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Lessons From a Field Evaluation of Two Connected-Lighting Systems

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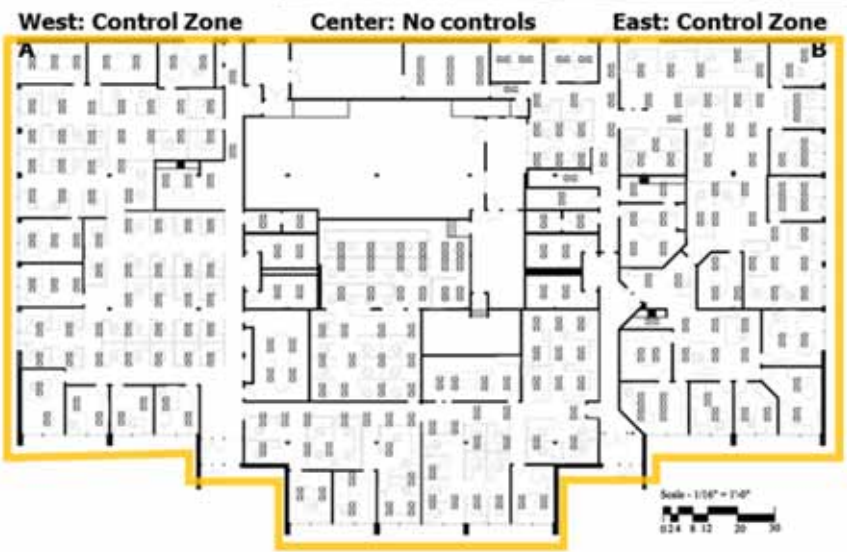
Introduction and objectives of the field study

- Evaluated two connected lighting control systems in an office building
  - Group control
    - one sensor per multiple fixtures
  - Individual control
    - One sensor per fixture
- Objectives:
  - To study the features, ease of specification, procurement, installation, commissioning, and operation of the two system approaches
  - To quantify energy savings with each control approach
  - To evaluate end-user satisfaction the lighting controls interaction, operation and availability

Site information

- Administrative offices for a state agency
  - Security-conscious
- Suburban business park in Troy, NY
- Building
  - Single-story, 1980s
  - 25,000 square feet
  - Open plan and private offices, conference rooms



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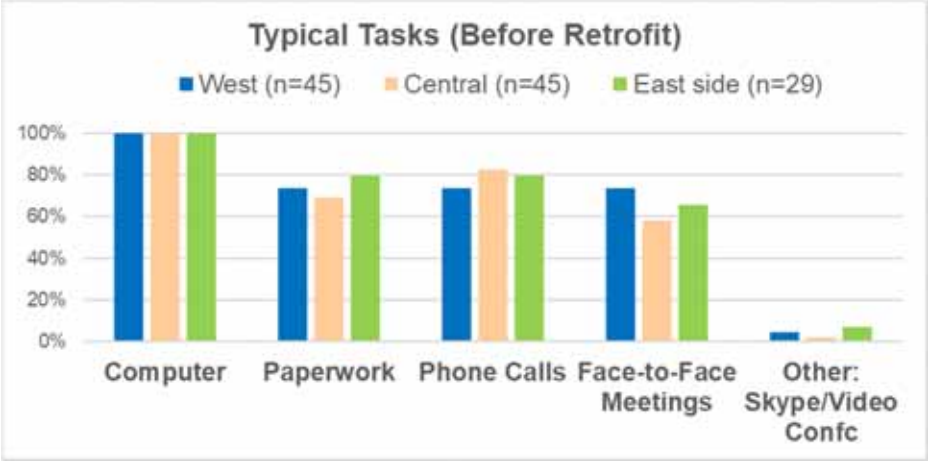
Site information

- Users
  - Heavy computer use
  - Prefer low light levels
- Patterns of use
  - Mostly day shift
    - 8:30 am to 5:00 pm
  - Some 24-h operations
    - Three shifts
    - Monitoring, security



