Optimal ENERGY *Integrated Energy Resources*

The Application and Costs of Lighting Controls

Efficiency Vermont

Better Buildings by Design Conference

February 6, 2014

Acknowledgements

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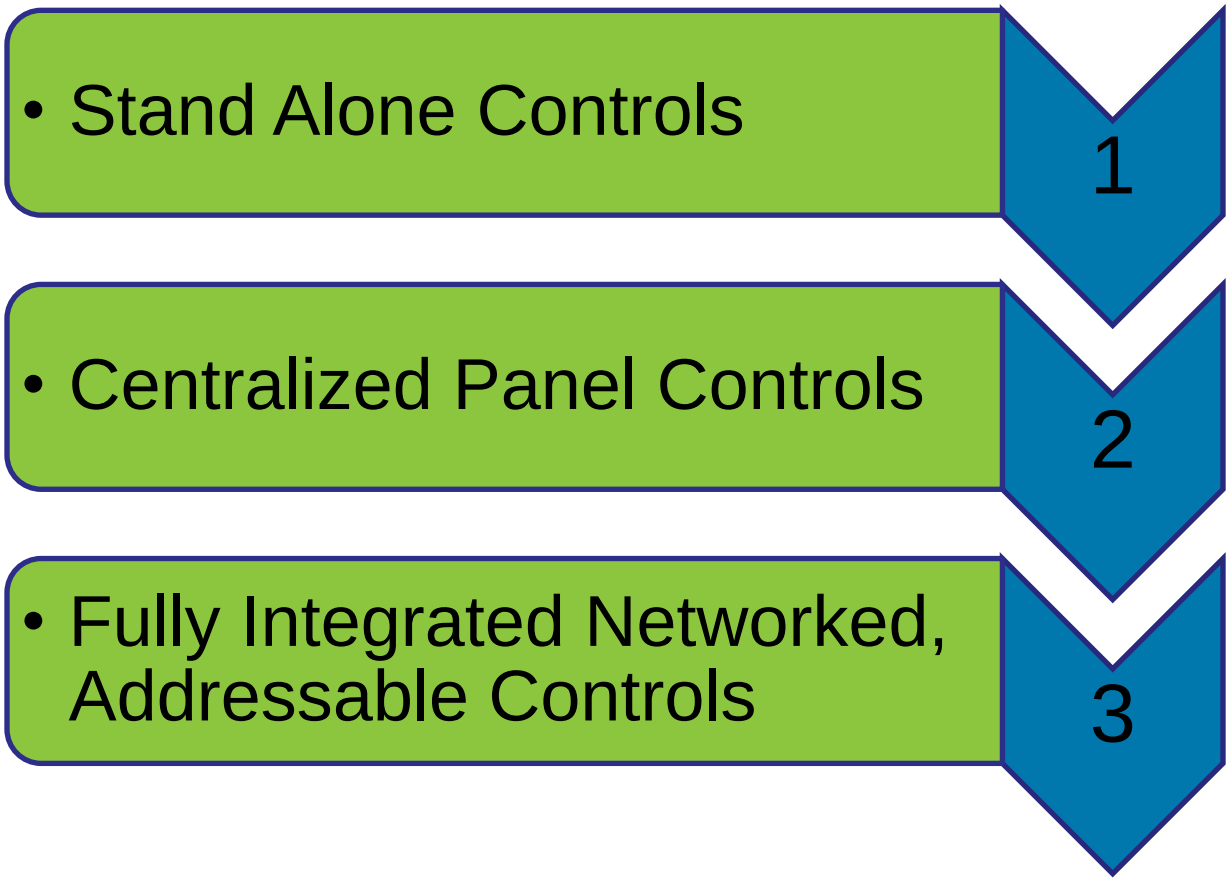
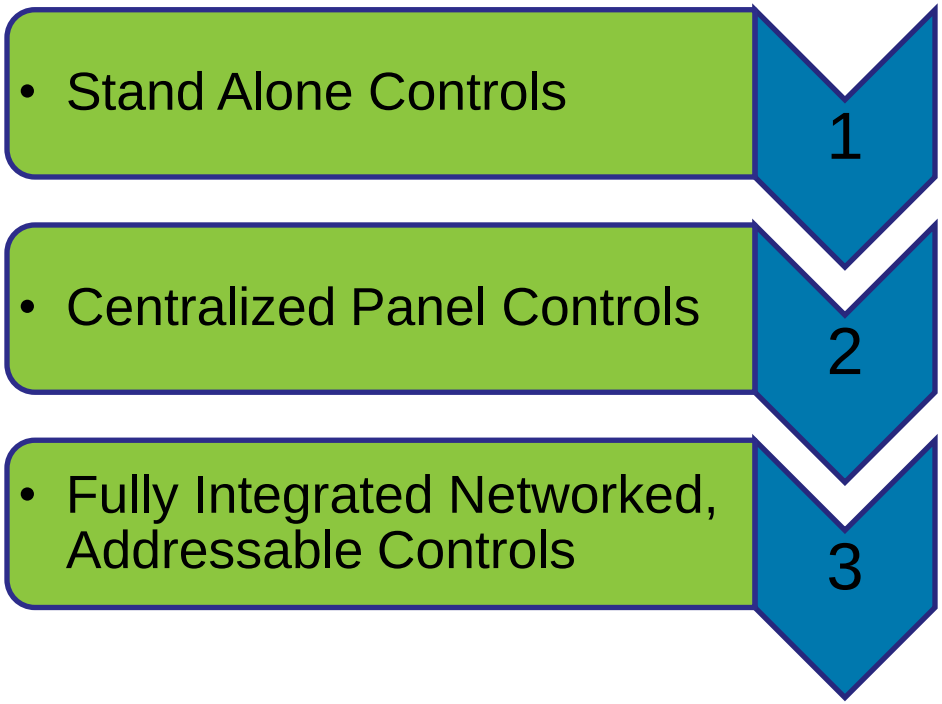
- Thanks to the following organizations and companies for contributing material

Light Right CONSORTIUM
nbi new buildings institute
PHILIPS
LEDALITE
ENCELIUM LIGHTING CONTROL FOR THE SMART BUILDING
WattStopper
LUTRON
LEVITON
FINELITE Better Lighting

Three Different "Levels" of Control Systems



Three Different "Levels" of Control Systems



How do these levels correlate to:

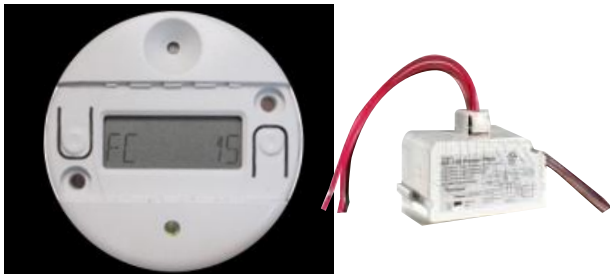
- Costs?
- Savings?
- Complexity?
- Functionality?
- Occupant Satisfaction?
- Marketability / Rents?

Stand-Alone Controls

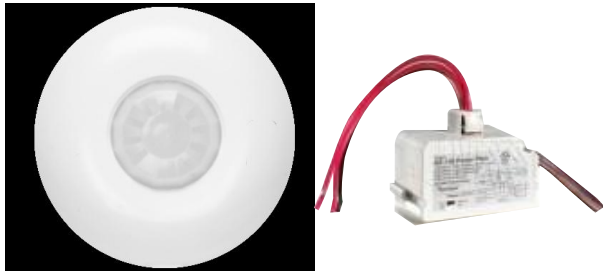
Line Voltage Wall Switch

Line Voltage Occupancy/Vacancy Sensor

Two Zone or "Bi-Level" Occupancy/Vacancy Sensor



Stand-Alone Photocell w/ Relay/Power Pack



Stand-Alone Occupancy Sensor w/ Relay/Power Pack

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Stand-Alone Controls Pros/Cons

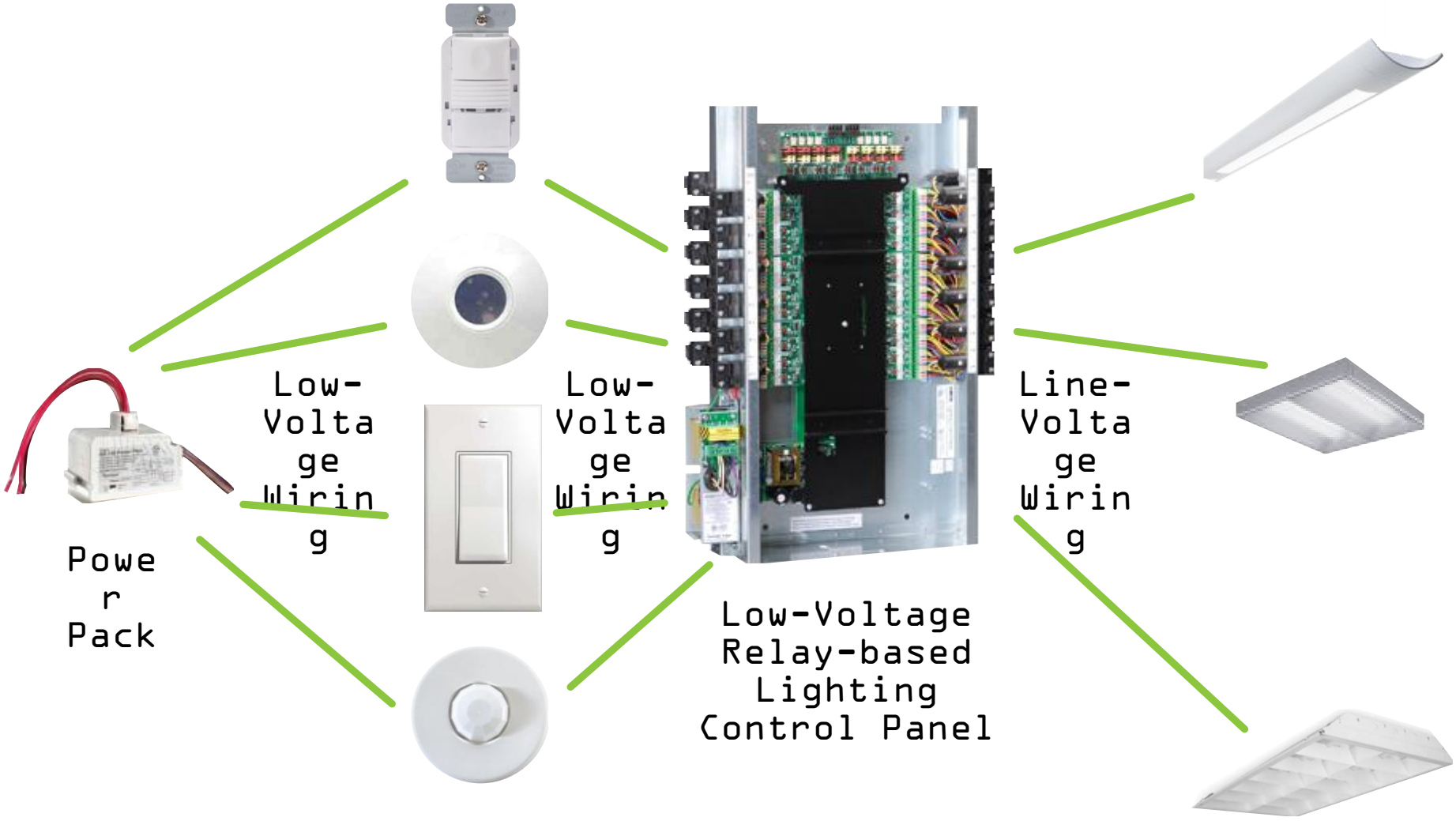
Pros:

- May be less expensive
- Familiar wiring methods

Cons:

- Less Flexible
- Complicated to combine multiple control strategies
- Less energy savings

Centralized Panel Controls



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Centralized Panel Controls Pros/Cons

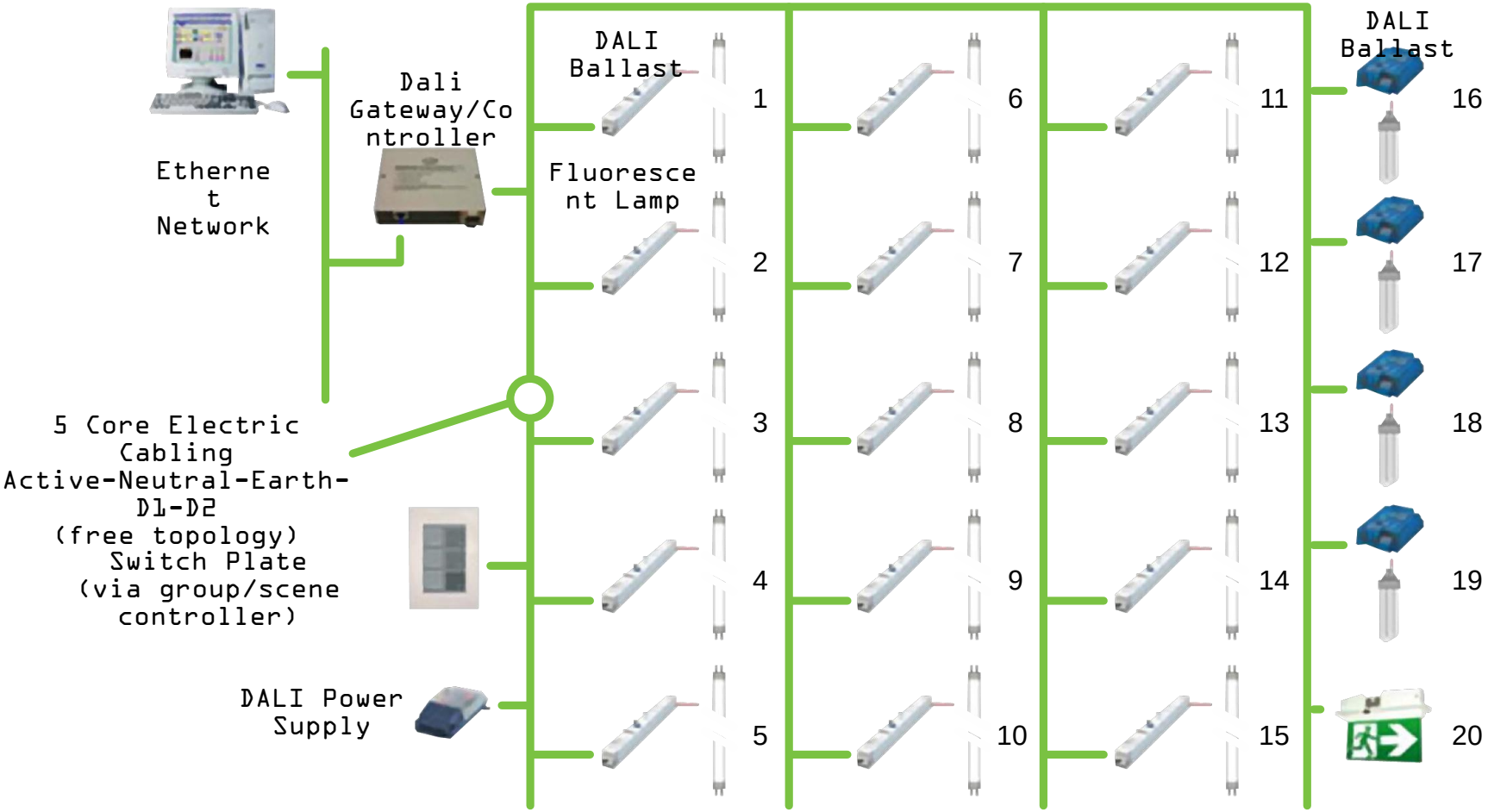
Pros:

- More flexible
- Programming & monitoring from a centralized location
- Can be integrated into BAS systems (security, HVAC)

Cons:

- Requires low-voltage wiring to be installed
- Less familiar wiring methods may result in higher bid costs
- Limitations on zoning & no. of control strategies

