

Time Scheduling



A large, purple, multi-pointed starburst graphic with a jagged, irregular shape, centered on the page. It contains the text "Sidebar Conversation" and "Target Light Levels" in yellow.

Sidebar Conversation
Target Light Levels

IES Illuminance Recommendations

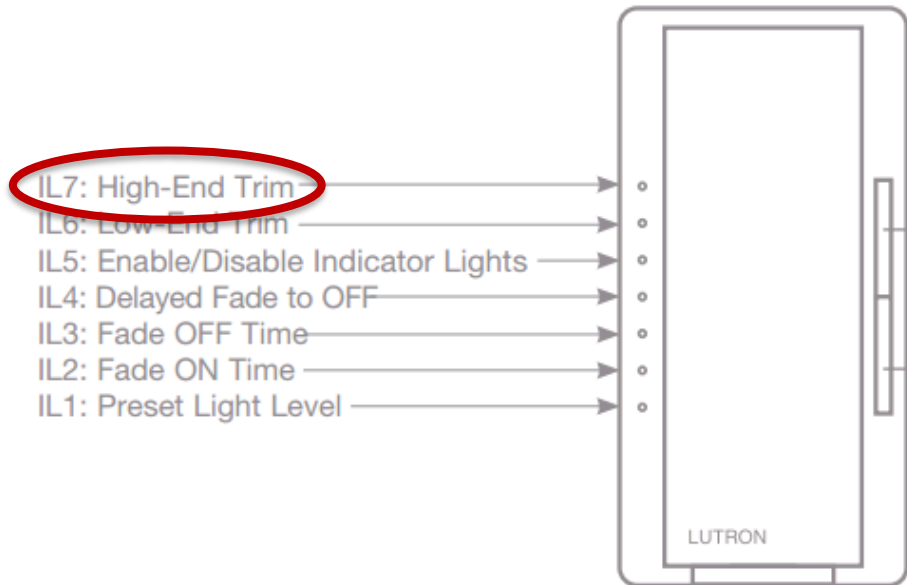
Applications | Lighting for Education

Table 24.2 | Educational Facilities Illuminance Recommendations continued from previous page

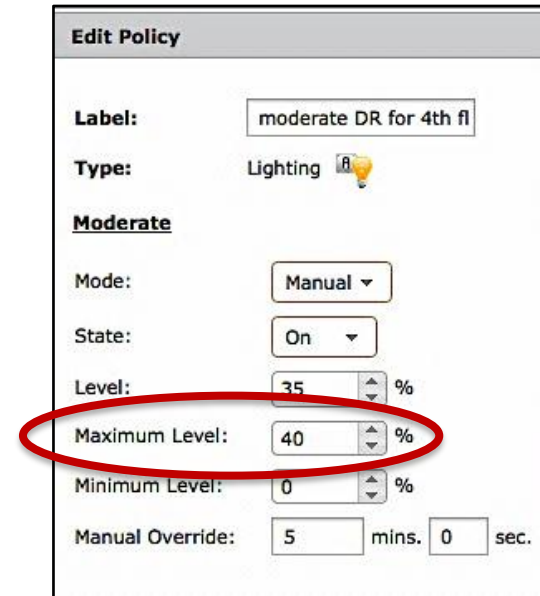
Applications and Tasks*	Notes	Recommended Maintained Illuminance Targets (lux) ^{a, b, d}										
		Horizontal (E _h) Targets					Vertical (E _v) Targets					
		Visual Ages of Observers (years) where at least half are					Visual Ages of Observers (years) where at least half are					
		<25	25-65	>65	Gauge	Category	<25	25-65	>65	Gauge	Category	
AUDITORIA	(continued)	Category				Gauge	Category				Gauge	
* Performance	Dedicated to artistic performances (likely fixed seating); For dedicated theaters see 28 LIGHTING FOR HOSPITALITY AND ENTERTAINMENT											
* House	As the architect coordinates contrast markings with steps, curbs, and ramps, localized lighting may be deemed appropriate.											
- During event		2	2	2	Min	F	5	10	20	Avg		
- Pre/Post event		L	37.5	75	150	Avg	K	25	50	100	Avg	
* Stage												
- Access ramps/stairs	See AUDITORIA/Circulation											
- Amateur productions												
- Dance (performance)	E _v @floor; E _v @5' AFF	P	150	300	600	Avg	R	250	500	1000	Avg	
- Demonstration		T	500	1000	3000	Avg	R	250	500	1000	Avg	
- Music		P	150	150	300	600	Avg	R	250	500	1000	Avg
- Theater	Simple, no stage lighting cues	P	150	300	600	Avg	P	150	300	600	Avg	
- Professional productions	Stage lighting as determined by production crew; See IES DG-20-09 Stage Lighting A Guide to the Planning of Theatres and Auditoriums for guidance on architectural and electrical infrastructure											
* Prefunction	Anteroom or transition space adjoining auditorium											

High-End Trim / Task Tuning

Advanced Dimmer with High-End Trim Capability




Software-based High-End Trim



Edit Policy

Label: moderate DR for 4th fl

Type: Lighting 

Moderate

Mode: Manual ▾

State: On ▾

Level: 35 %

Maximum Level: 40 %

Minimum Level: 0 %

Manual Override: 5 mins. 0 sec.