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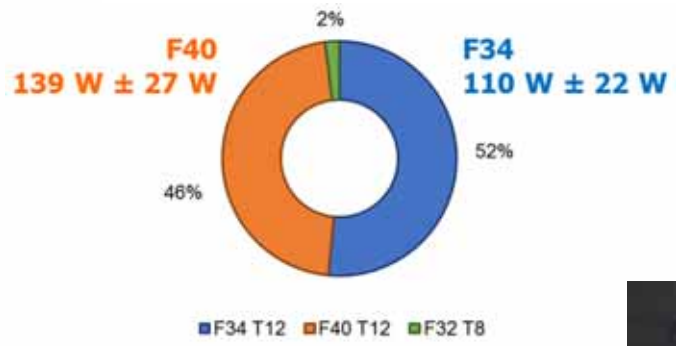
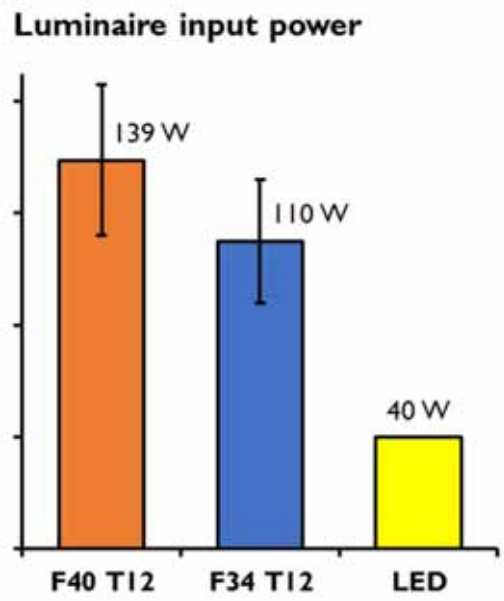
Lighting

- Before retrofit
  - Prismatic troffers, 2x4
  - F40, F34 T12
  - Several magnetic ballasts
- After retrofit (fall 2017)
  - LED troffers (2 manufacturers)
  - 40 W input power
  - 4000 lm, 4100 K, 80CRI





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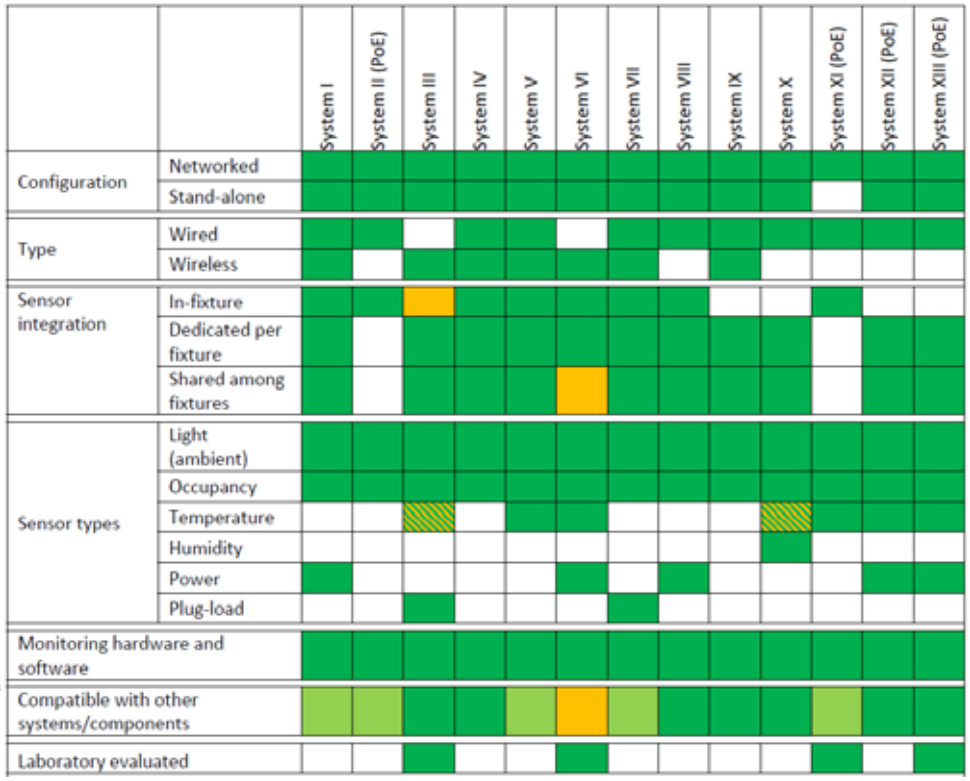
Control systems