Fully-Integrated Addressable Control System (Wired)



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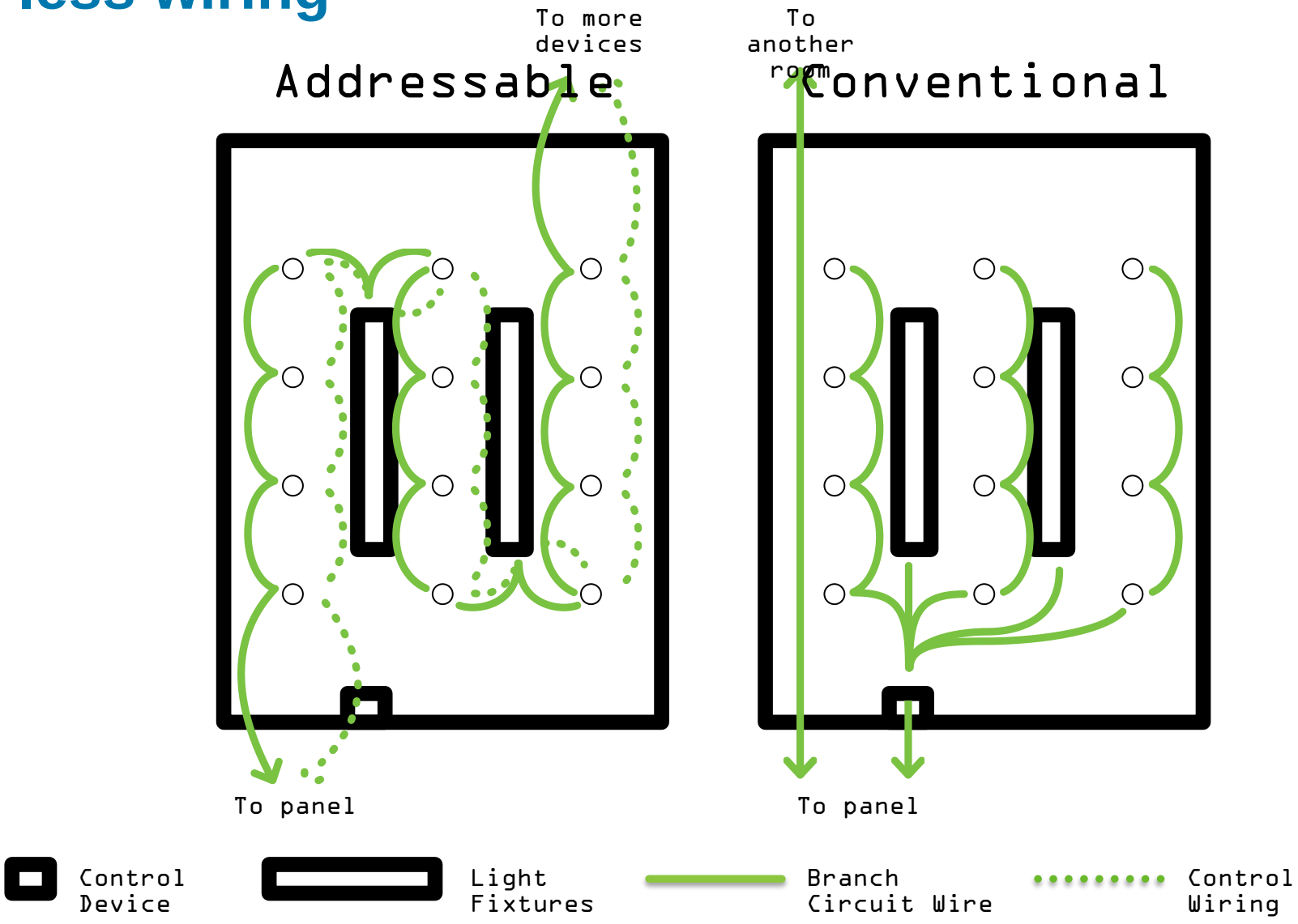
Addressable systems can require up to 60% less wiring



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Fully-Integrated Addressable Control System (Wireless)

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Fully-Integrated Addressable Control System

Pros:

- More flexibility > potential for more energy savings
- Programming and monitoring from a centralized location
- Allows for multiple control strategies
- Can be easily reconfigured, re-zoned, for changes in space layout and tenants without requiring rewiring

Cons:

- May have higher initial cost
- Proprietary products, trademarked DALI
- May require low-voltage wiring to be installed (wired)
- Less familiar wiring methods may result in higher bid costs
- May require a computer server
- Commissioning can be more complicated and

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Applying different "levels" of controls to an example 0ffice Space

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Review of Code Lighting Control Requirements per IECC 2009

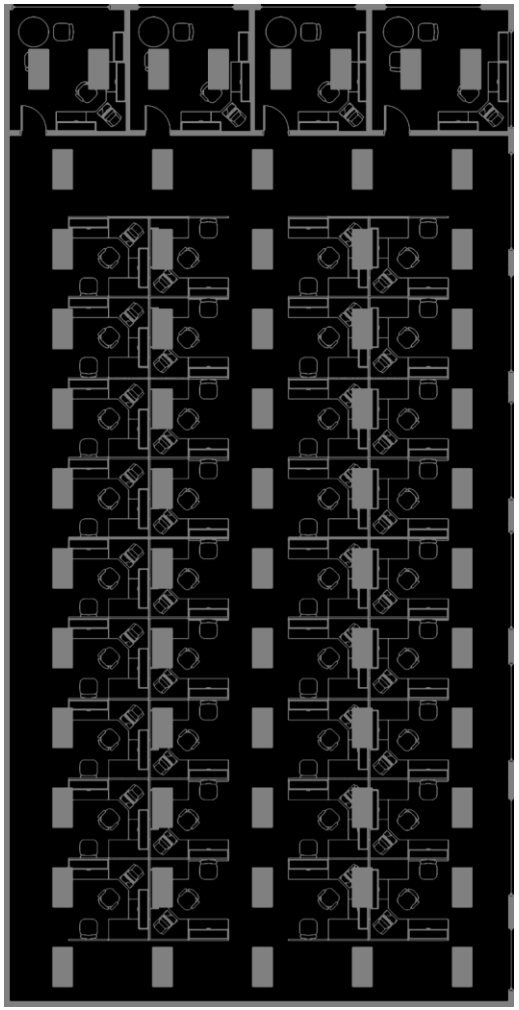
- Automatic Lighting Shutoff
  - "Buildings… shall be equipped with automatic control device to shut off lighting… based on either:"
    - Scheduled basis using time of day
    - Occupant Sensor
    - Signal from control or alarm system that indicates area is unoccupied
- Daylight Zone Control
  - Daylight zones shall be provided with individual controls that control the lights independent of general area lighting

2-Lamp T5 Troffers
on 8'x10' spacing

Four Private Offices

One Open Office

Vertical Glazing
on East & North



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First Approach

Use Stand-alone Controls to Meet the Code Minimum

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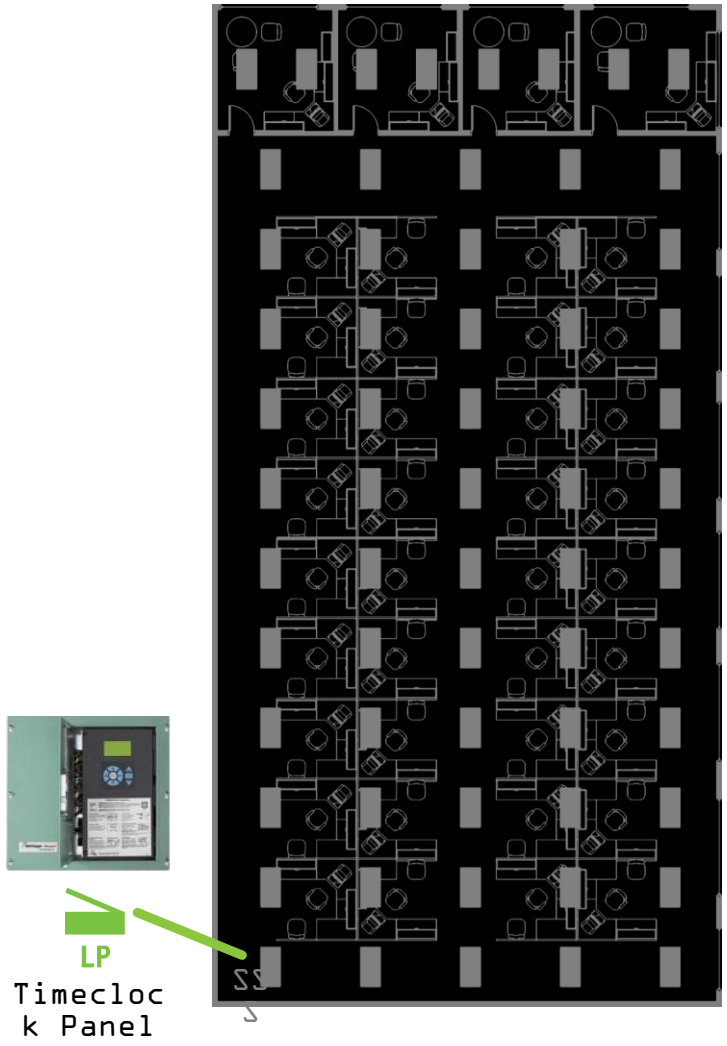
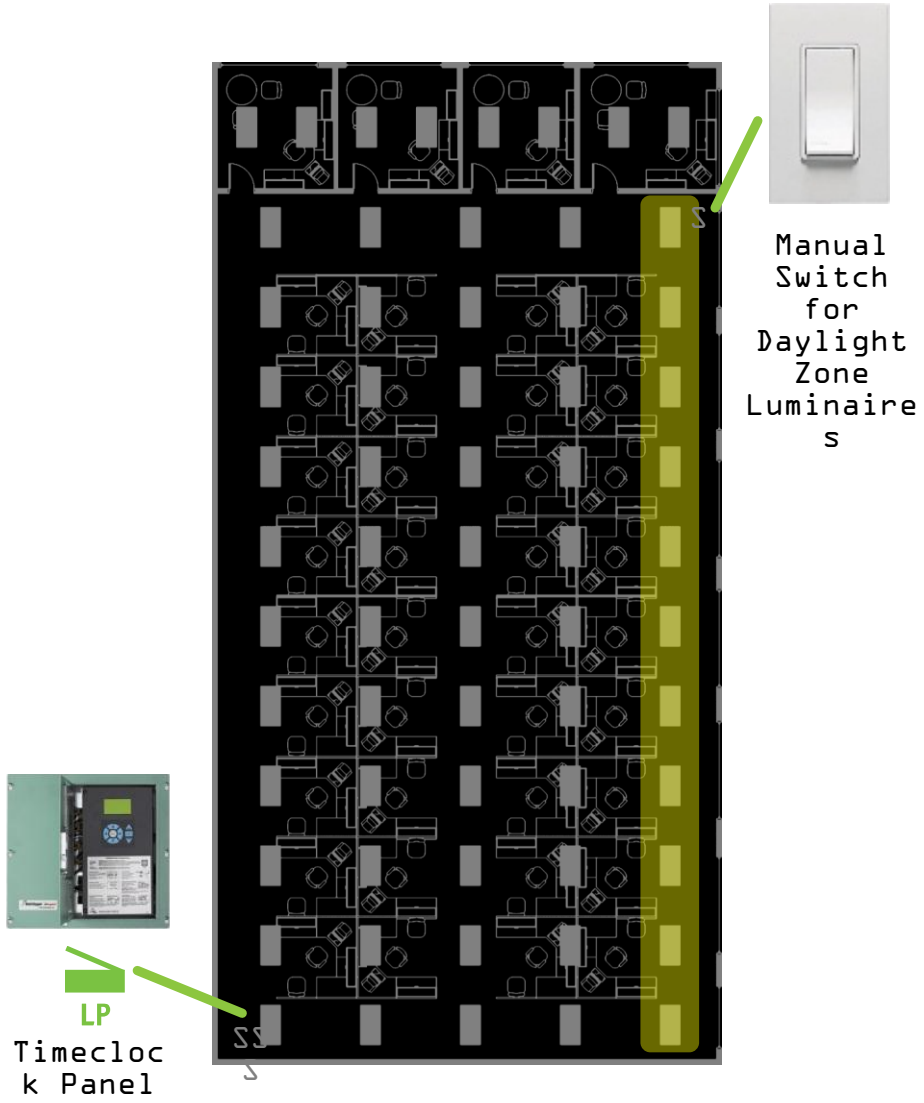
Open Office Control Strategies

- Timeclock scheduling (all zones)



Open Office Control Strategies

- Timeclock scheduling (all zones)
- Manual switch for daylight zone luminaires



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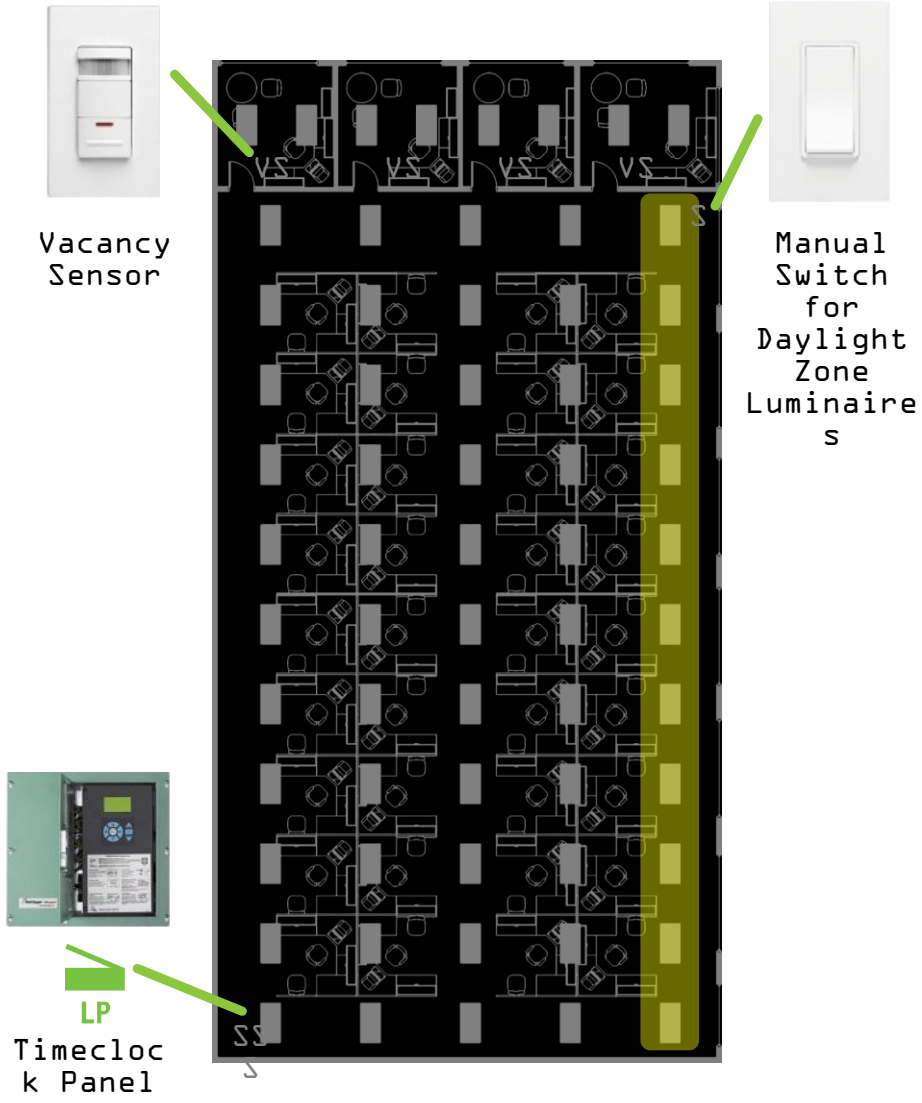
Open Office Control Strategies