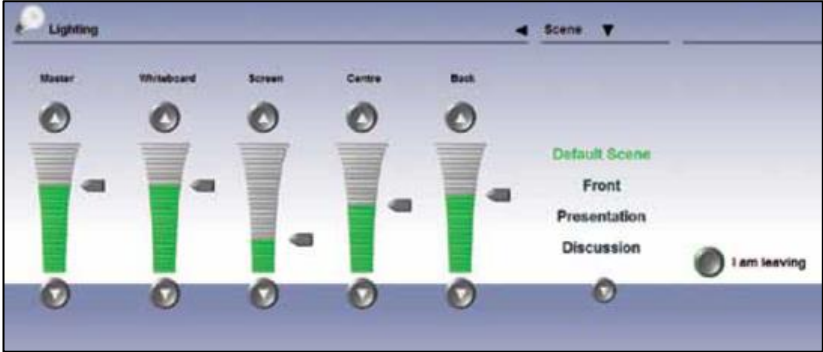
Daylight Harvesting



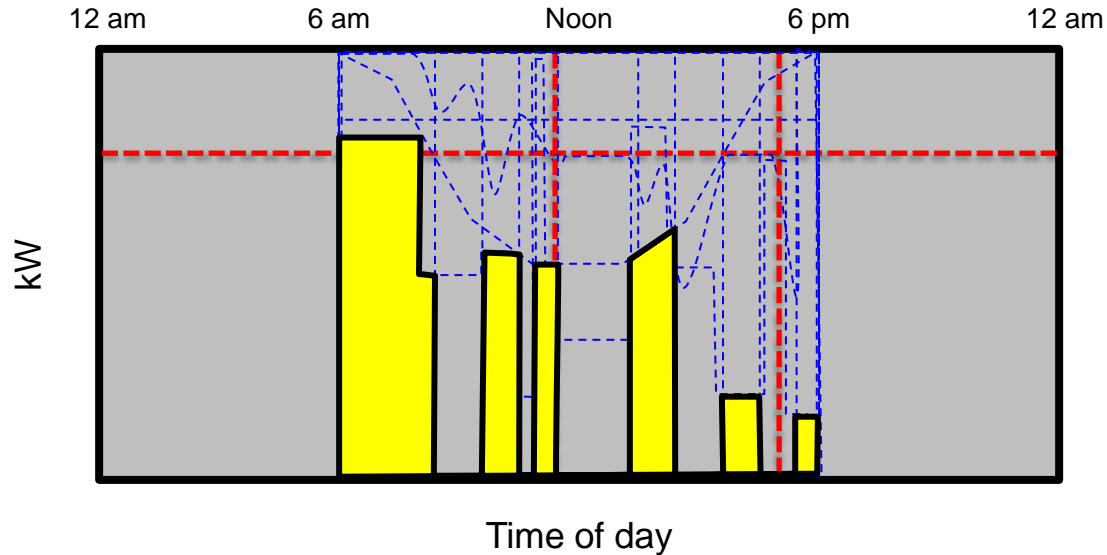
Occupancy / Vacancy Sensing



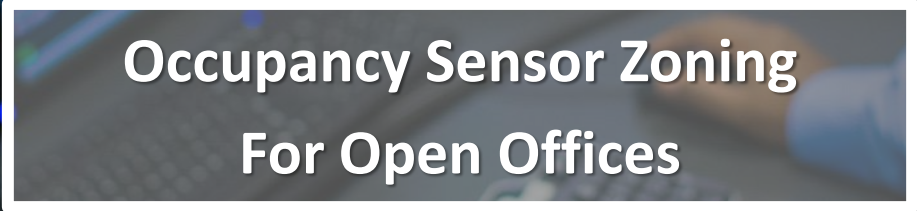
Personal Control



Aggregate Strategies for a Given Space



Aggregate strategies for that space, and the resulting energy use.

A white rectangular box with a thin black border containing the text "Occupancy Sensor Zoning For Open Offices" in a bold, white, sans-serif font. The background of the entire image is a man in a blue shirt and glasses working at a computer workstation with multiple monitors displaying data charts and graphs.

Occupancy Sensor Zoning For Open Offices

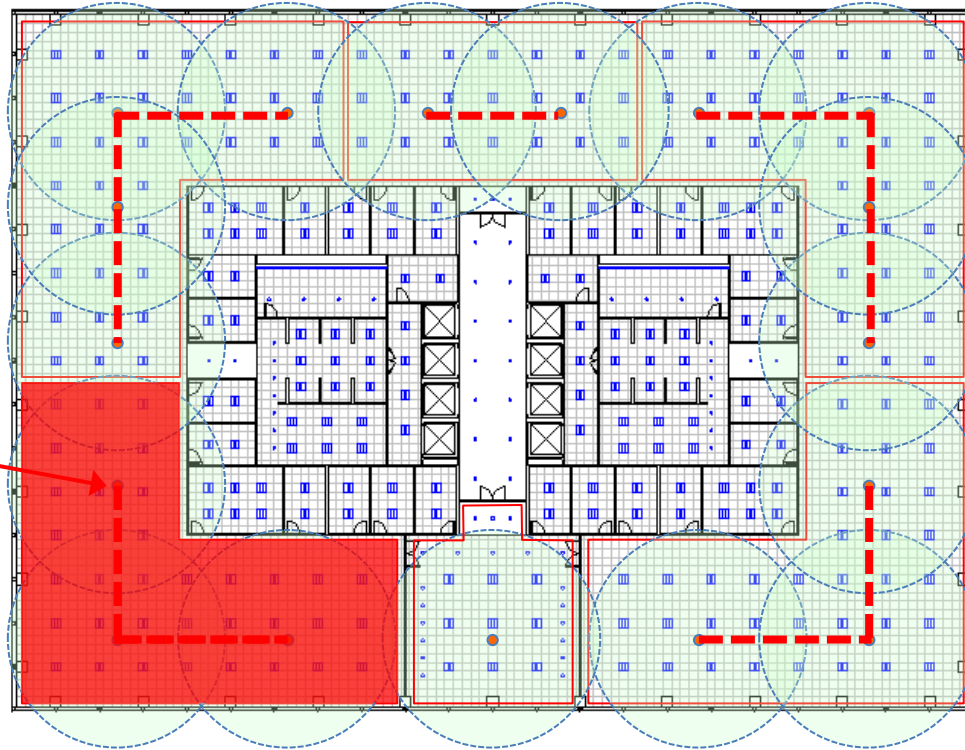
“Occupant sensor controls”

1st pass; occupancy sensors with large coverage pattern (1500 ft²/sensor)

17 occupancy sensors

6 zones (including reception; sensors would work “in parallel” in each zone)

Occupancy sensor with 1500 ft² coverage pattern



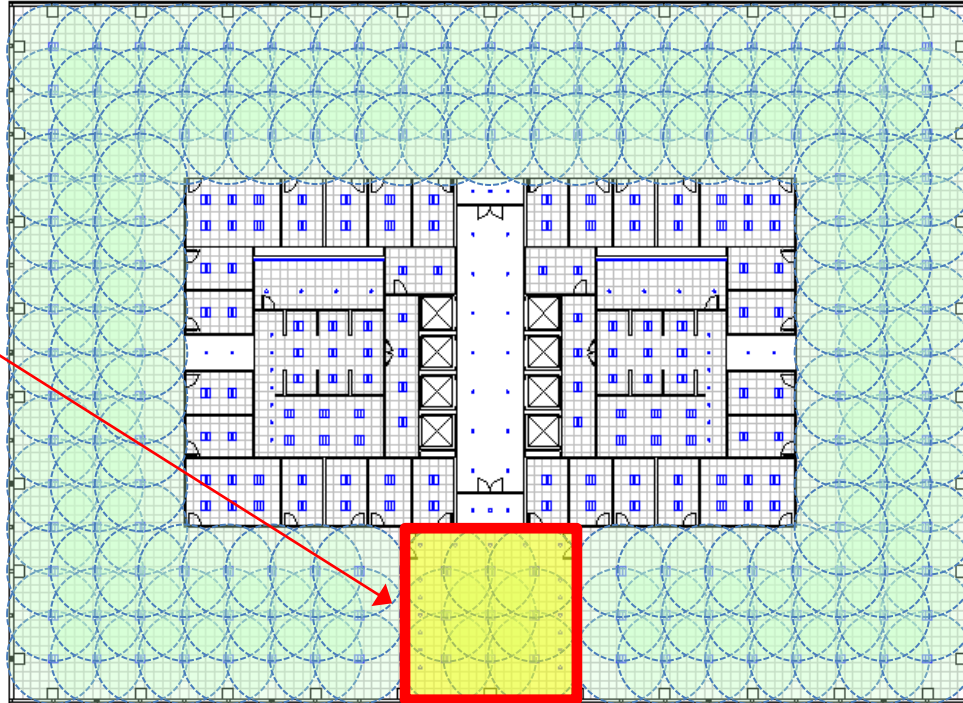
“Occupant sensor controls”

4th pass – LLLC (fixture-integrated, 100 ft²/sensor)

174 occupancy sensors


☛ With “fixture-integrated” sensors in an LLLC system, every fixture is essentially its own zone.

☛ In LLLC systems, the software allows you to “group” multiple fixtures. For example, the (9) fixtures in the partitioned reception area can be grouped so that if any fixture picks up motion, all (9) fixtures will turn on.