- Design and specification
  - Difficult to specify, get information, samples, or purchase (2016)
  - Mostly closed, proprietary systems



– lighting control solution or solution family has the feature according to manufacturer

– lighting control solution or solution family has the feature but is limited according to manufacturer

– not recommended by manufacturer

– Temperature sensing only at the thermostat

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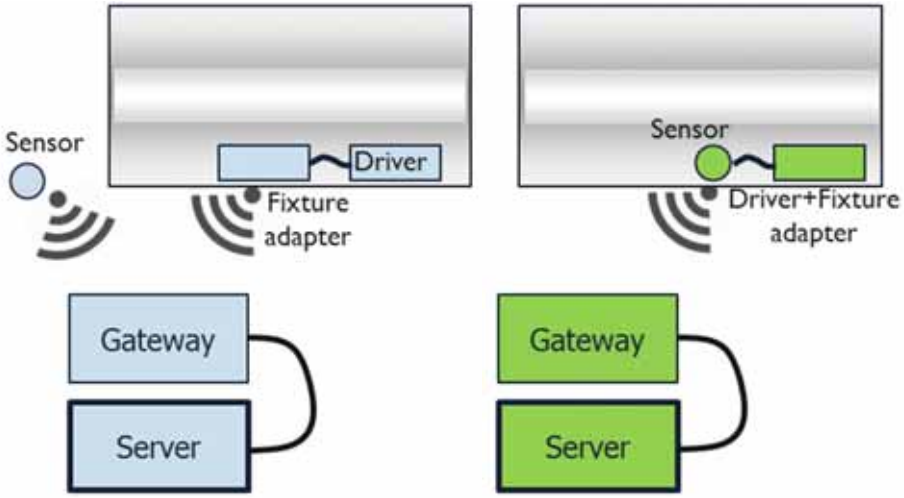
Control systems

- Similar architectures
  - Both wireless
  - Both operated through server within premises
  - Similar control features
- Major differences
  - Fixture-integrated sensors (individual control) vs. grouped control
  - One open to sensors by others
  - Information reported by the systems
    - Measured vs. calculated; timing of reports