- Timeclock scheduling (all zones)
- Manual switch for daylight zone luminaires

Private Office Control Strategies

- Line Voltage Vacancy Sensors



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Savings Analysis using Stand-Alone Controls

Space	Control Strategy	Controlled Fixture(s) % Savings	Total Project % Savings
Open	Timeclock Scheduling Control	15%	14%
Open	Daylight Zone Luminaires Switch	0%	0%
Private	Vacancy Sensors	30%	2%

Total Cumulative Lighting Control Savings: 16%

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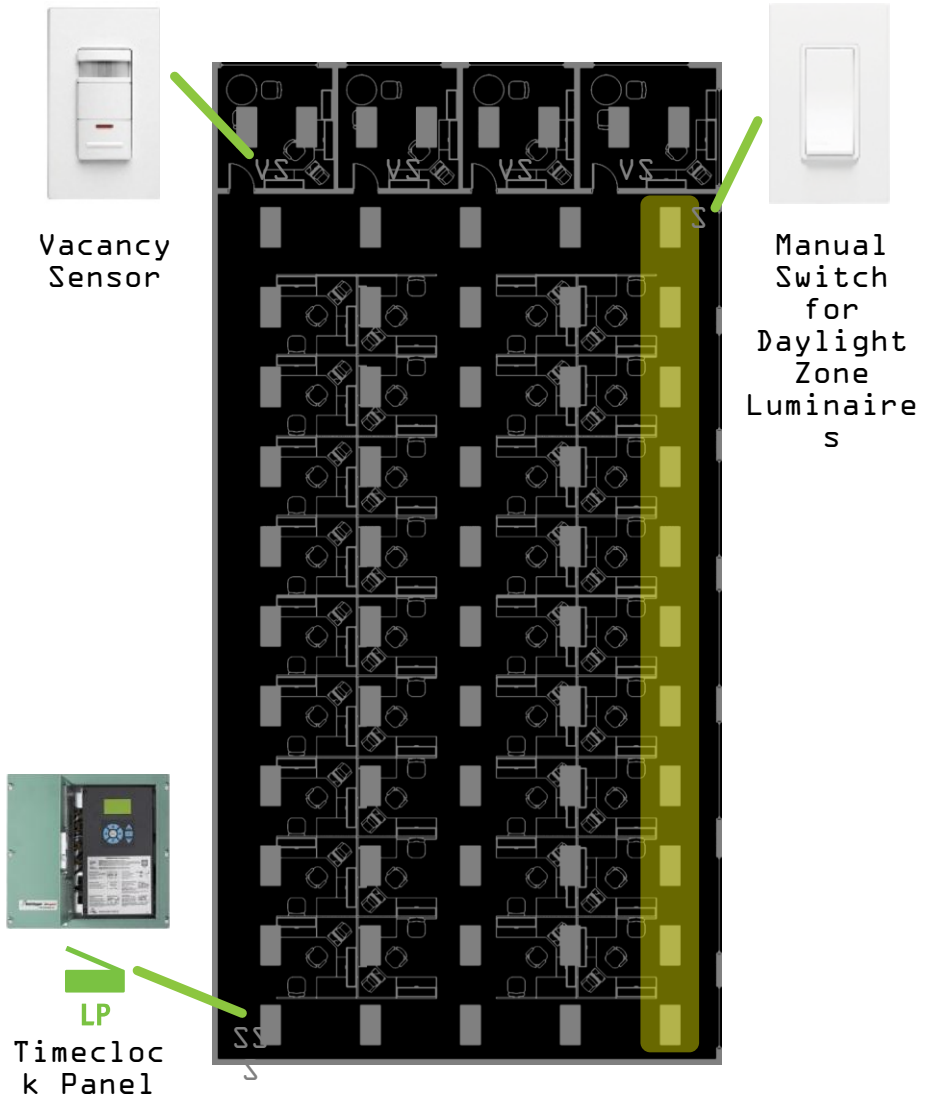
What are the Pros & Cons of this approach?

- Functionality
- Cost
- Wiring
- Energy Savings
- Flexibility
- Occupant Satisfaction
- Marketability & Rents



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Second Approach

Centralized Relay Panel with Additional Control Strategies

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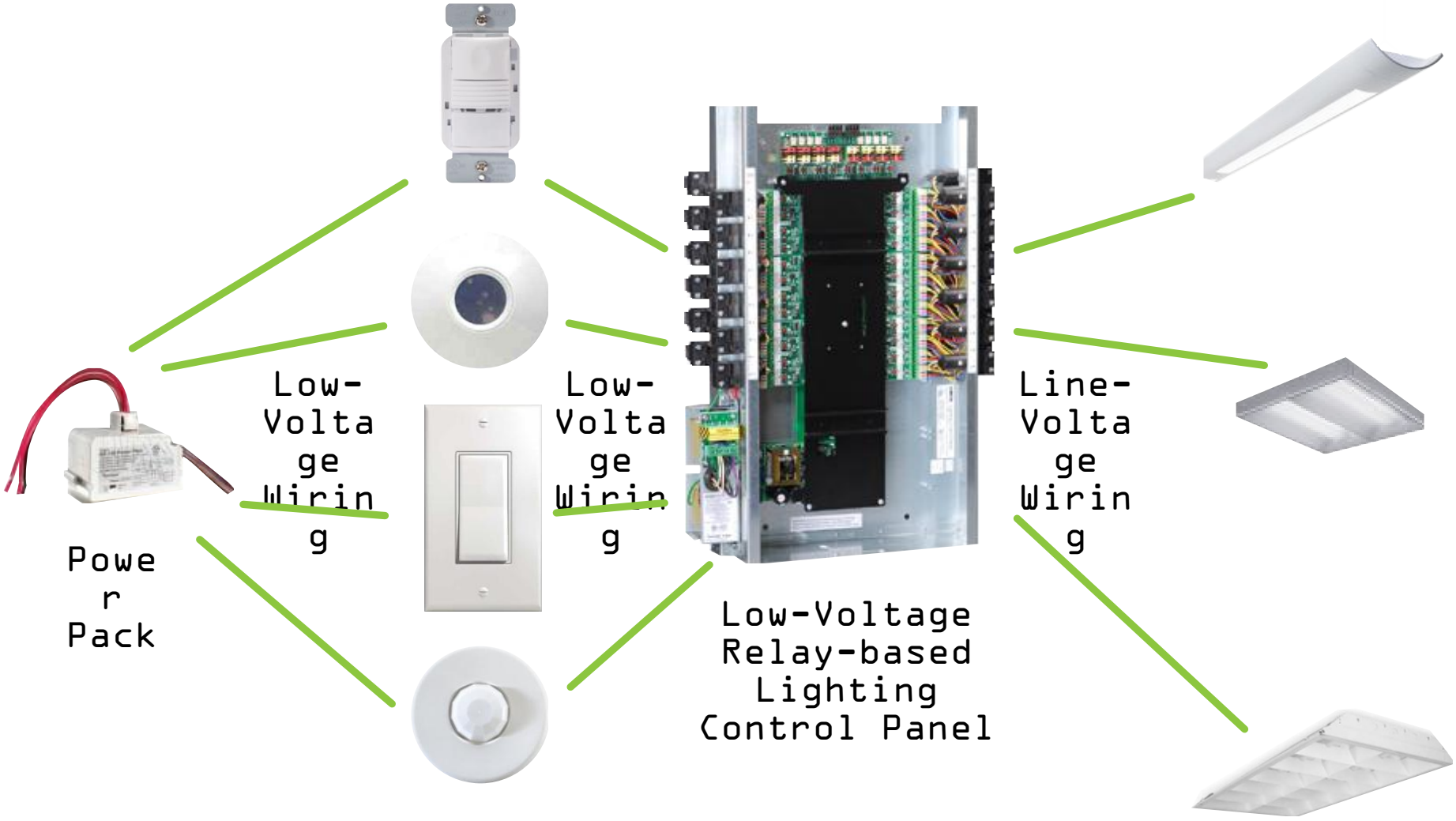
Centralized Panel Controls



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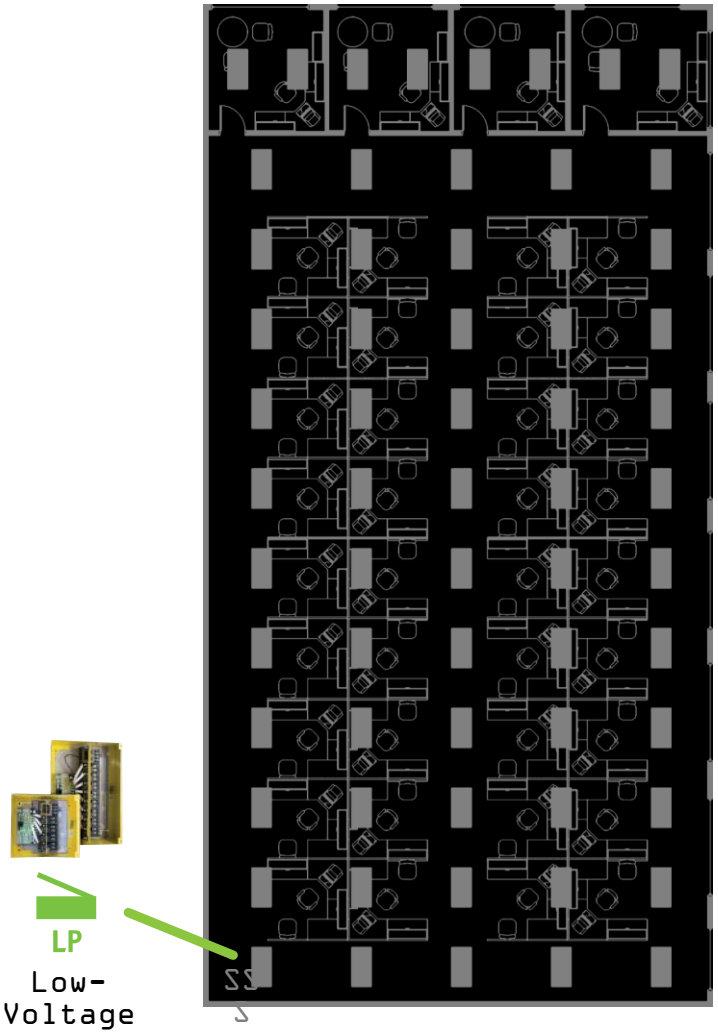
Open Office Control Strategies:

- Timeclock scheduling by day



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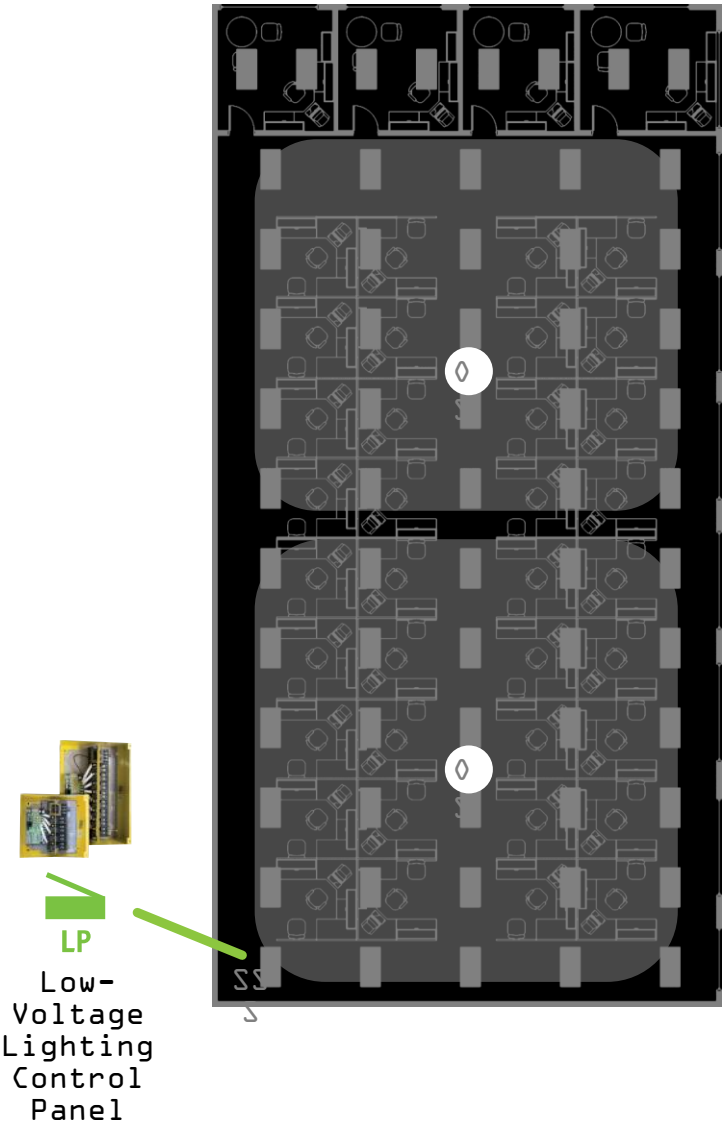
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night



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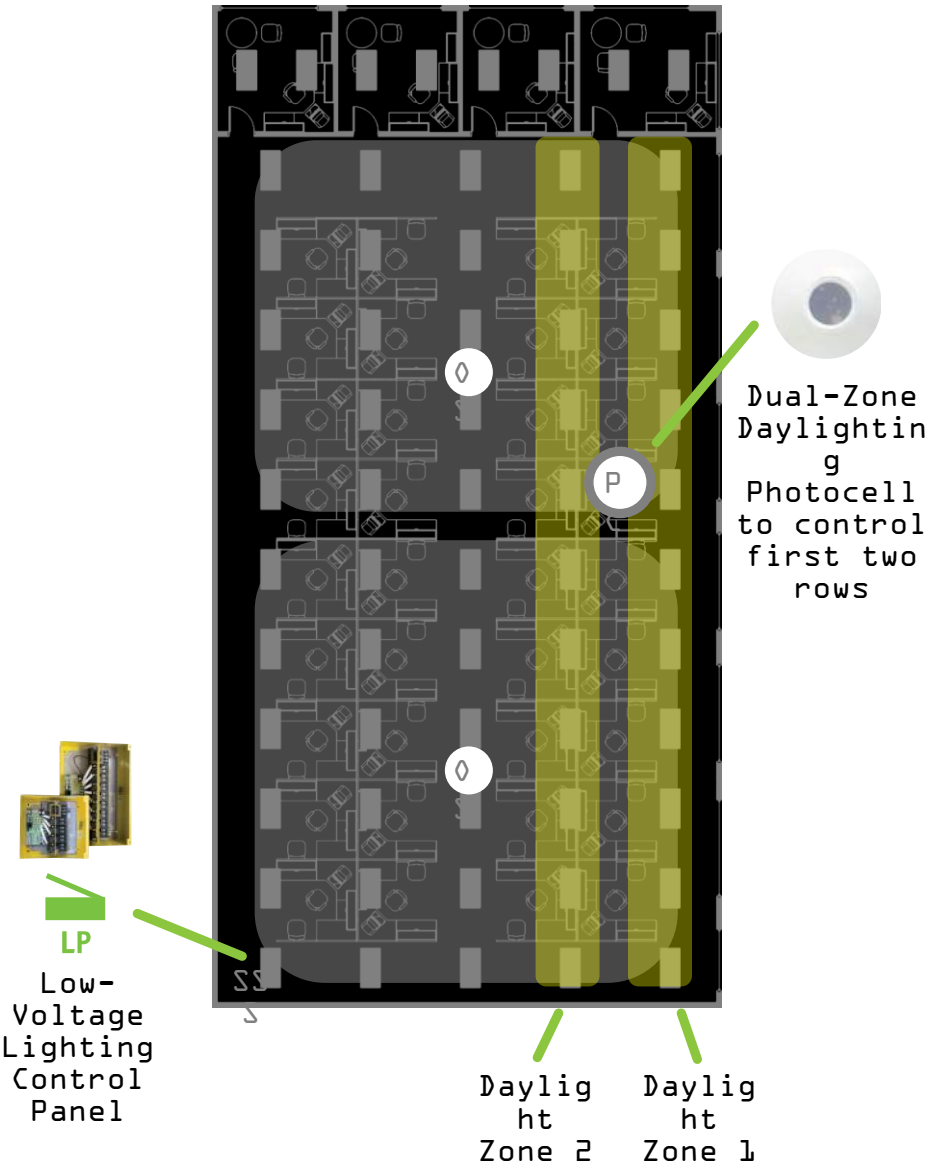
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night
- Daylight responsive dimming for daylight zone luminaires (2 zones)