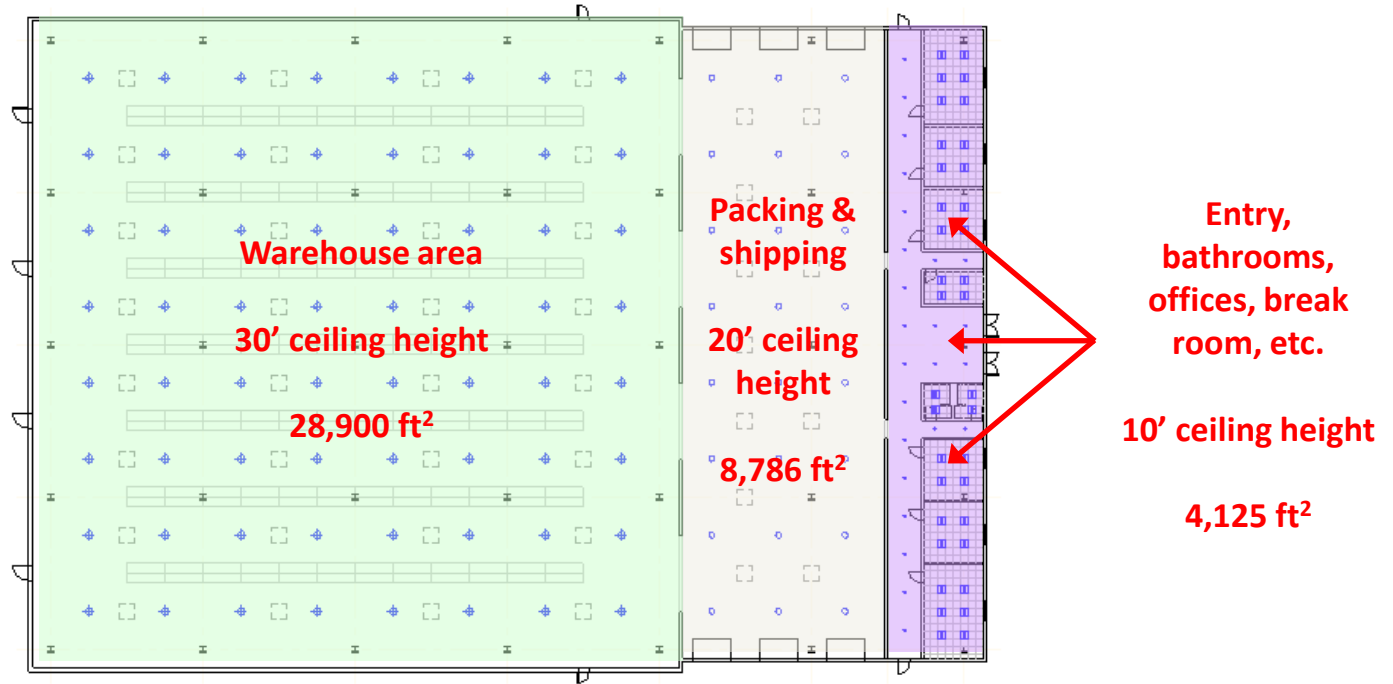
LLC system with “pre-programmed, autonomous behavior”



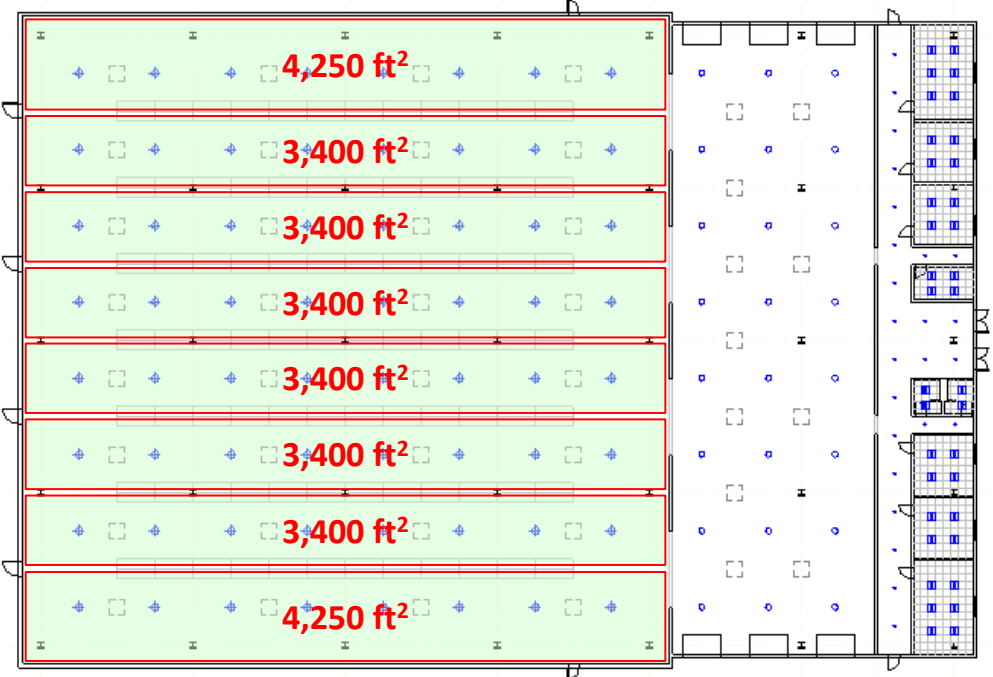
A person wearing a blue long-sleeved shirt is sitting on a couch, using a silver laptop. The laptop screen displays a website with the Ameren logo and various data points. The person's hands are on the keyboard, and a white USB cable is plugged into the side of the laptop.

Zoning for Warehouses

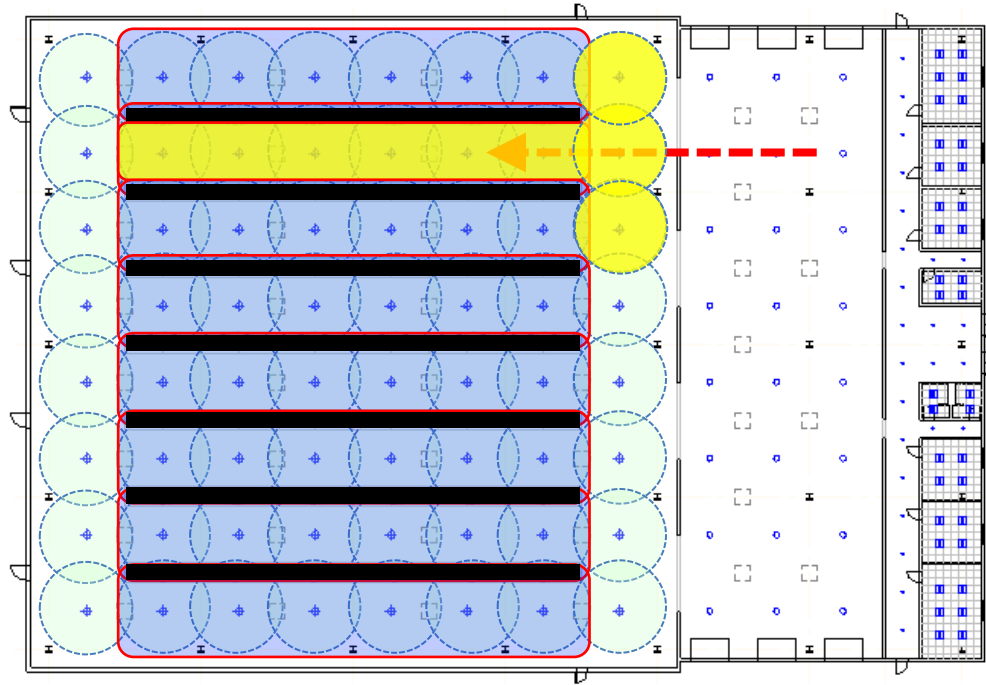
Warehouse building information (41,811 ft² total area)



Warehouse zones – alternate layout



Warehouse zones – using an LLLC system with aisles grouped for occupancy sensing



A utility worker wearing a bright yellow-green hard hat with the Ameren logo, safety glasses, a high-visibility yellow-green vest over a tan long-sleeved shirt, and work gloves. He is holding a pair of pliers and looking off to the side. The background shows a utility site with power lines and a worker on a lift in the distance.