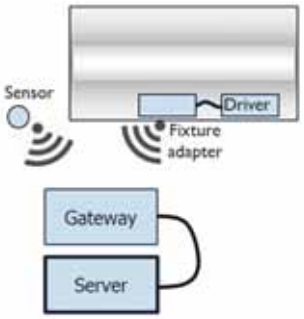
Control zones

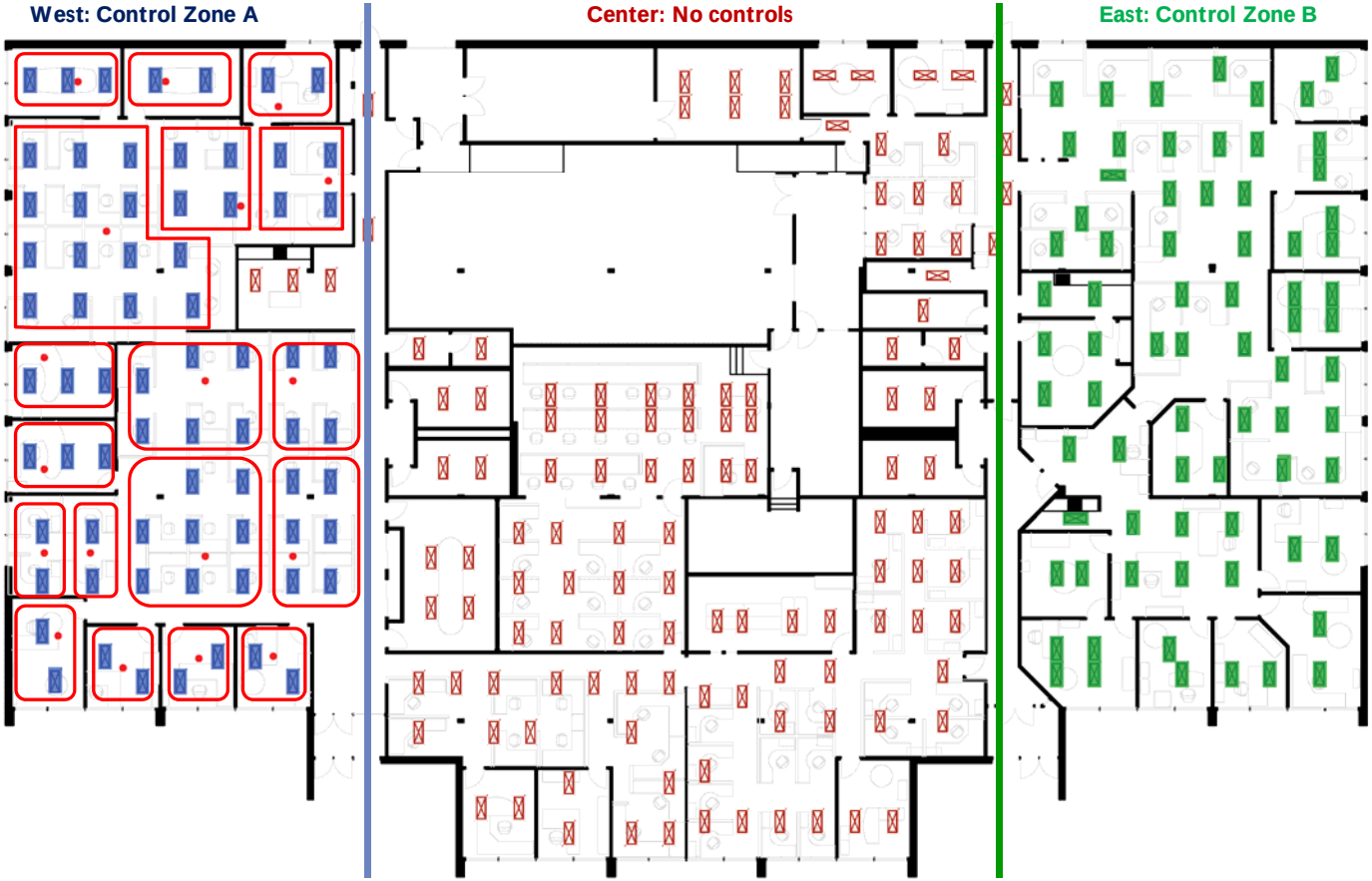
Zone A

2 Open office areas
7 Private offices
2 Conference rooms

71 fixtures

18 sensors
Ceiling mounted



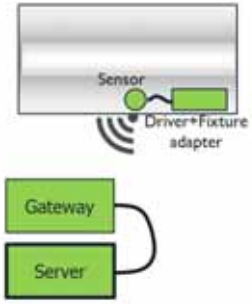


Zone B

2 Open office areas
8 Private offices
3 Conference rooms

74 fixtures

74 sensors
Fixture mounted



Results and lessons learned: Installation and Commissioning

- Installation
  - Uneventful for the most part
  - Commissioning can take time
    - Discovery of units, profile assignments
    - Not immediate response, specially when large number of fixtures
    - Sensors vary in sensitivity and coverage
  - Learning curve for facilities manager
  - Need a dedicated person to take ownership of project and follow through after installation