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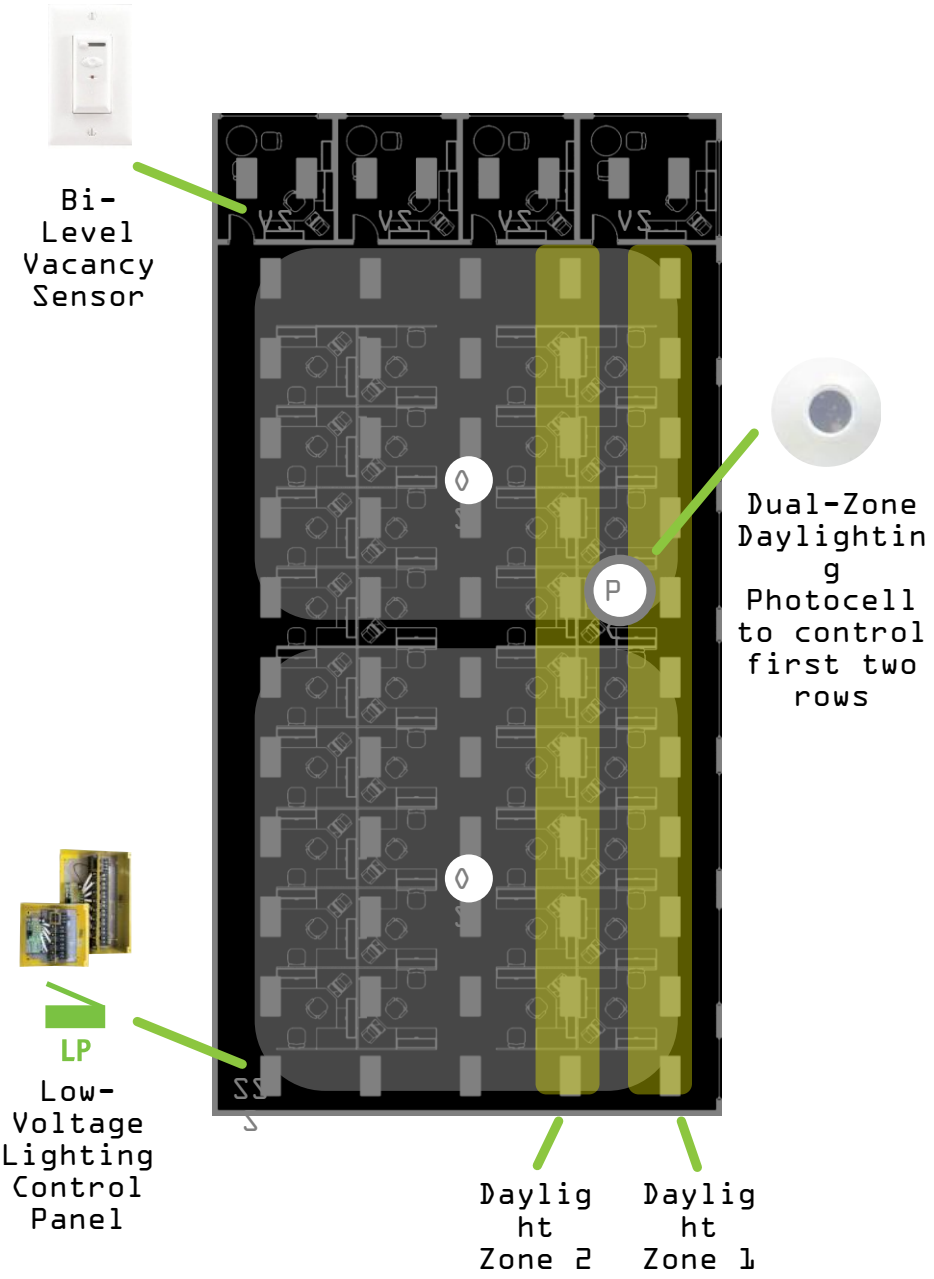
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night
- Daylight responsive dimming for daylight zone luminaires (2 zones)

Private Office Control Strategies:

- Vacancy Sensors with bi-level switching



Centralized Panel w Additional Control Strategies Savings Analysis

Space	Control Strategy	Controlled Fixture(s) % Savings	Total Project % Savings
Open	Timeclock by Day, Occupancy Control at night	21%	19%
Open	Daylight Responsive Dimming for Daylight Zone Luminaires	23%	8%
Private	Vacancy Sensors	30%	2%
Private	Bi-Level Switching	9%	1%

Total Cumulative Lighting Control Savings: 30%

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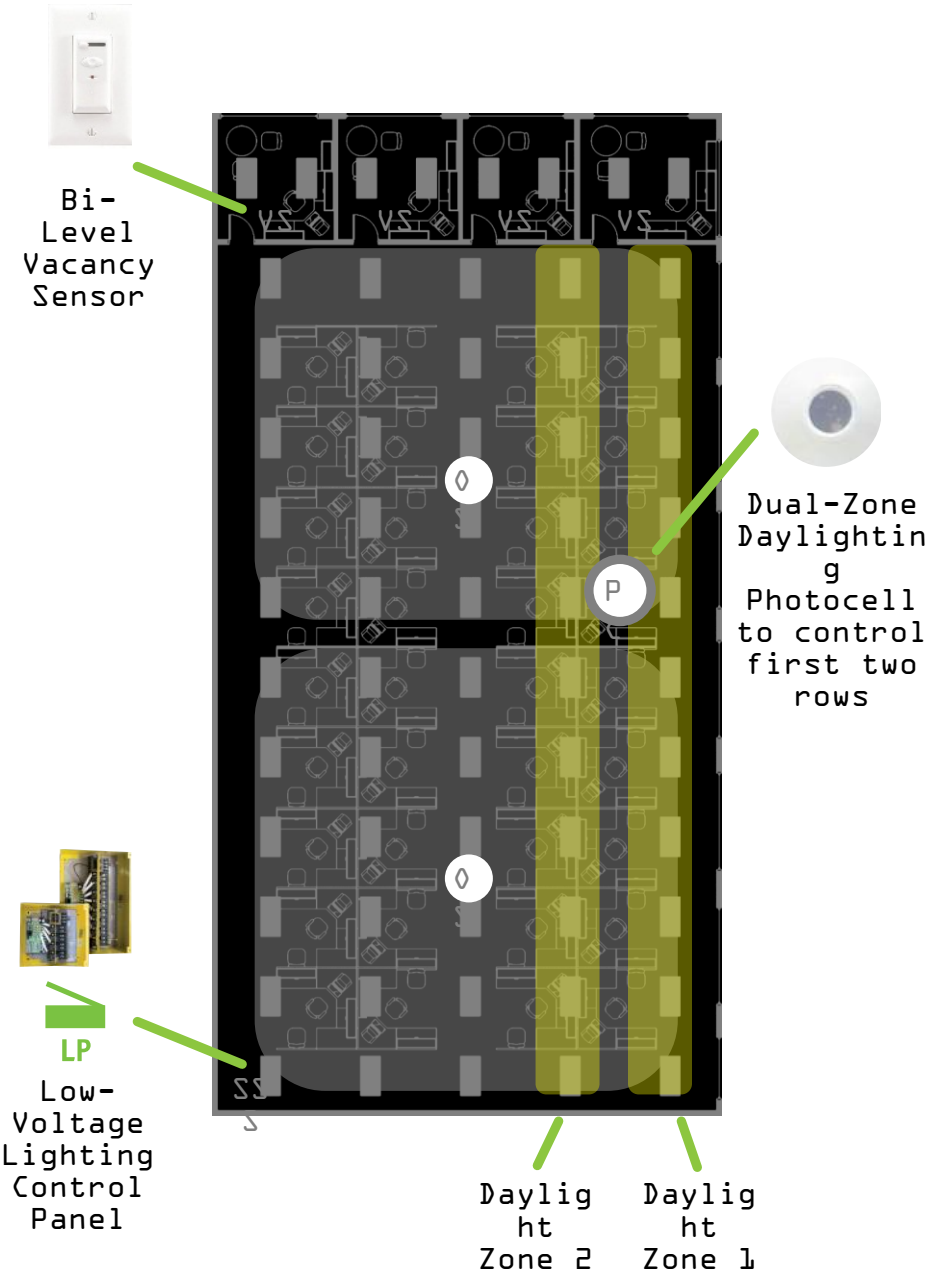
What are the Pros & Cons of this approach?

- Functionality
- Cost
- Wiring
- Energy Savings
- Flexibility
- Occupant Satisfaction
- Marketability & Rents



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Third Approach

Fully Addressable, Wireless with all Cost-effective Control Strategies

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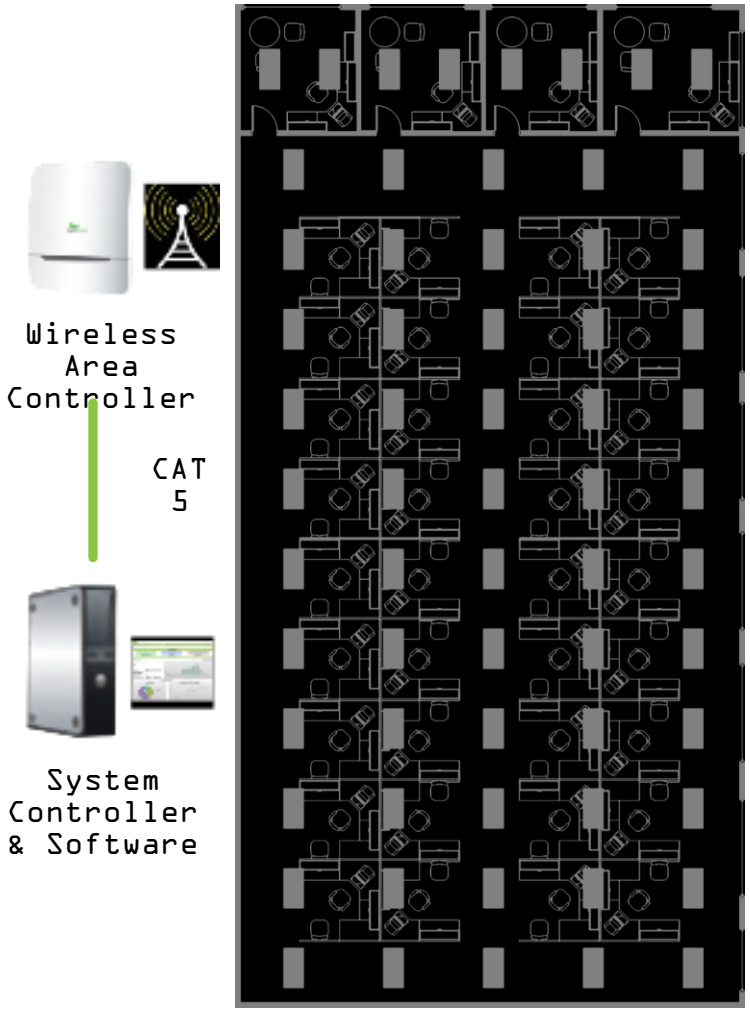
Open Office Control Strategies:

- Timeclock scheduling by day



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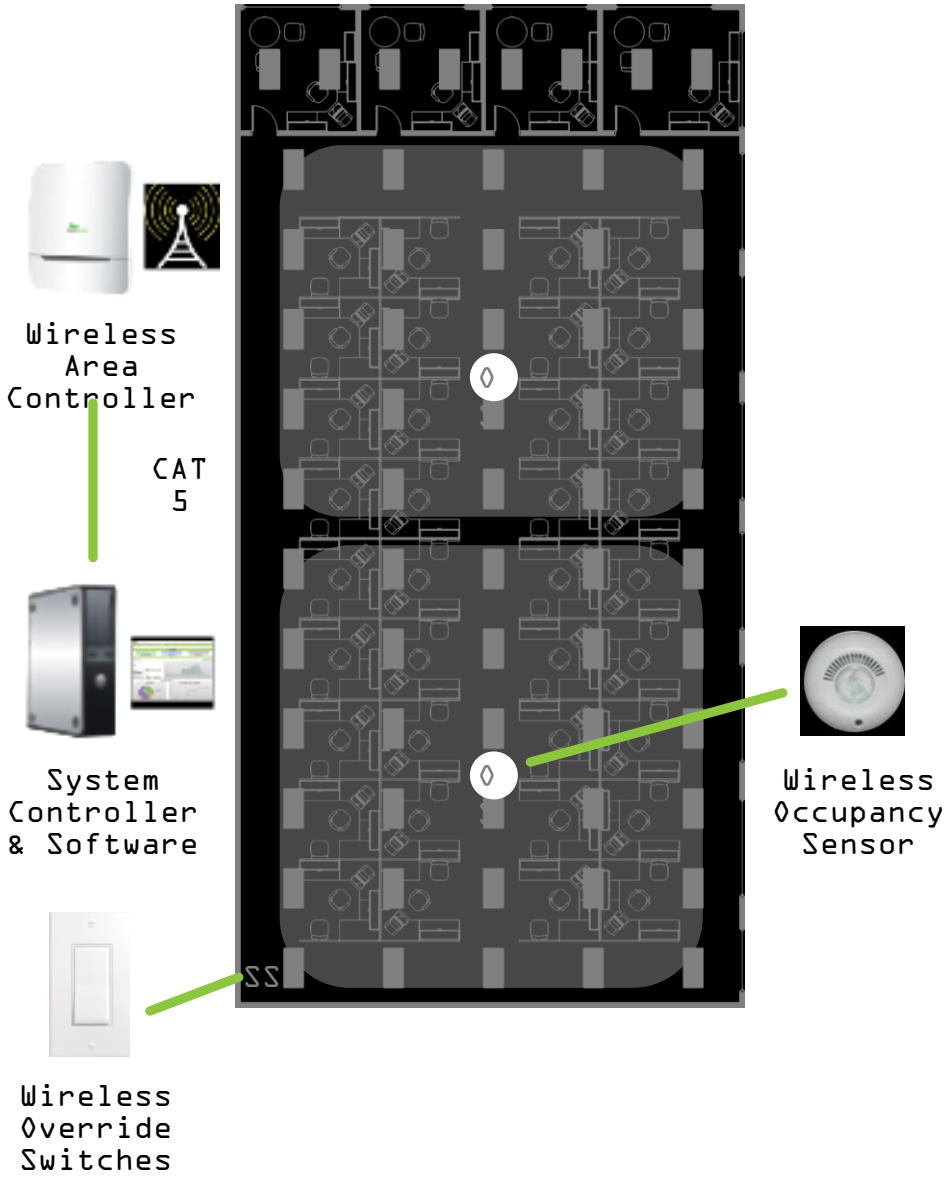
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night