LLC System Components

LLLC – minimum required system components



- What are the minimum required components in an LLLC system?
 - **Fixture-integrated controllers** (to switch ON/OFF; dim up and down; connect to the network)
 - **Fixture-integrated occupancy sensors and photosensors**
 - **Switches** (most spaces in code-compliant projects need a switch <or dimmer switch>)
 - **Network** – networks may be:
 - **Wired ... or ...**
 - **Wireless** ... if you use a wireless LLLC system, then you will also need a wireless gateway(s). Gateways are not necessarily required for wired system. Some systems can work without gateways or servers.
 - **Apps or software** – to commission, program, zone and operate the system

- Many people call controllers “power packs”. **Don’t do that!** Power packs are devices that have 1.) relays and 2.) transformers. They are typically used for things like powering and connecting to occupancy sensors to turn lights ON and OFF.
- **Controllers in NLC systems typically have:**
 - **Relays** – to turn lights ON and OFF
 - **Dimming outputs** – typically 0-10V (but they can use other protocols such as DALI or proprietary)
 - **Network connection** – this can be either:
 - **Wired** – in which case there will be an Ethernet or other kind of port for the wire/conductors
 - **Wireless** – in which case there will be 1.) a radio, and 2.) an antenna
 - Some controllers have other things as well, such as ports for sensor inputs (especially if they are designed for use in LLLC systems).

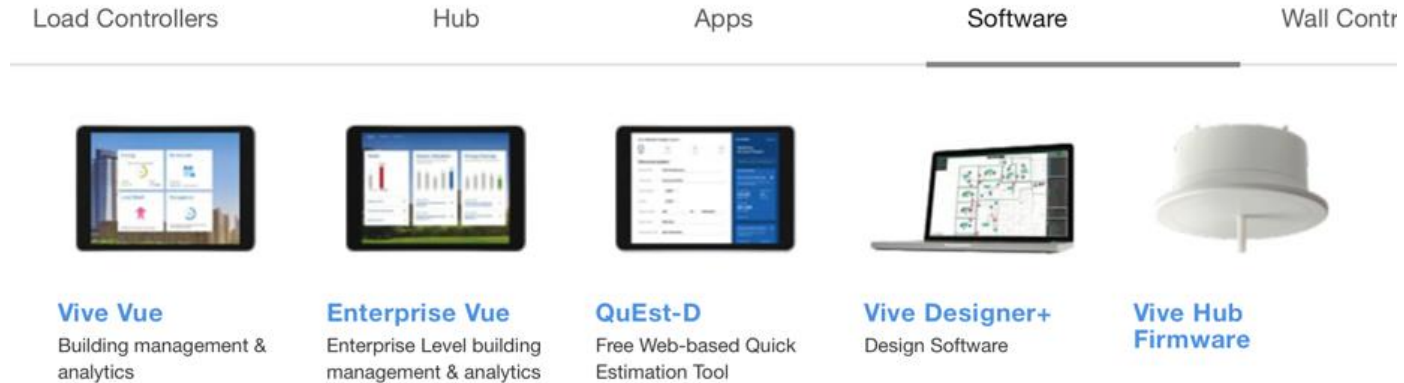
Fixture-integrated sensors



Fixture-integrated sensors

Fixtures without pre-installed sensors or controllers

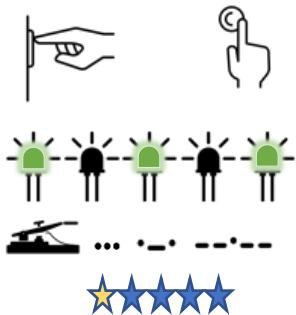
Apps/software



These are examples of software that provide additional functionality beyond the native app in the “hub” (server/gateway)

Different user interfaces/methods of commissioning

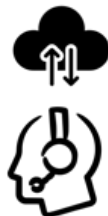
Push n' Program



Remote Control



Totally Remote



Desktop / Web Applications



App-Based



Courtesy of John Arthur Wilson

A person is sitting on a couch, using a silver laptop. The laptop screen displays the Ameren website, which includes a navigation menu and several content cards. The person's hands are on the keyboard, and they are wearing a blue long-sleeved shirt. A white USB cable is plugged into the laptop. The background is a blurred indoor setting.

Lighting Control System Topologies

Wireless LLLC system (w/fixture-integrated sensors)