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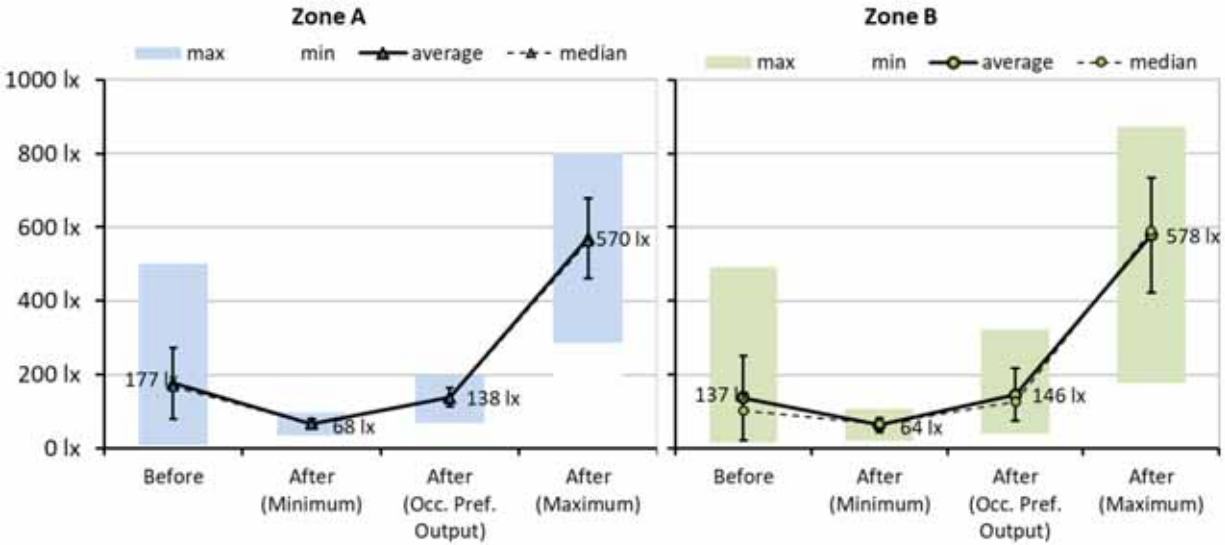
Results and lessons learned: Lighting

- Lighting
  - Initial light levels too high: High-end trim very valuable to match light levels to base case
  - Better uniformity than base case
  - More people responded that lighting is better than before and similar buildings



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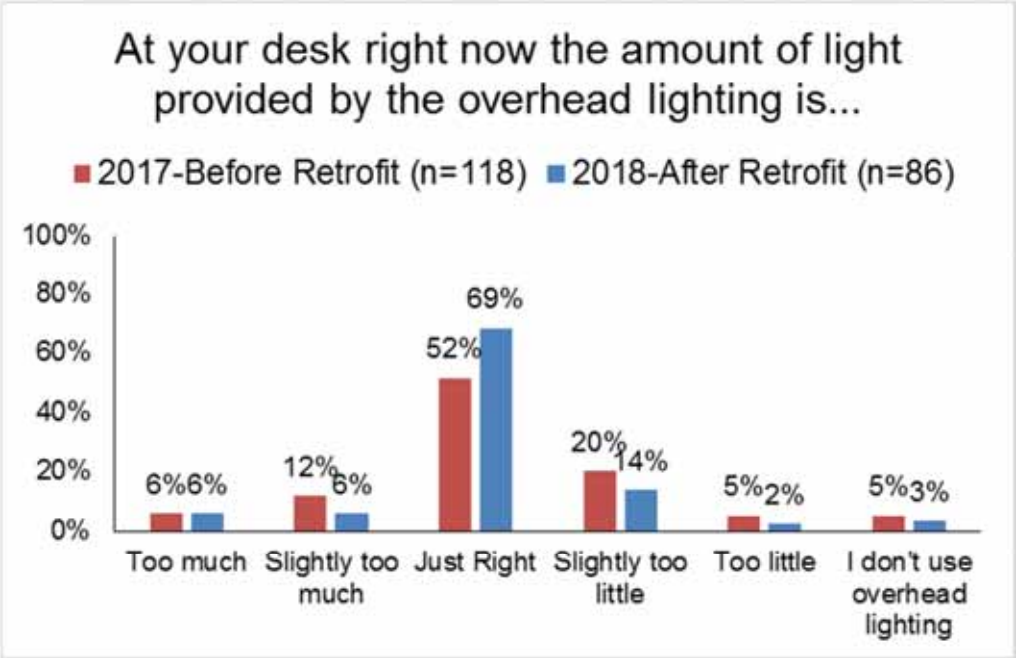
Results and lessons learned: Lighting