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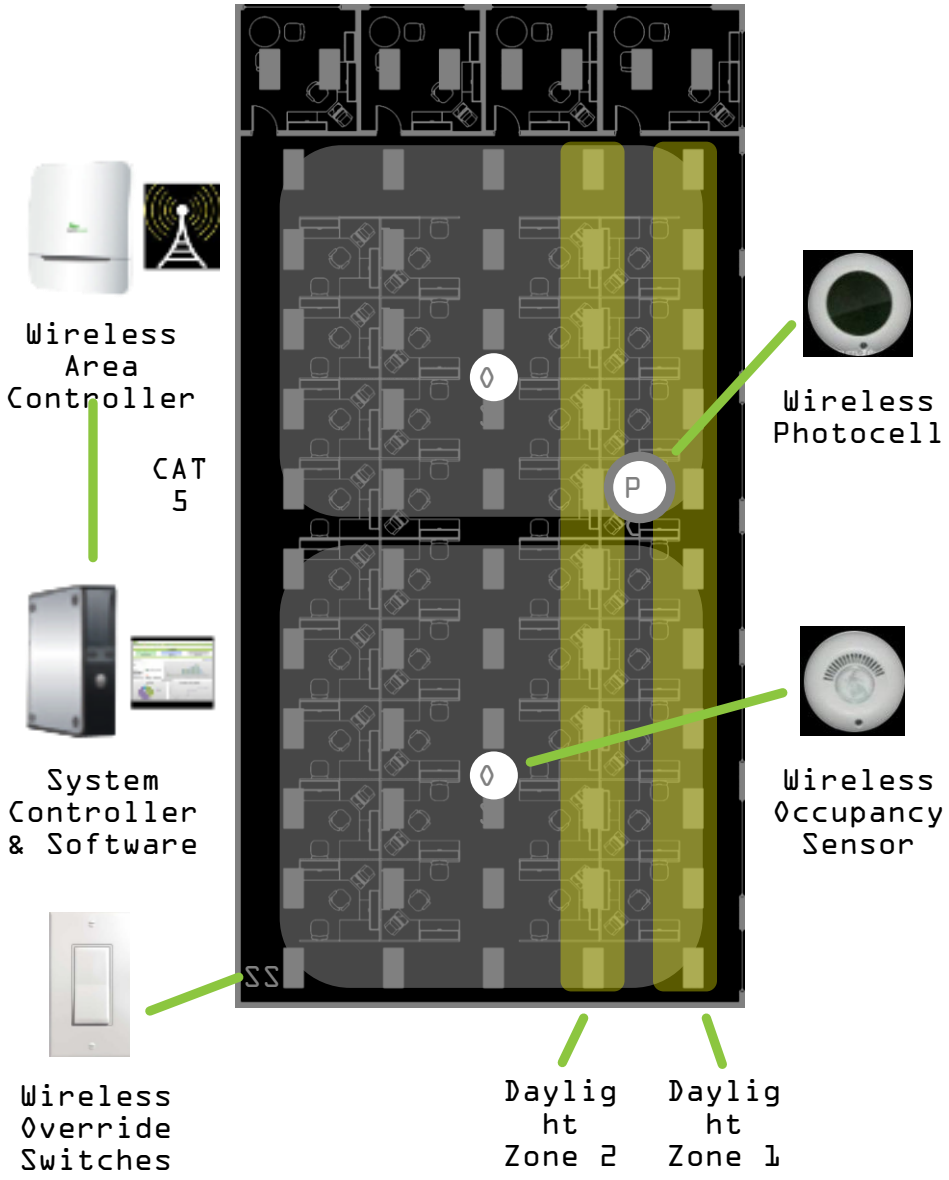
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night
- Daylight responsive dimming for daylight zone luminaires



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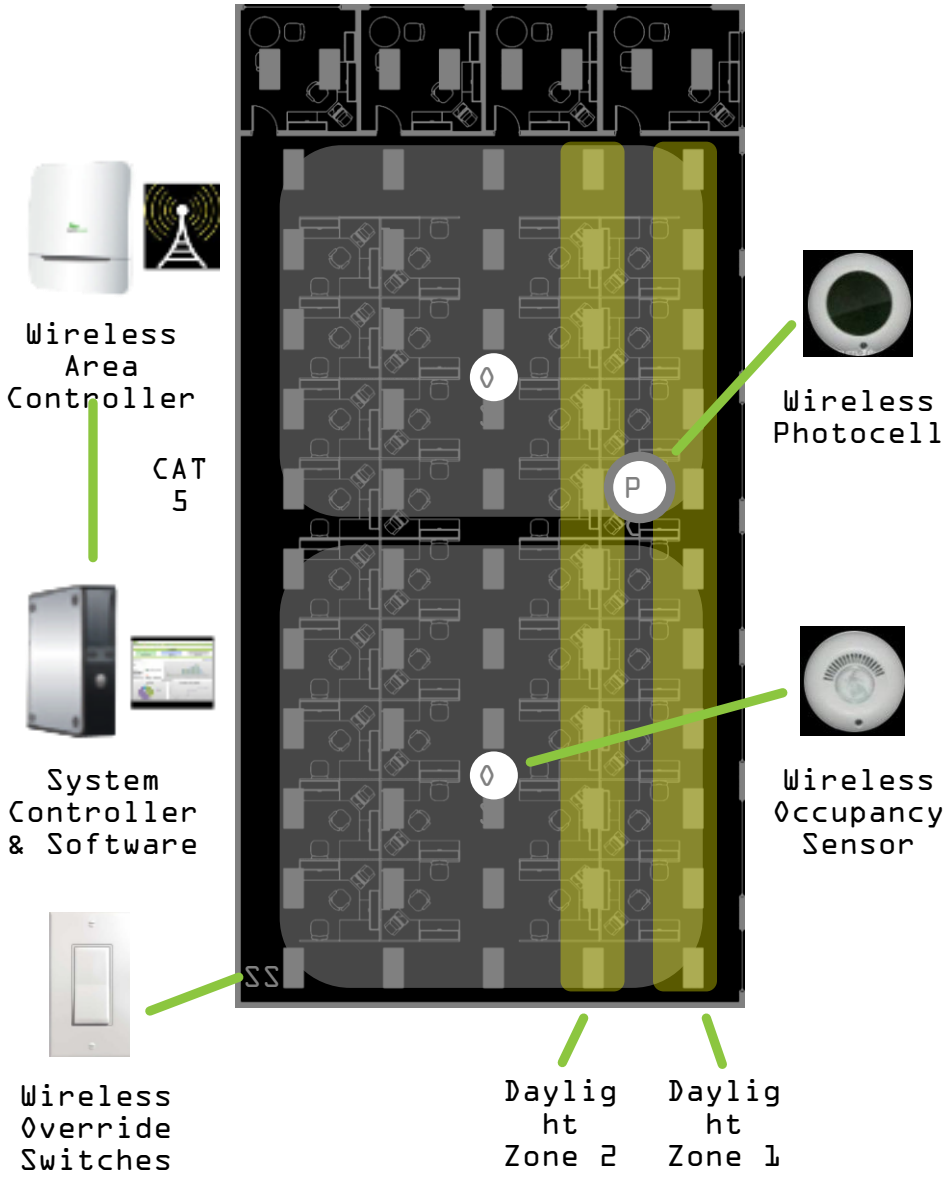
Open Office Control Strategies:

- Timeclock scheduling by day
- Occupancy control at night
- Daylight responsive dimming for daylight zone luminaires
- Task Tuning



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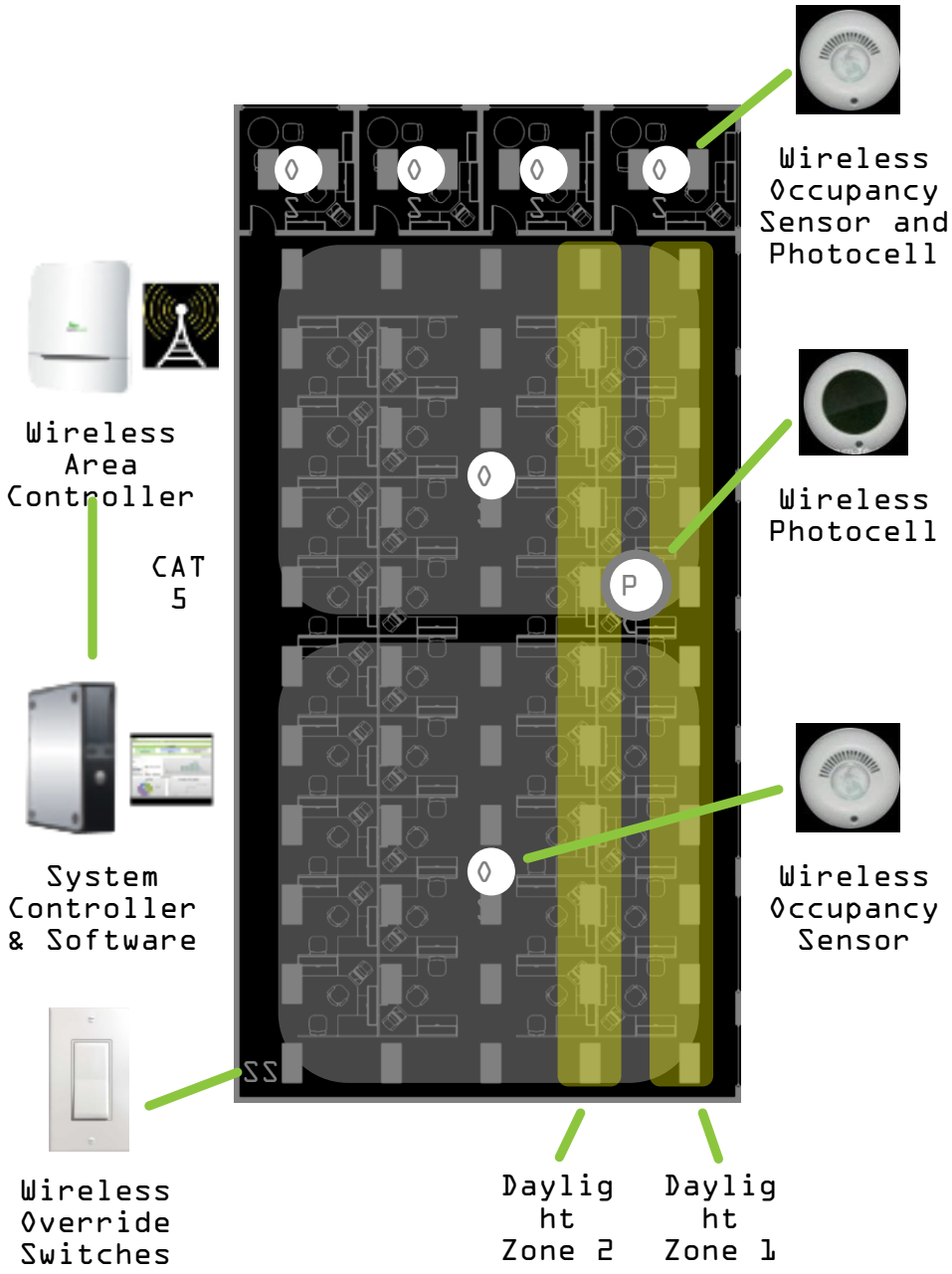
Private Office Control Strategies:

- Vacancy sensors



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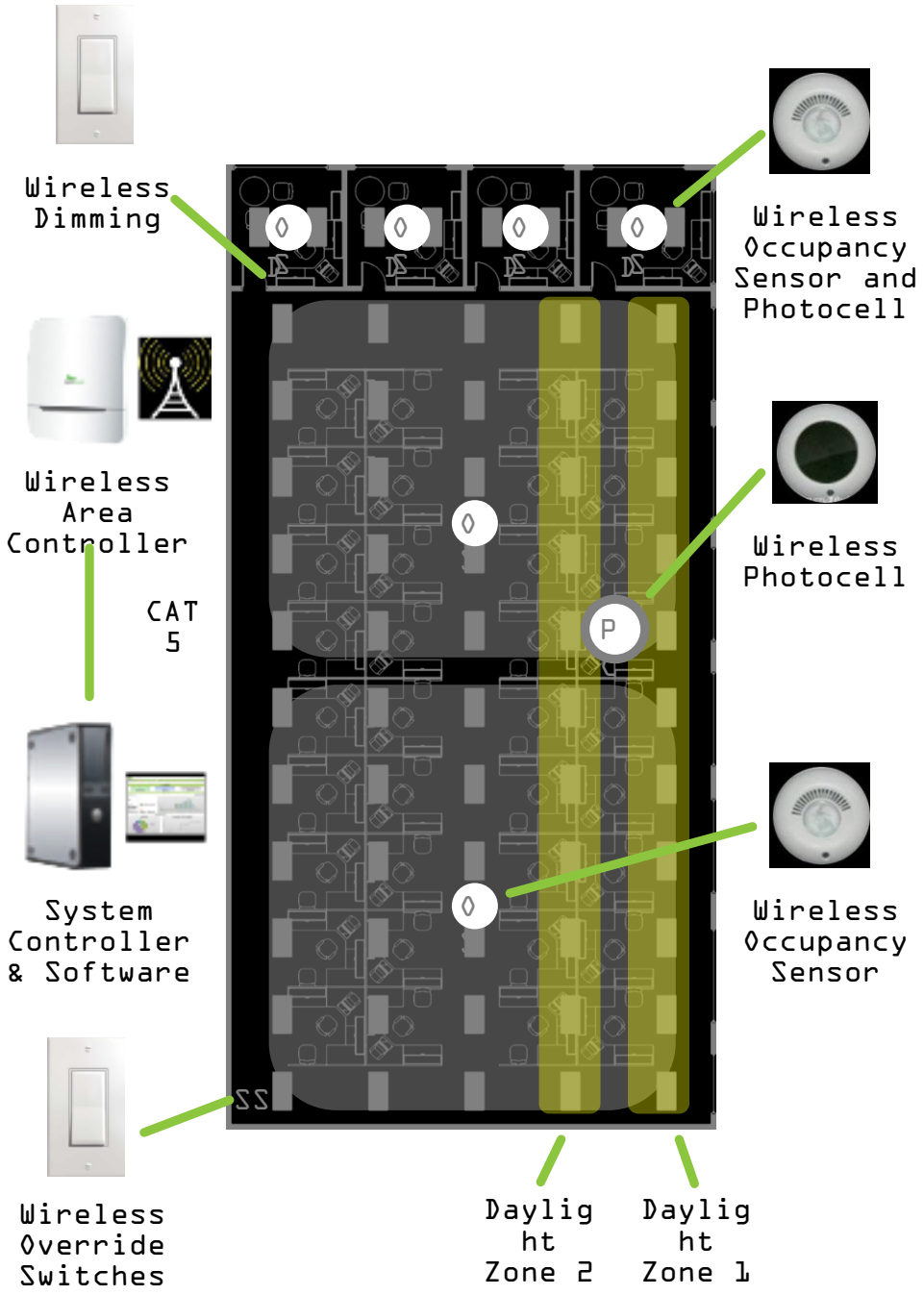
Private Office Control Strategies:

- Vacancy sensors
- Personal Dimming



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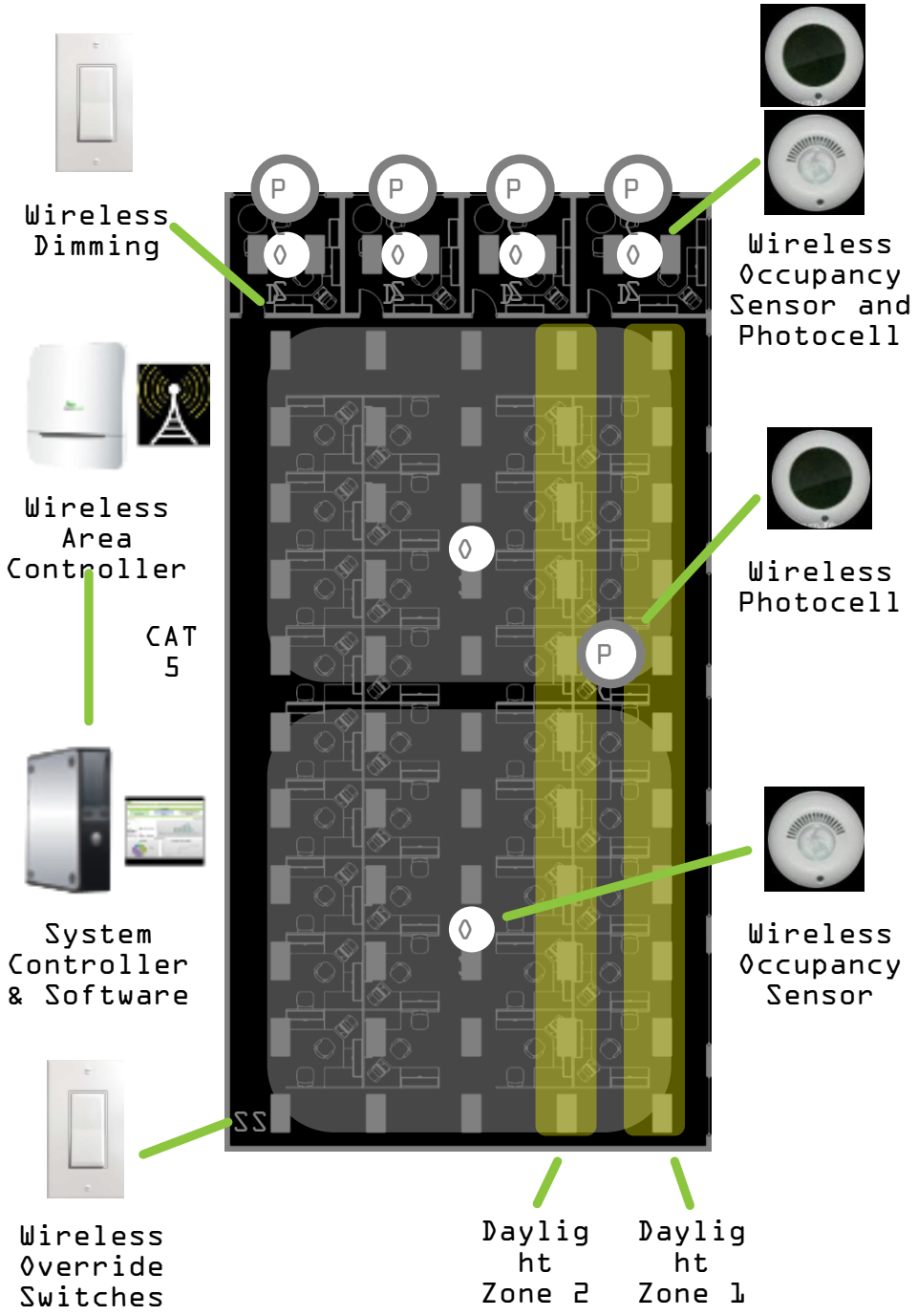
Private Office Control Strategies:

- Vacancy sensors
- Personal Dimming
- Task Tuning



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Fully Addressable Wireless w all Cost-Effective Control Strategies Savings Analysis

Space	Control Strategy	Controlled Fixture(s) % Savings	Total Project % Savings
Open Office	High-end trim dimming	10%	9%
Open Office	Timeclock Scheduling Control during day, Occupancy Control at night	19%	17%
Open Office	Daylight Responsive Dimming for first two rows of luminaires near glazing	8%	7%
Private Office	High-end trim dimming	10%	1%
Private Office	Vacancy Sensors	27%	2%
Private Office	Personal dimming	10%	1%

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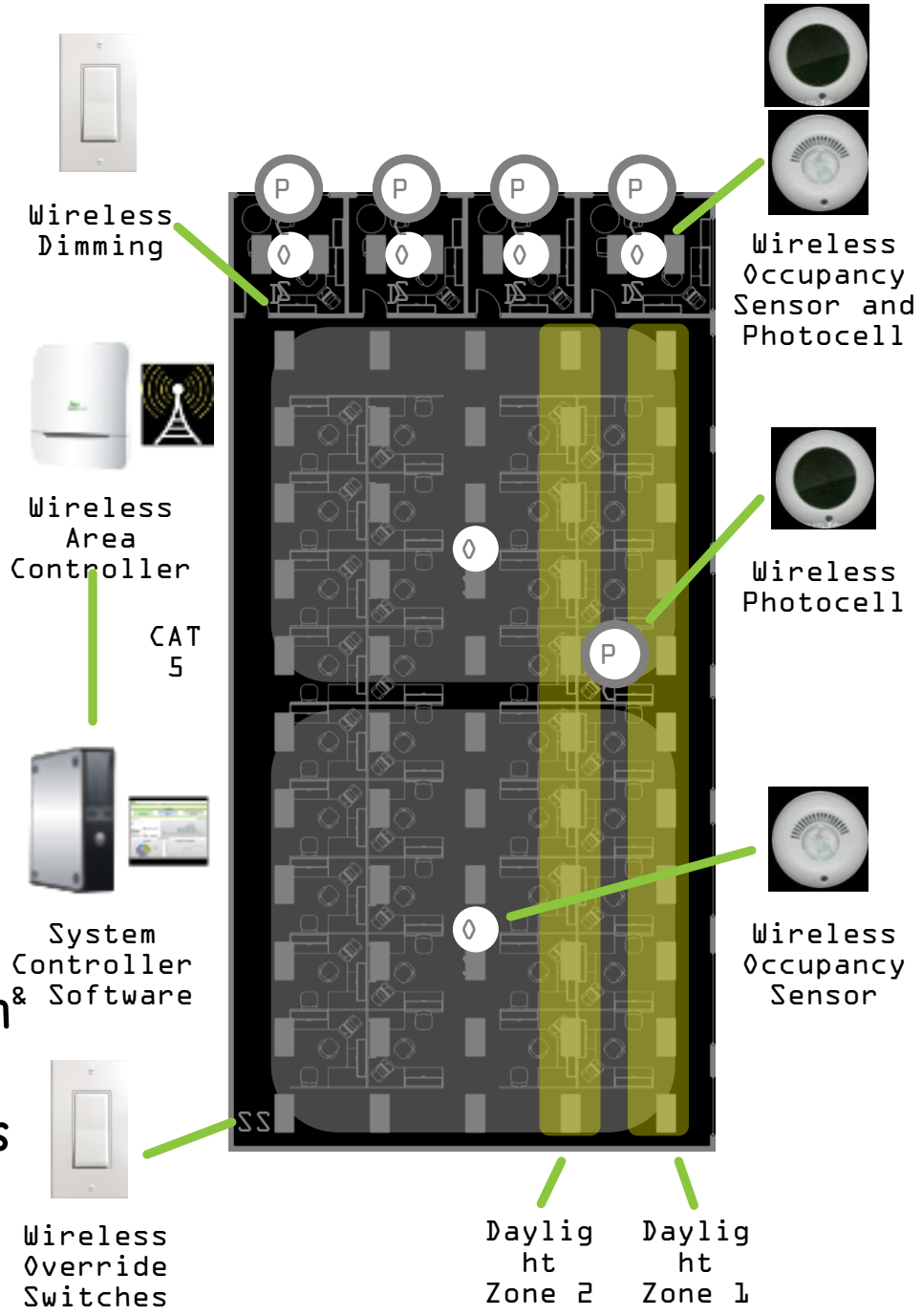
Total Cumulative Lighting Control Savings: 37%

What are the Pros & Cons of this approach?

- Functionality
- Cost
- Wiring
- Energy Savings
- Flexibility
- Occupant Satisfaction
- Marketability & Rents



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Should more advanced controls cost more?

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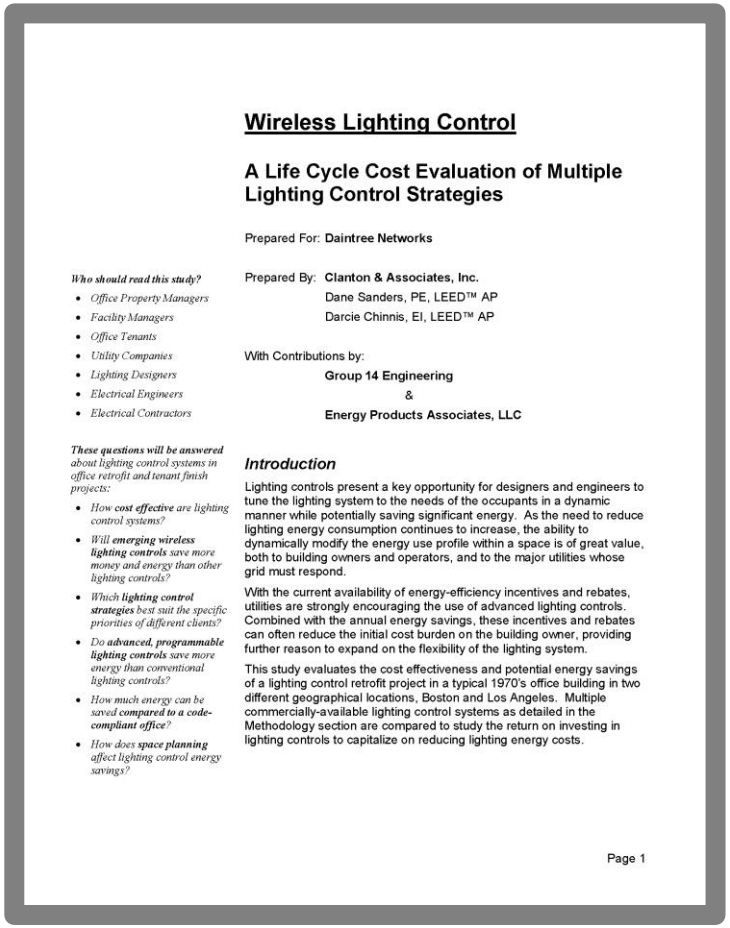
Clanton Lighting Control Study

- Life Cycle Cost Evaluation of Multiple Lighting Control Strategies
- Compares different levels of lighting control upgrades in Boston & Los Angeles
- Do or should Advanced Lighting Controls cost more?
- Do Advanced Lighting Controls save more?



Wireless Lighting Control

A Life Cycle Cost Evaluation of Multiple Lighting Control Strategies

Prepared For: **Daintree Networks**

Prepared By: **Clanton & Associates, Inc.**
Dane Sanders, PE, LEED™ AP
Darcie Chinnis, EI, LEED™ AP

With Contributions by:
Group 14 Engineering
&
Energy Products Associates, LLC

Who should read this study?

- *Office Property Managers*
- *Facility Managers*
- *Office Tenants*
- *Utility Companies*
- *Lighting Designers*
- *Electrical Engineers*
- *Electrical Contractors*

***These questions will be answered** about lighting control systems in office retrofit and tenant finish projects:*

- *How **cost effective** are lighting control systems?*
- *Will **emerging wireless lighting controls** save more money and energy than other lighting controls?*
- *Which **lighting control strategies** best suit the specific priorities of different clients?*
- *Do **advanced, programmable lighting controls** save more energy than conventional lighting controls?*
- *How much energy can be saved **compared to a code-compliant office**?*
- *How does **space planning** affect lighting control energy savings?*

Introduction

Lighting controls present a key opportunity for designers and engineers to tune the lighting system to the needs of the occupants in a dynamic manner while potentially saving significant energy. As the need to reduce lighting energy consumption continues to increase, the ability to dynamically modify the energy use profile within a space is of great value, both to building owners and operators, and to the major utilities whose grid must respond.

With the current availability of energy-efficiency incentives and rebates, utilities are strongly encouraging the use of advanced lighting controls. Combined with the annual energy savings, these incentives and rebates can often reduce the initial cost burden on the building owner, providing further reason to expand on the flexibility of the lighting system.

This study evaluates the cost effectiveness and potential energy savings of a lighting control retrofit project in a typical 1970's office building in two different geographical locations, Boston and Los Angeles. Multiple commercially-available lighting control systems as detailed in the Methodology section are compared to study the return on investing in lighting controls to capitalize on reducing lighting energy costs.

Page 1

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Analyzed 6 different levels of Lighting Control Upgrades

Networked Addressable

(6) Wireless Full Dimming

(5) Wireless Partial Dimming

(4) Addressable Ballasts

Central Panel

(3) Dimming Panel

(2) Relay Panel

Stand-Alone

(1) Localized control

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Baseline Building

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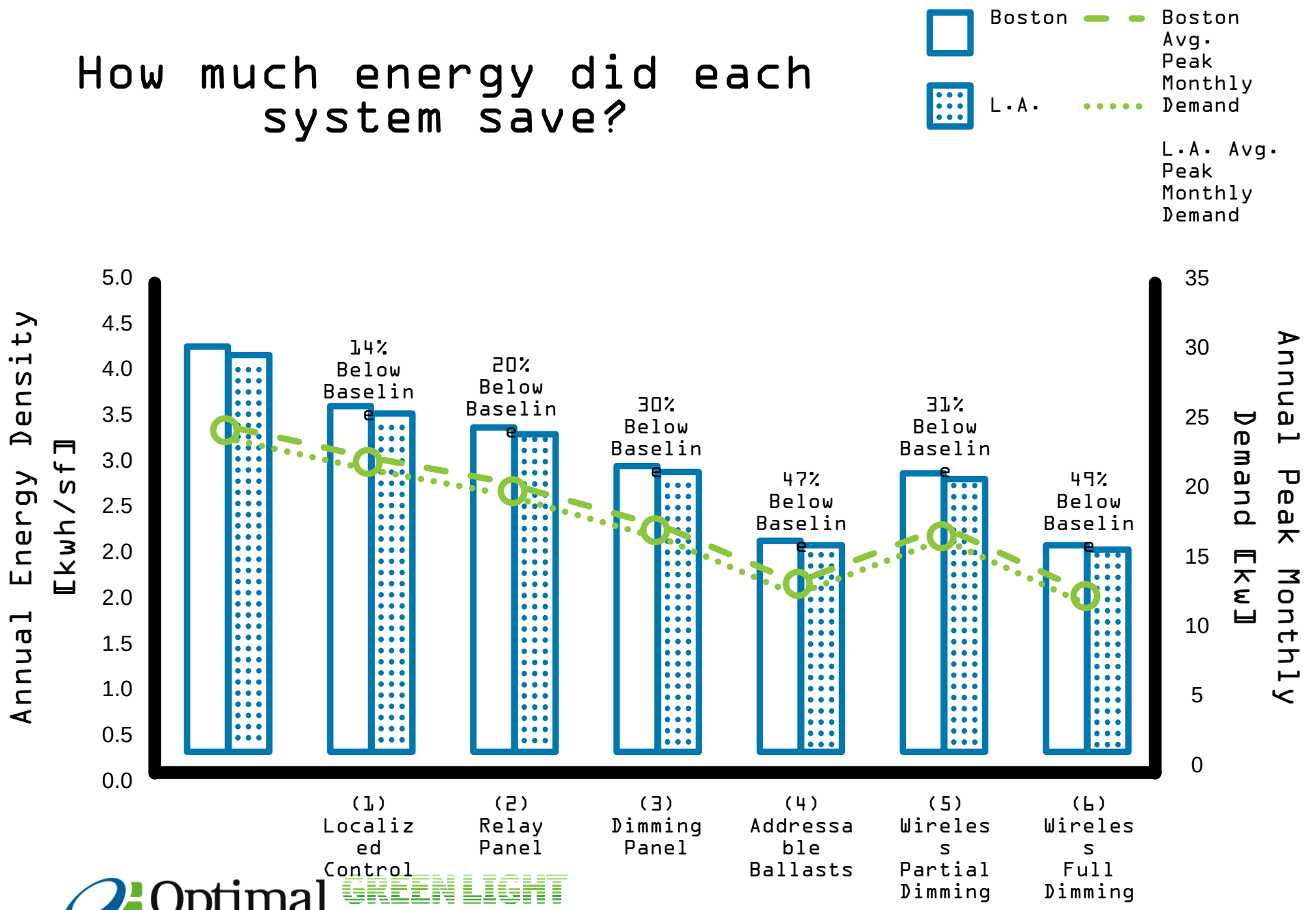
How much energy did each system save?