Wireless controls and sensors



Centralized control and integration



Simple to use software



Communication protocols



Communicate via RF to control components











Communicate via WiFi to smart devices

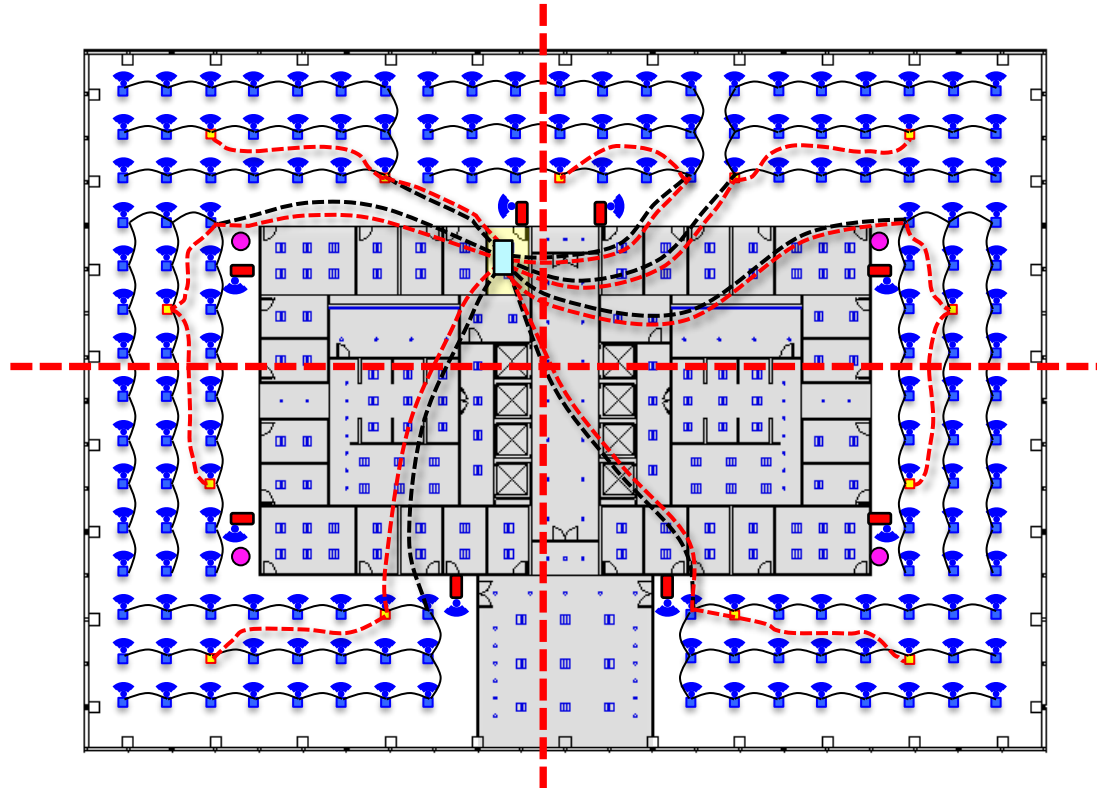


Communicate with wired Ethernet to Live Hub

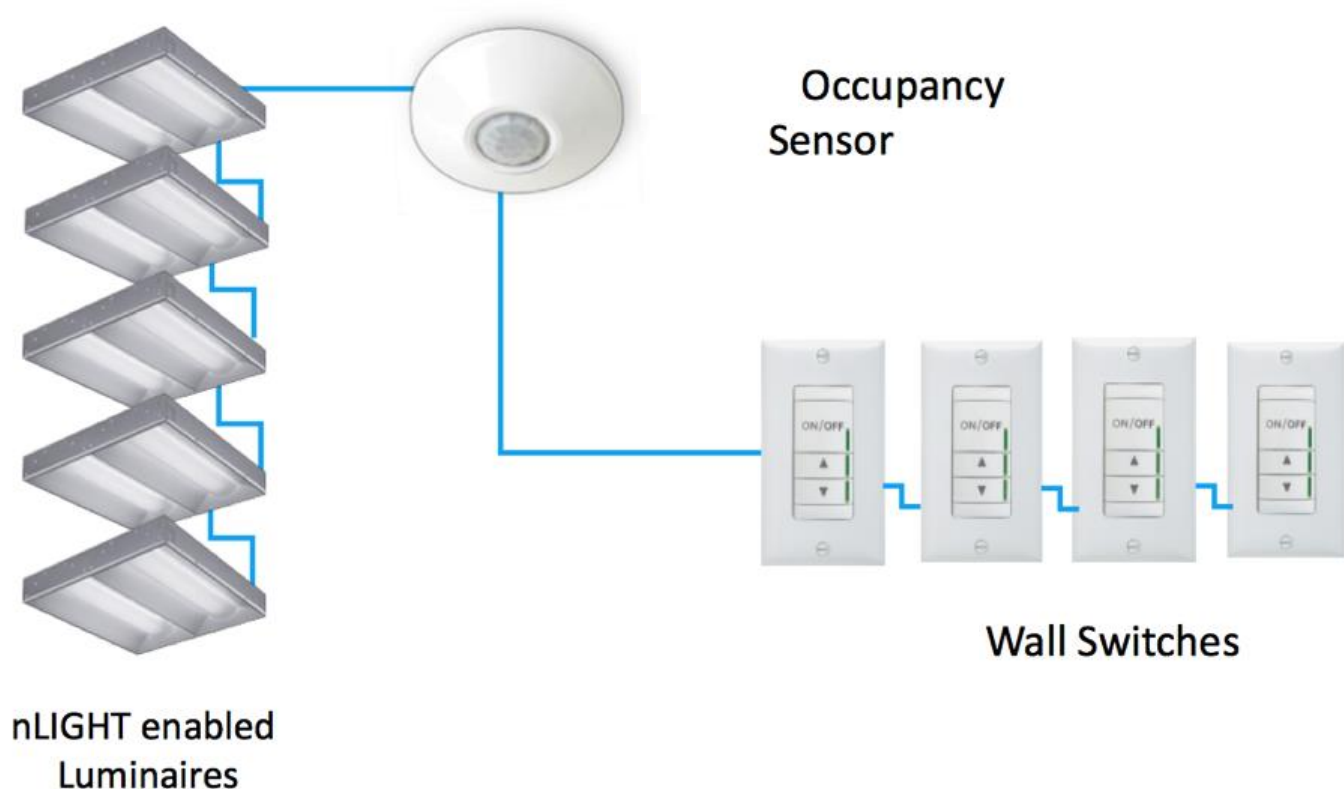
Wireless LLLC system (w/fixture-integrated sensors)

LEGEND:

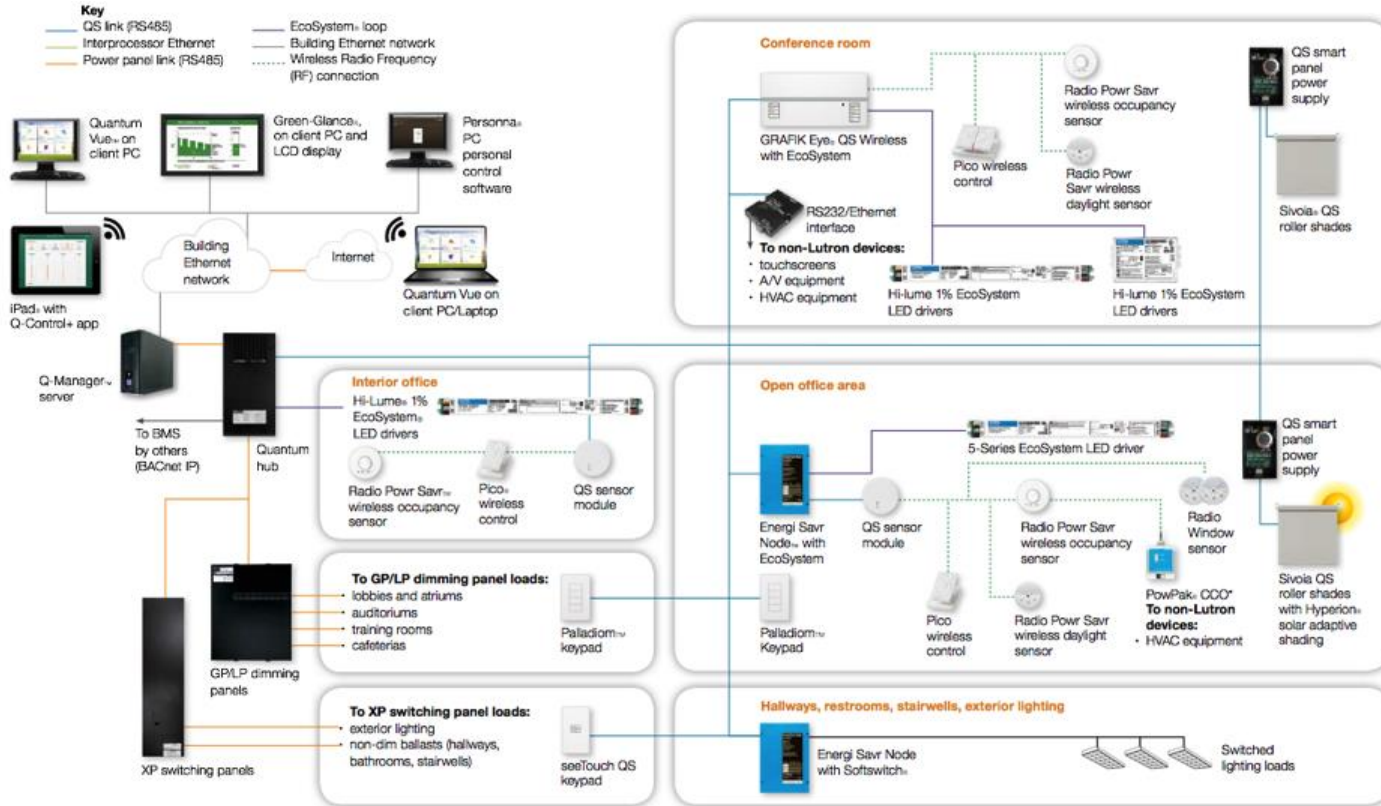
-  Existing circuit breaker panel
-  2x2 fixture (normal power) with wireless controller, integrated occupancy sensor and photosensor
-  EM fixture (integral battery) with wireless controller, integrated occupancy sensor and photosensor
-  Wireless gateway
-  Wireless wallbox switch/dimmer
-  Home-run to panel
-  Branch circuit (power wires)
-  Constant-charging circuit (unswitched)