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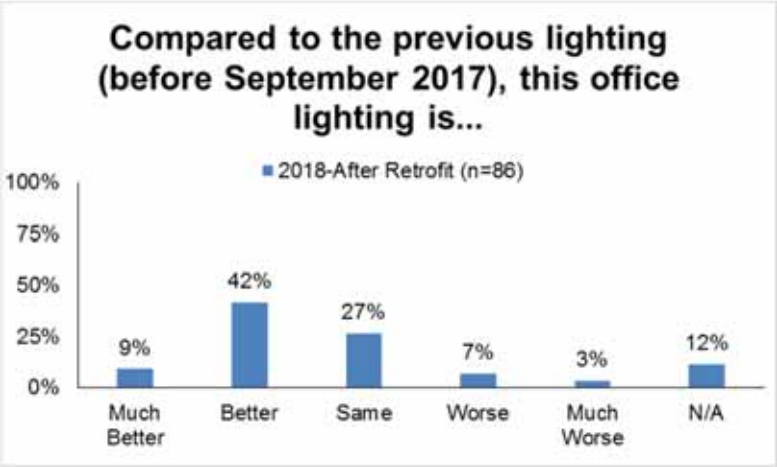
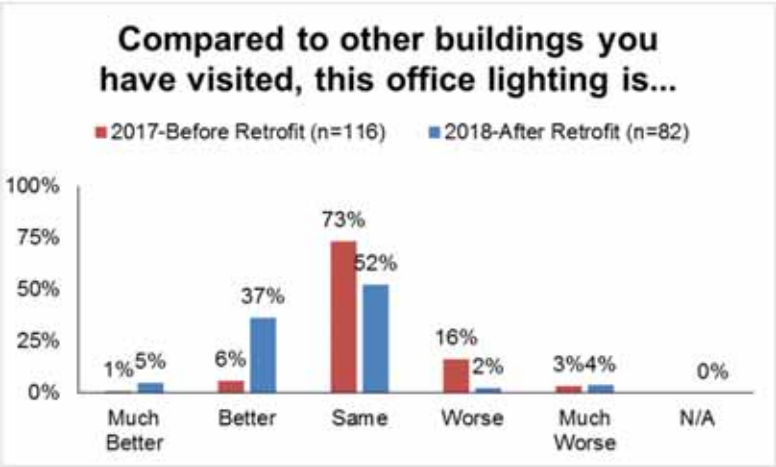
Results and lessons learned: Lighting





Occupant acceptance improved overall

- *"I am happy with it."*
- *"Looks much nicer than before."*
- *"It was a welcomed improvement!"*

Malfunctions from the wireless lighting controls noticeable/unacceptable

- *"Lights turning on/off by themselves is annoying, especially in the middle of a meeting with the door closed."*
- *"I prefer when the lights stay on unless someone has flipped the switch."*