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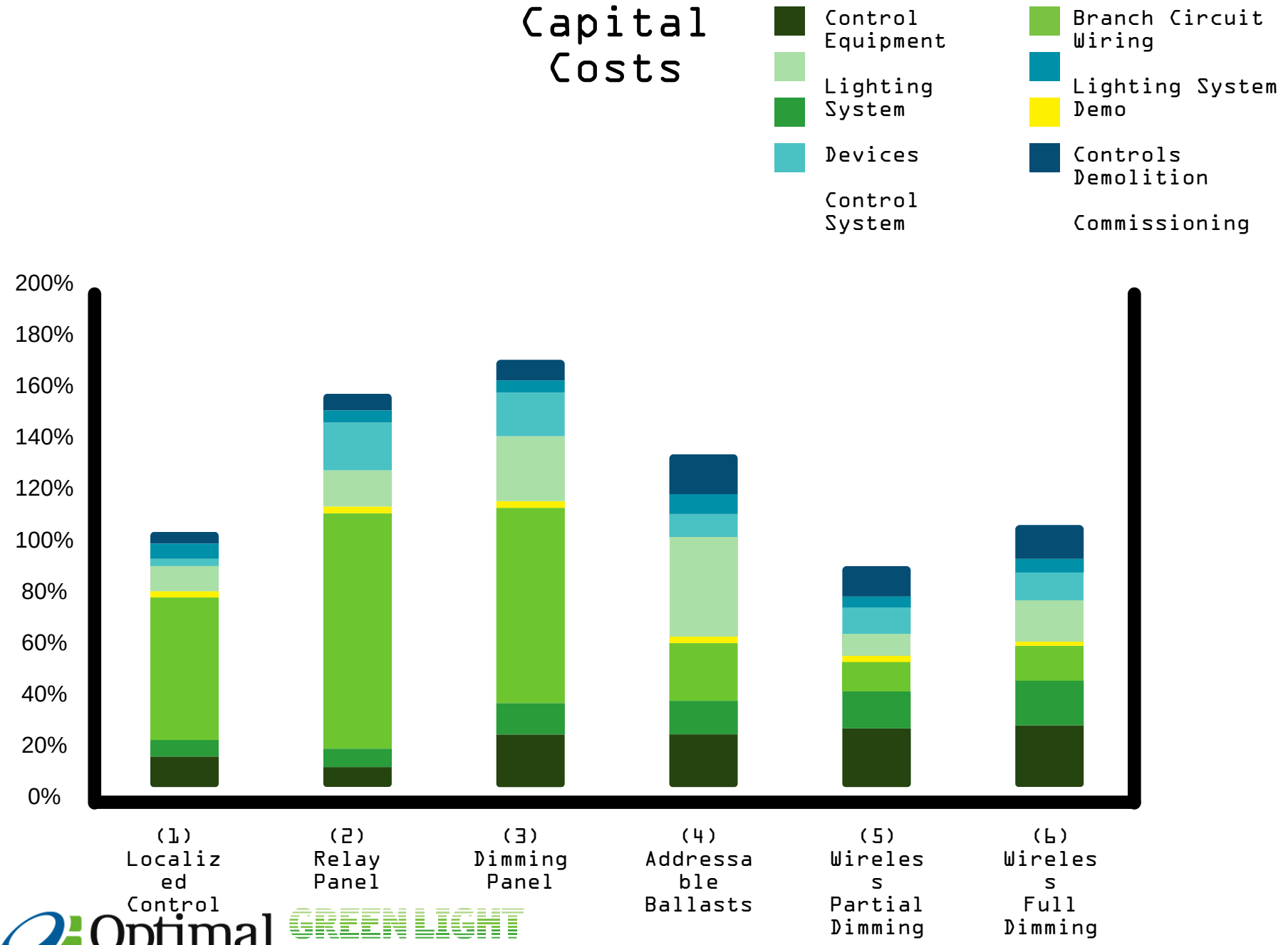
Capital Costs



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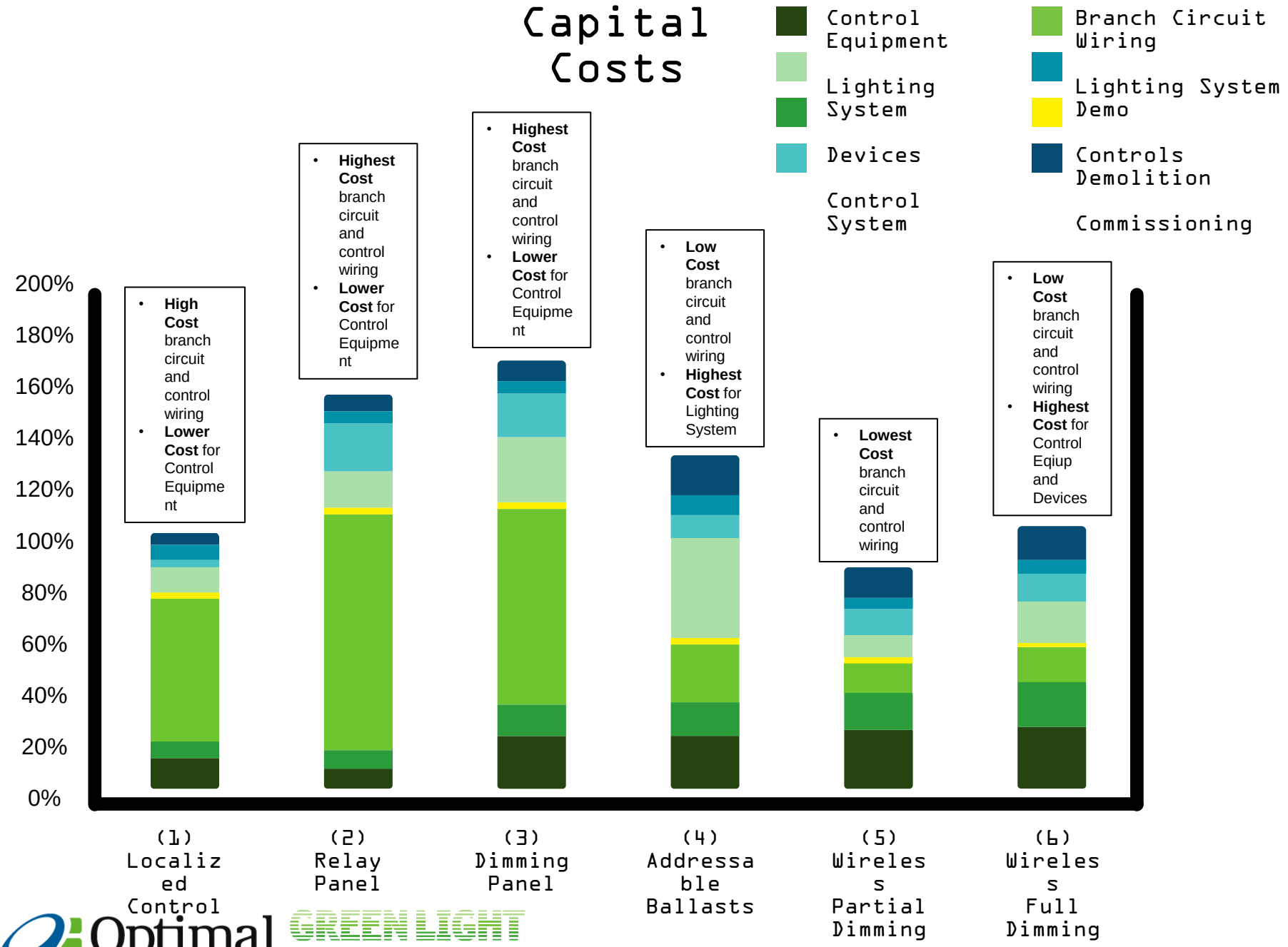
Capital Costs



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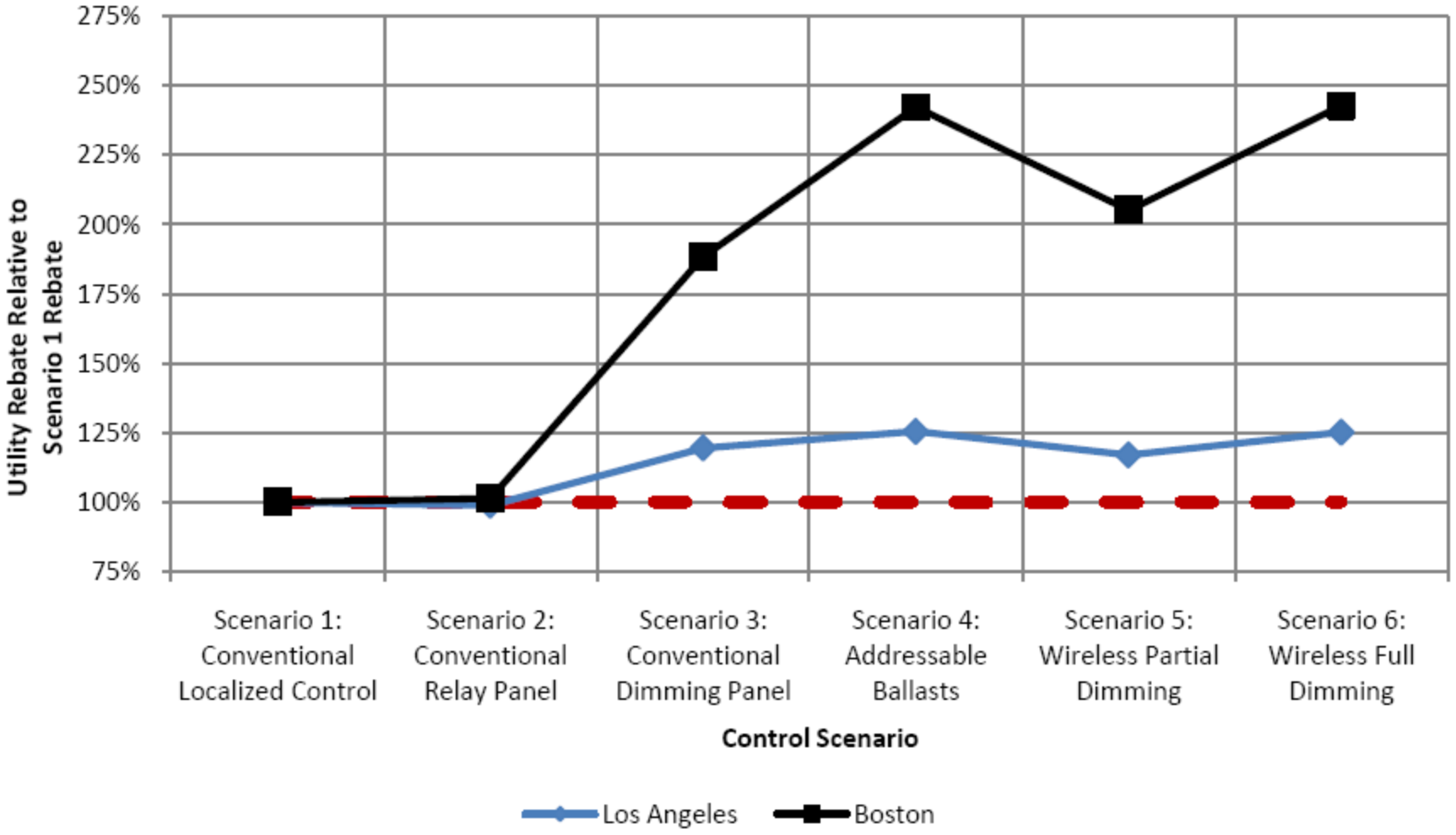

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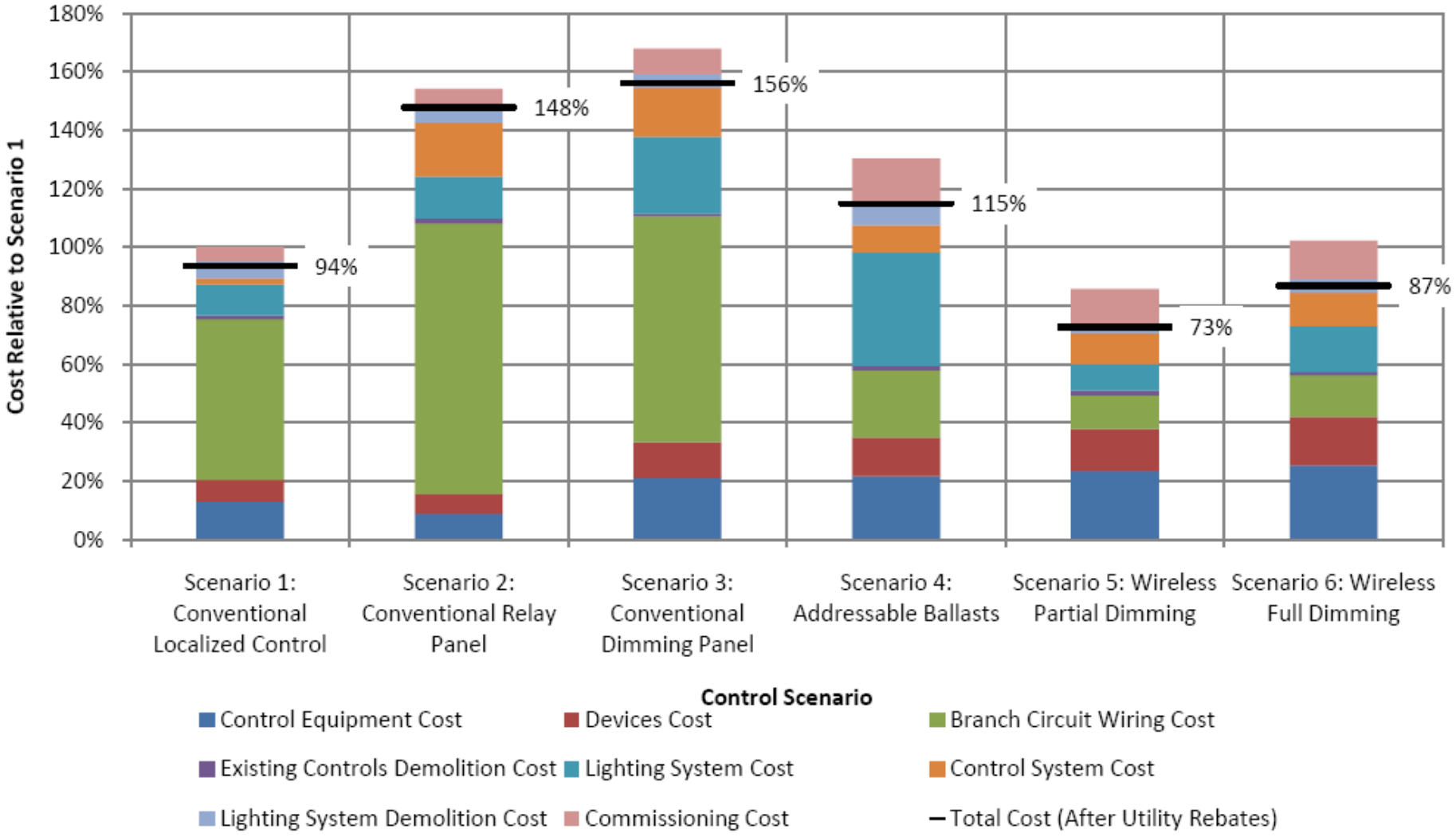
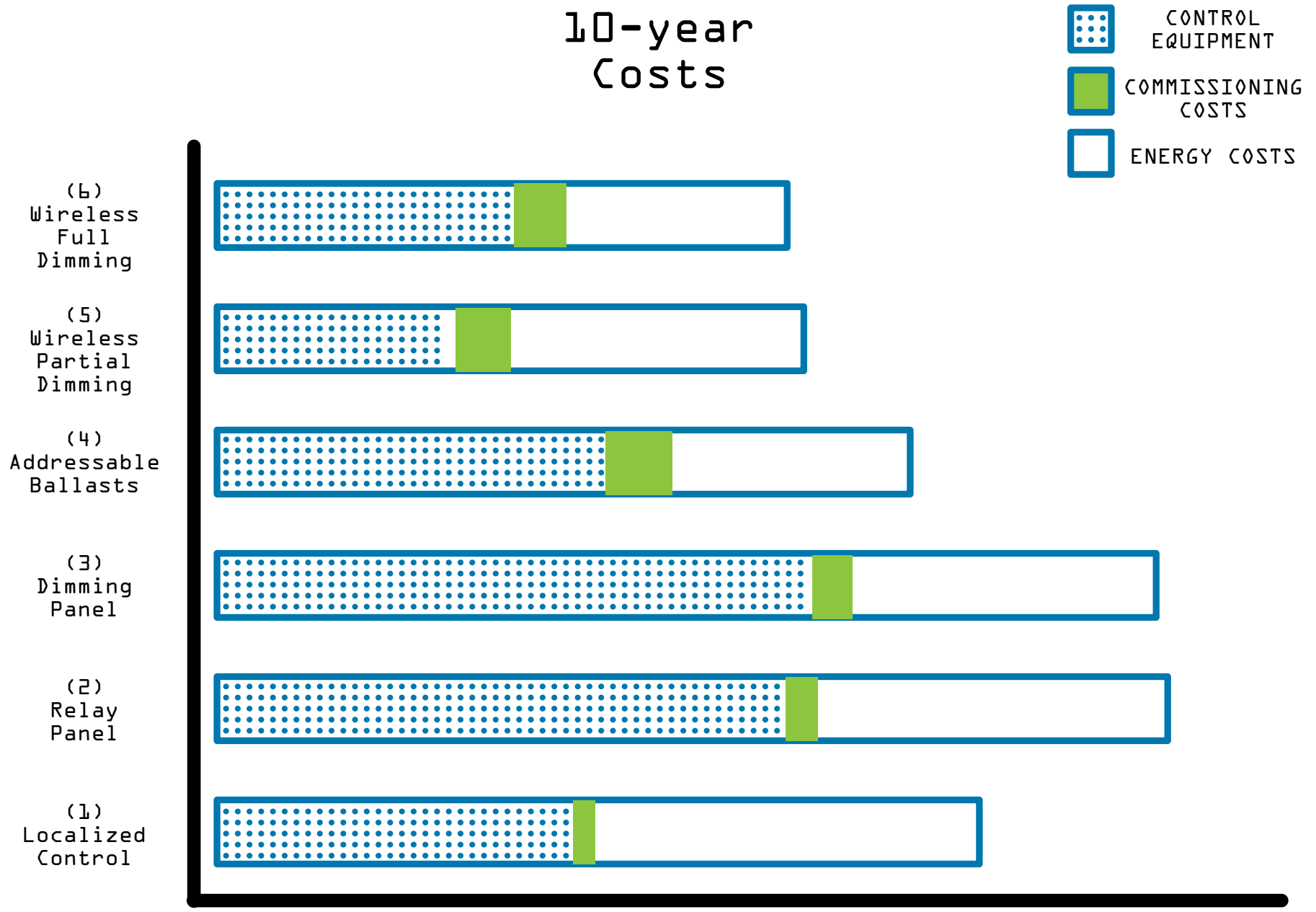