Wired LLLC system (w/fixture-integrated sensors)

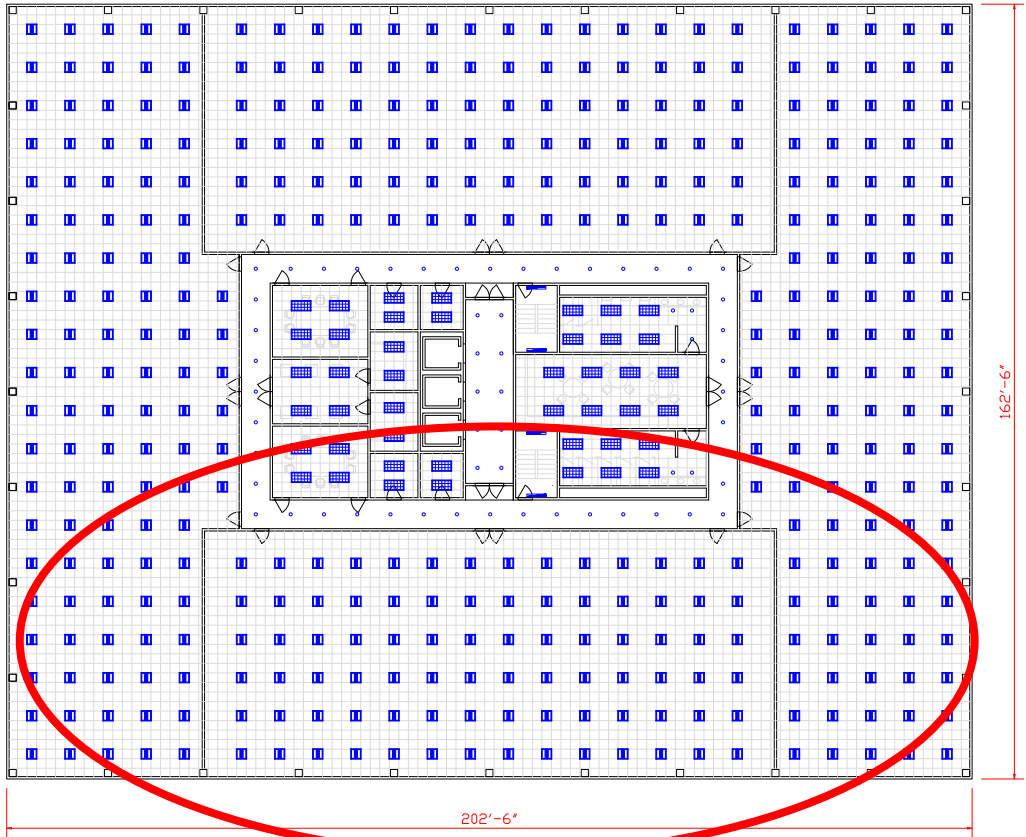


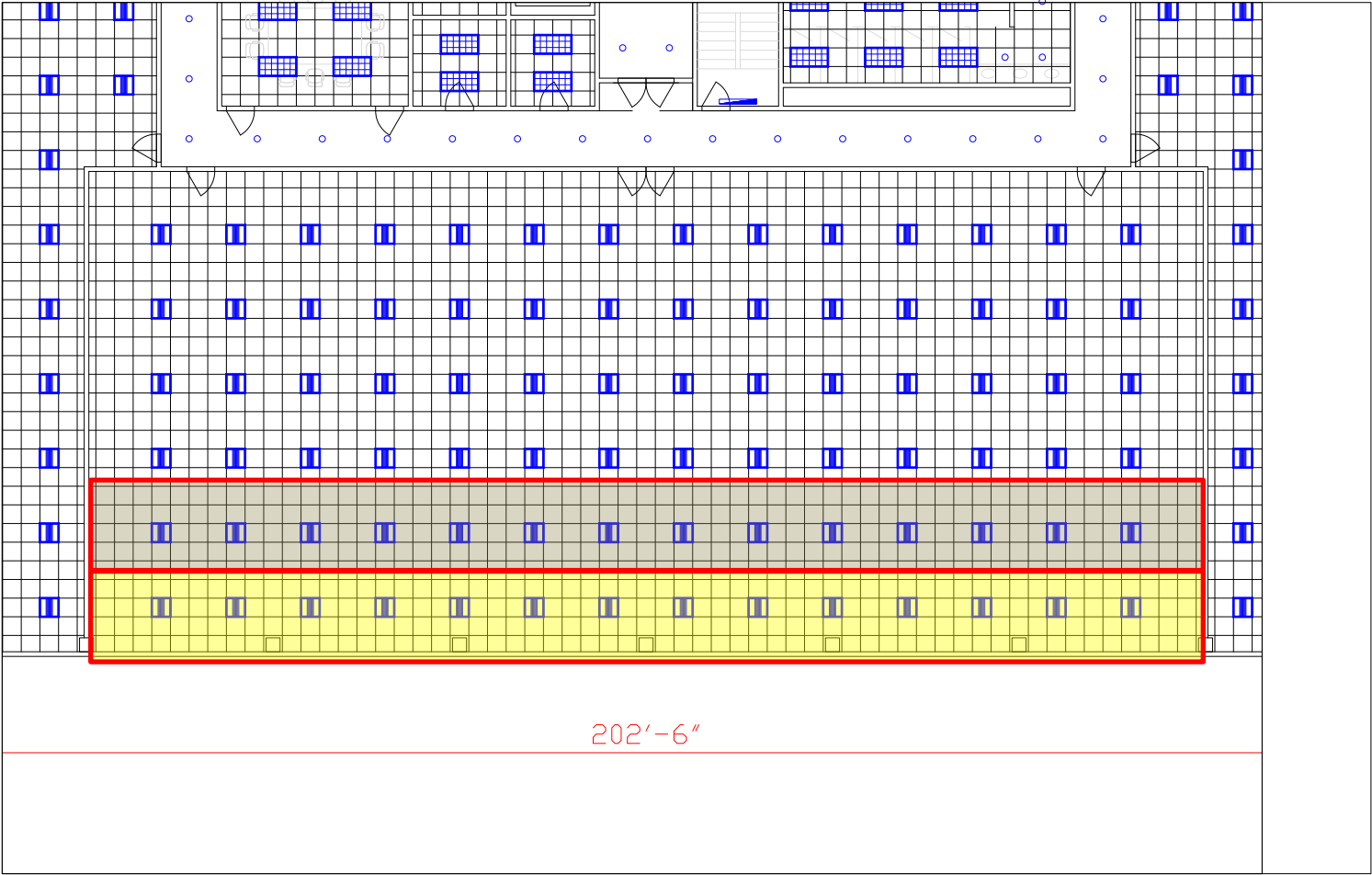
Wired DALI system

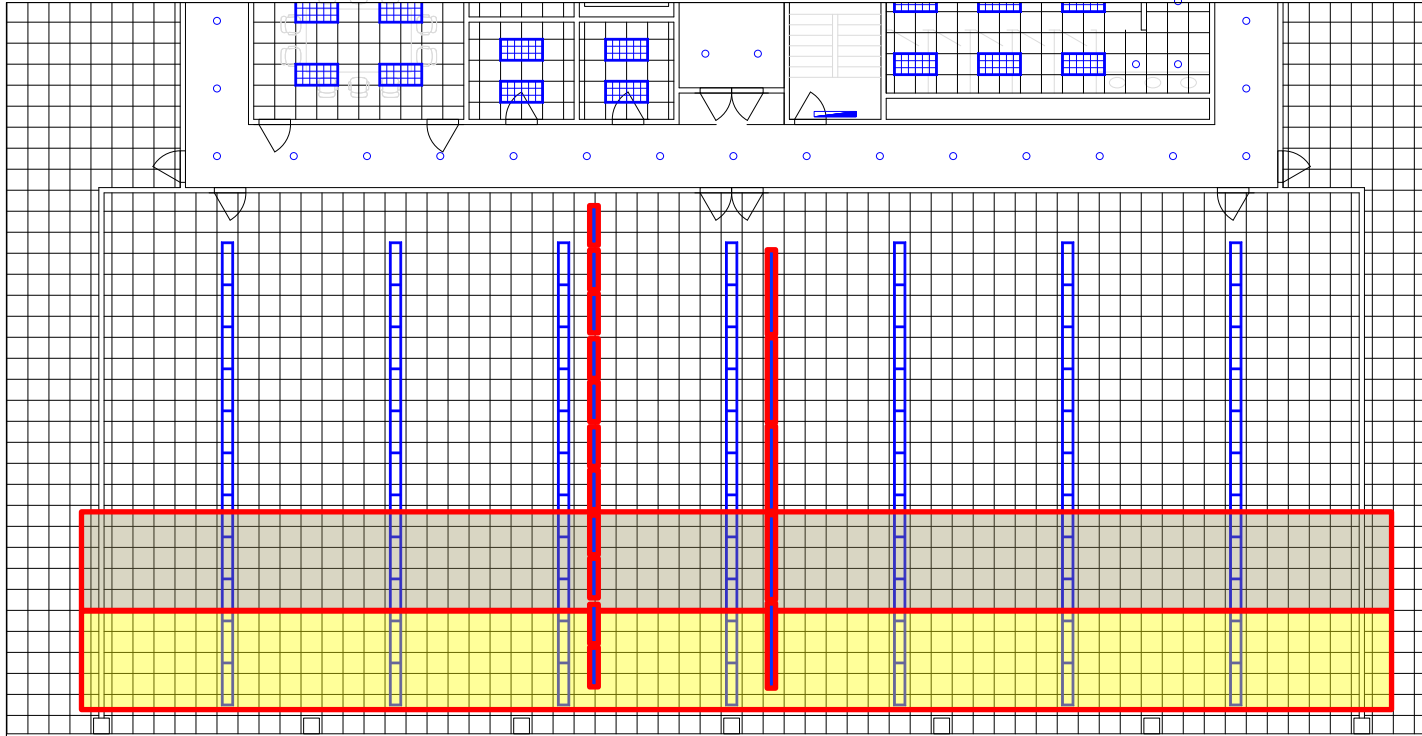


A person wearing a blue long-sleeved shirt is sitting on a couch, using a silver laptop. The laptop screen displays the Ameren website interface. A white text box with a thin border is overlaid on the laptop keyboard area.


Configuring NLC/LLC systems
with fixture layouts