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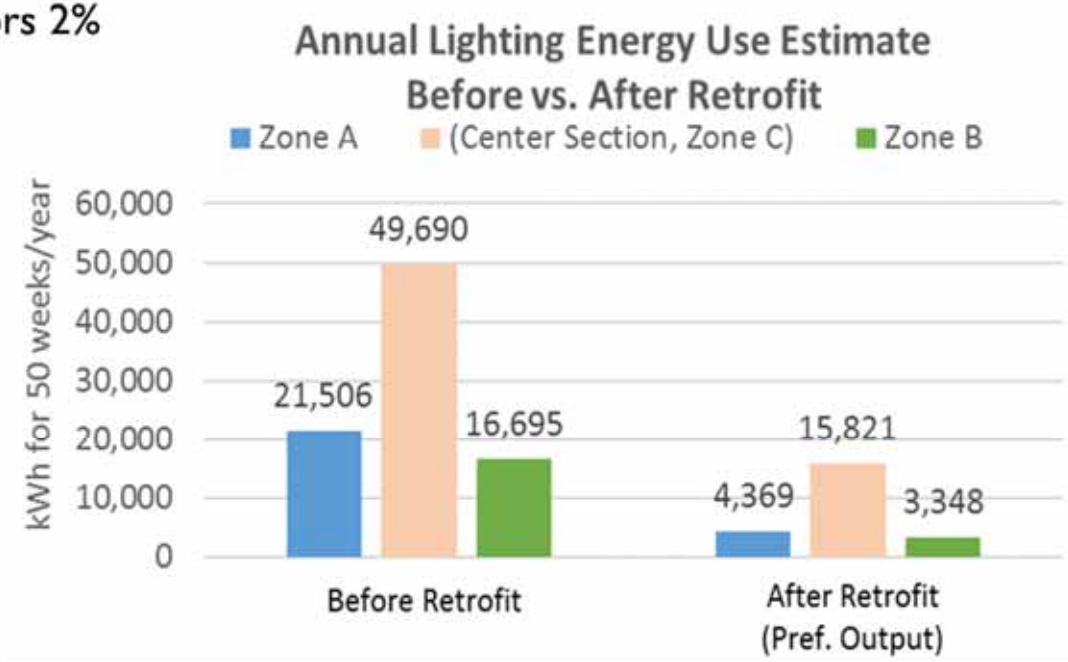
Results: Energy savings

- Energy savings: 73% on average
  - LED retrofit + high-end trim
  - Additional savings due to sensors 2%



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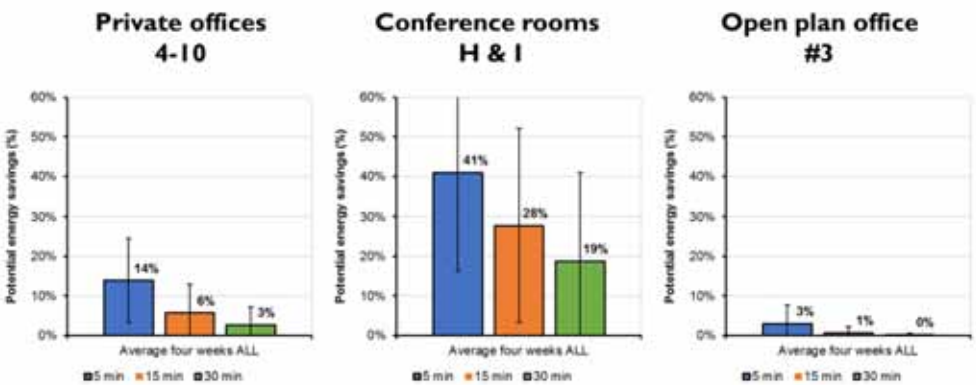
Results: Energy savings

In this application, the potential energy savings from occupancy sensors was limited

- 8:00 am to 6:00 pm, weekdays
- Private offices
  - 5 min timeout = 20 Wh/day per fixture
  - 30 min timeout = 4.3 Wh/day per fixture
- Conference rooms
  - 5 min timeout = 59 Wh/day per fixture
  - 30 min timeout = 27.4 Wh/day per fixture
- Open plan office areas
  - 5 min timeout = 4.3 Wh/day per fixture
  - 30 min timeout = 0