Figure 11 – Capital Cost Breakdown for Boston

10-year Costs



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Key Findings of Clanton Study

- Advanced Lighting Controls can achieve 50% less energy than code-compliant lighting controls
- Wireless Advanced Lighting Controls have lower capital costs than other systems studied in office retrofit applications
- Reduced labor & energy costs of advanced networked lighting control systems can out-weigh increased equipment & commissioning costs

- Will this be true on your project?

Challenges With Pricing

Does uncertainty or lack of familiarity increase bid price?

Will the wiring savings be realized?

What can we do to address these challenges?

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Strategies to Reduce the Cost of Advanced Controls

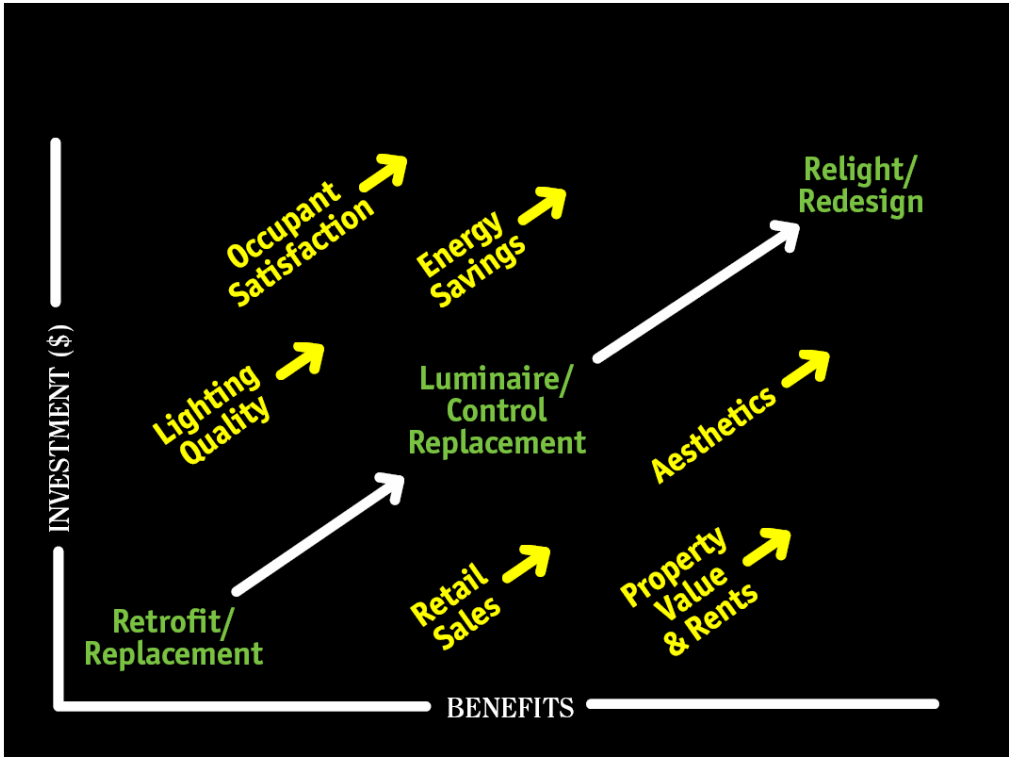
- Hold mandatory pre-bid training for all bidders
  - Highlight issue of controls pricing
  - Communicate that you are looking to realize savings from reduced wiring
  - Controls pricing should not be based on standard $/SF
  - Clearly explain how controls will be wired
  - Clearly identify who is responsible for what

Strategies to Reduce the Cost of Advanced Controls

- Carefully and Fully Specify Controls
  - Provide Design Narrative for all Controls
  - Provide Control Intent and Zoning Diagrams
  - Specify Initial Calibration Settings
  - Identify who is responsible for what
  - Align responsibility with who is most knowledgeable and/or cost-effective for each task
    - Example: Consider putting responsibility on Manufacturer for Commissioning and System Functionality
    - Example: Require the contractor is trained on control system

Strategies to Keep Advanced Controls on Projects

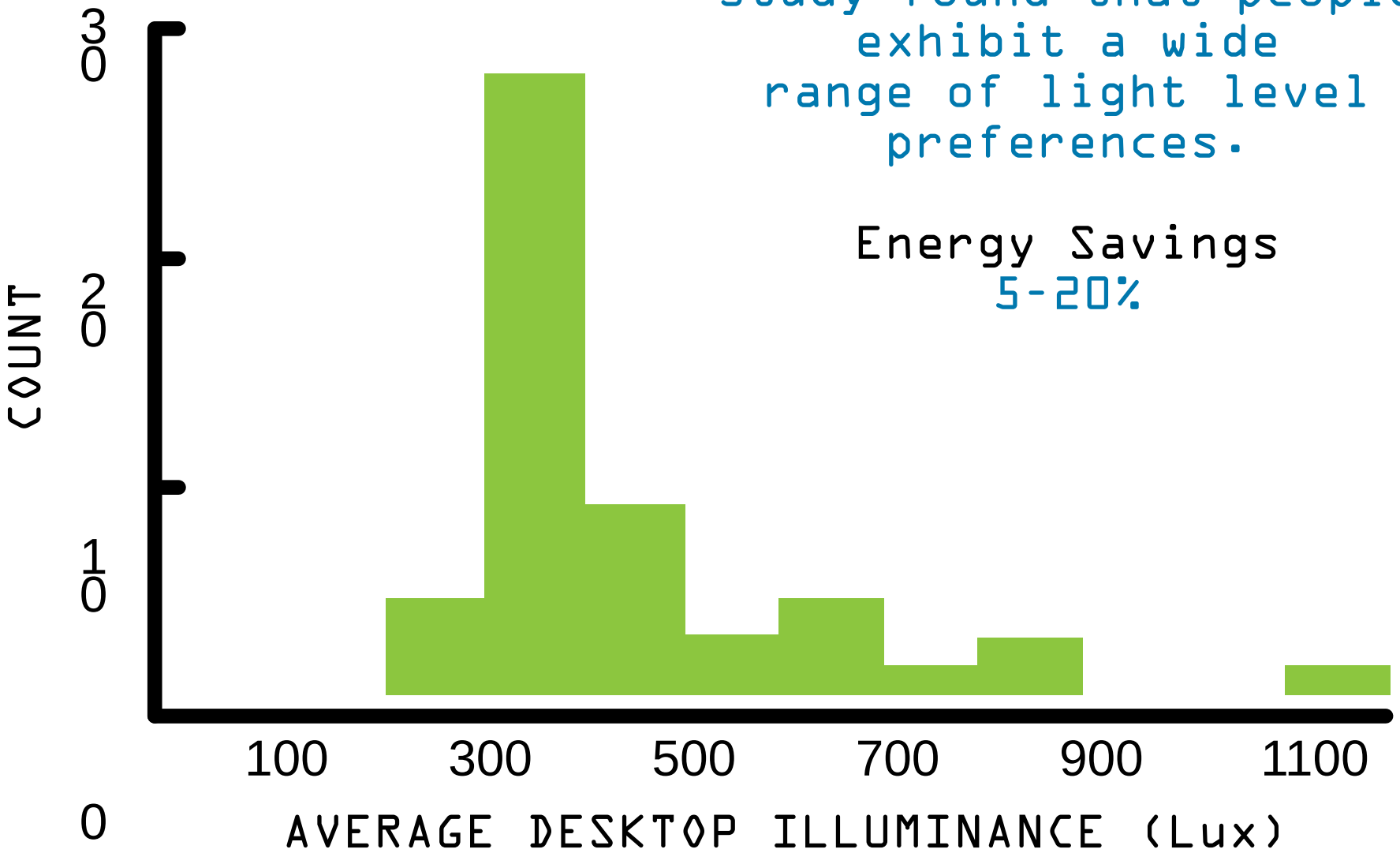
- Reduce the Costs per previous slides
- Play up the benefits beyond energy savings:



Light Level Preferences

A 2004 open office study found that people exhibit a wide range of light level preferences.

Energy Savings
5-20%



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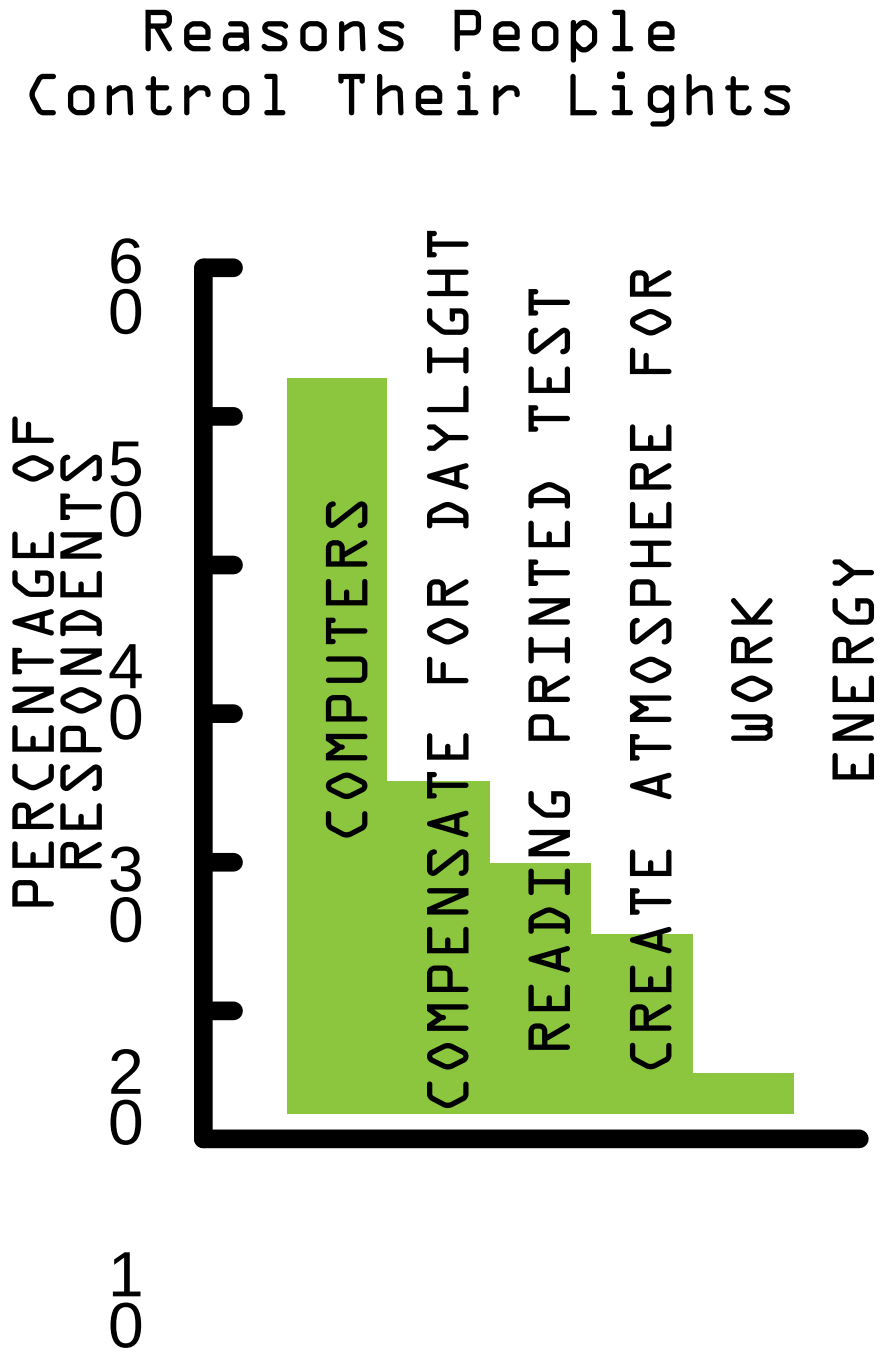
Source: LightRight Consorti

Allowing workers to control their light can result in higher productivity and occupant satisfaction

People costs typically outweigh building costs by 13:1

Investing in personal controls can lead to desirable financial outcomes beyond energy savings



Optimal ENERGY

GREEN LIGHT NEW YORK

Green Buildings and Property Value / Rents / Lease Rates

Certification on Office Values, Fuerst et al, 2011

* 4-5% Rental Premium, 25% Sales Premium for LEED or ENERGY STAR Buildings

Sustainability and the Dynamics of Green Building, Eichholtz et al, 2010

* 6% Rental Premium, 11-13% Sales Premium for LEED or ENERGY STAR Buildings

Green Design and the Market for Commercial Office Space, Wiley et al, 2010

* 7-17% Rental Premium, 8-18% Sales Premium, 10-11% higher Occupancy Rates for ENERGY STAR

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Optimal ENERGY *Integrated Energy Resources*

Thank You

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