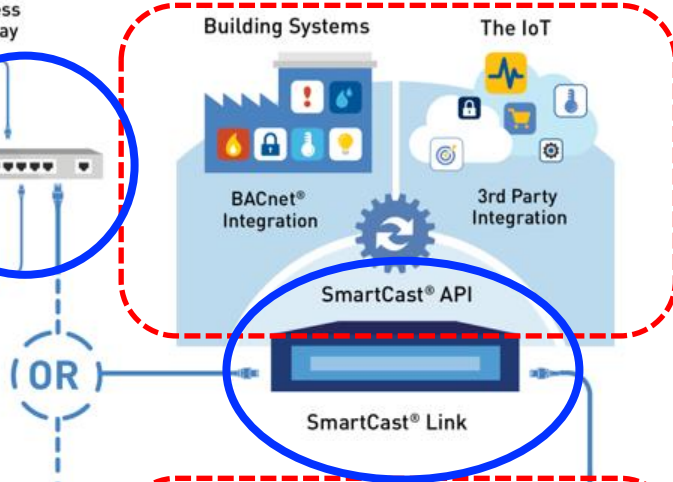
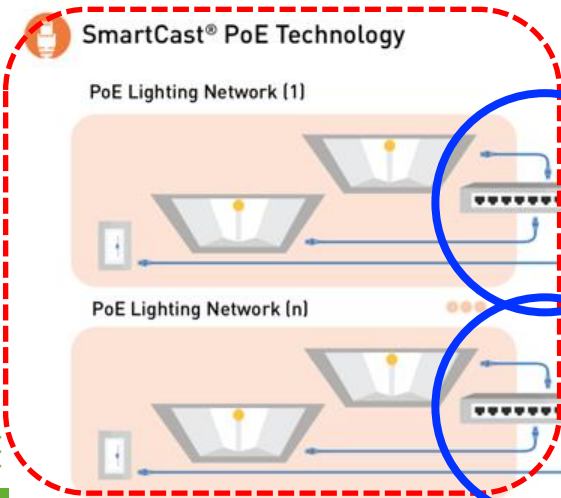
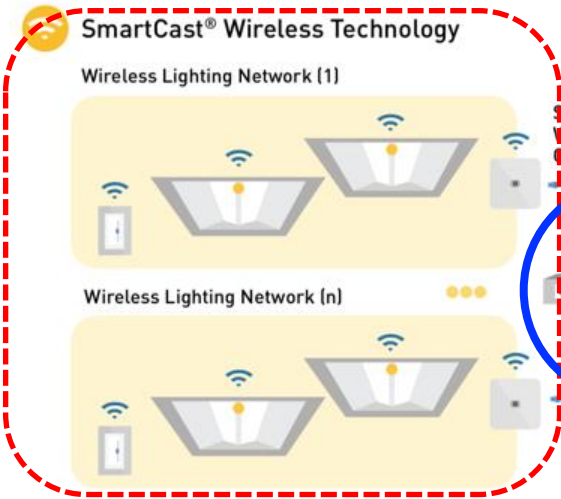
202'-6"

A man wearing glasses and a blue button-down shirt is seated at a desk in a control room. He is looking intently at several computer monitors that display various data visualizations, including charts and tables. His hands are positioned over a keyboard. The scene is dimly lit, with the primary light source being the screens.

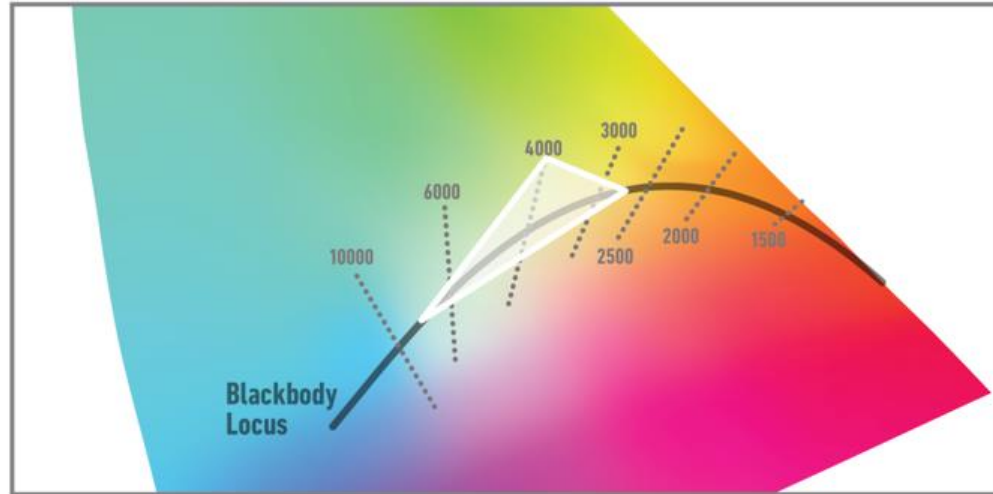
Topics and activities for in-person classes

Additional topics for in-person classes

1. COVID mitigation strategies using NLCs
2. IoT (Internet of Things)
3. Color-changing (RGB)/tunable-white (warm-cool)
4. Hands-on activities:
 1. Attendees will commission a wireless LLLC/NLC system
 2. Attendees will commission a Bluetooth LLLC system



Wattstopper tunable-white with 3 primaries



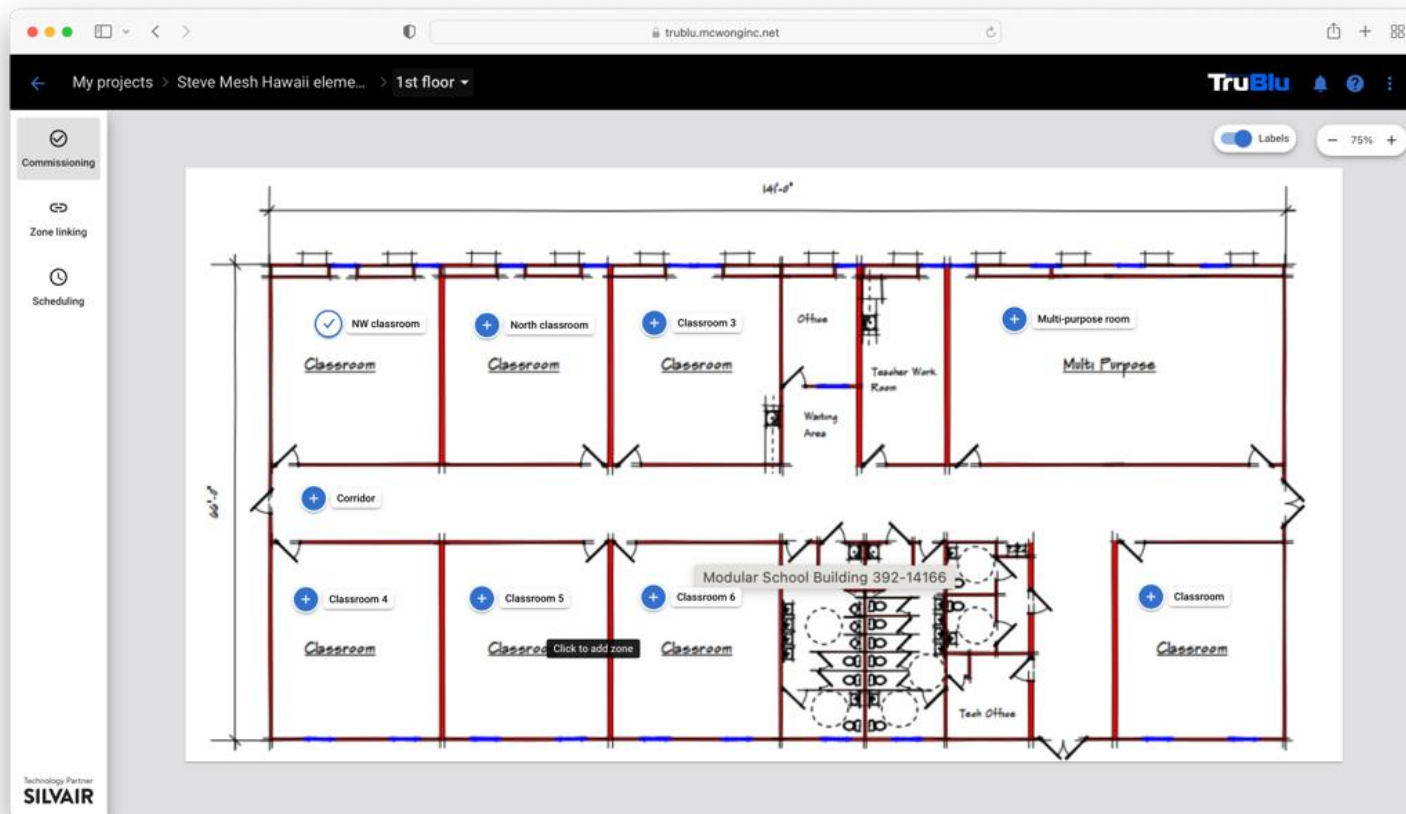
Blanco 3

Three white LEDs
(2700K – 6500K)

Tunable range is within the
white shaded gamut.

Image courtesy of WattStopper

Commissioning a Bluetooth system



The screenshot displays the TruBlu web interface for commissioning a Bluetooth system. The browser address bar shows `trublu.mcwonginc.net`. The navigation path is `My projects > Steve Mesh Hawaii eleme... > 1st floor`. The interface includes a sidebar with the following options: Commissioning (checked), Zone linking, and Scheduling. The main area shows a floor plan of a modular school building with the following rooms and labels:

- NW classroom (checked)
- North classroom (+)
- Classroom 3 (+)
- Office
- Multi-purpose room (+)
- Classroom
- Classroom
- Classroom
- Teacher Work Room
- Multi Purpose
- Waiting Area
- Corridor (+)
- Classroom 4 (+)
- Classroom 5 (+)
- Classroom 6 (+)
- Classroom
- Classroom
- Classroom
- Classroom
- Classroom
- Classroom
- Teah Office

The floor plan also includes dimensions: `141'-0"` for the width and `60'-0"` for the height. A tooltip for "Modular School Building 392-14166" is visible over the central part of the plan. A "Click to add zone" button is located near Classroom 5. The bottom left corner of the interface identifies the Technology Partner as SILVAIR.

Thank You to:

Ameren Illinois Energy Efficiency Program

Resource Innovations

Instructor information

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Honolulu, HI 96814

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steve@stevemesh.com



Next Power Lunch:

DOE Better Plants

Wednesday, July 14th



Energy Efficiency
PROGRAM

AmerenIllinoisSavings.com