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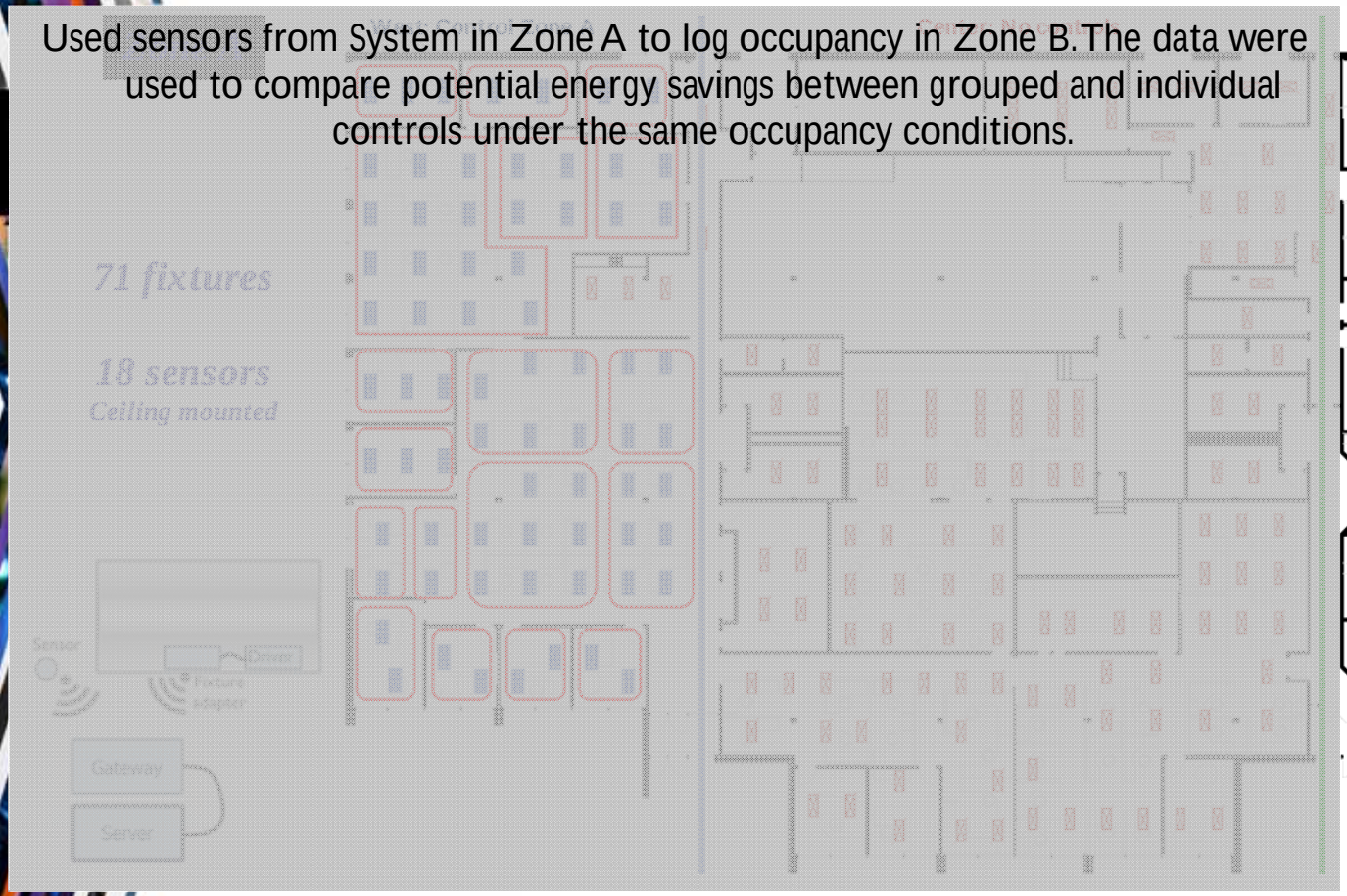
Results: Individual vs. grouped sensors

Used sensors from System in Zone A to log occupancy in Zone B. The data were used to compare potential energy savings between grouped and individual controls under the same occupancy conditions.



East: Control Zone B

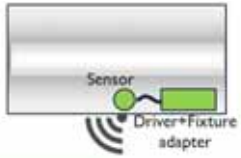
Zone B

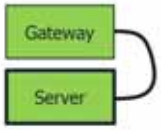
2 Open office areas
8 Private offices
3 Conference rooms

74 fixtures

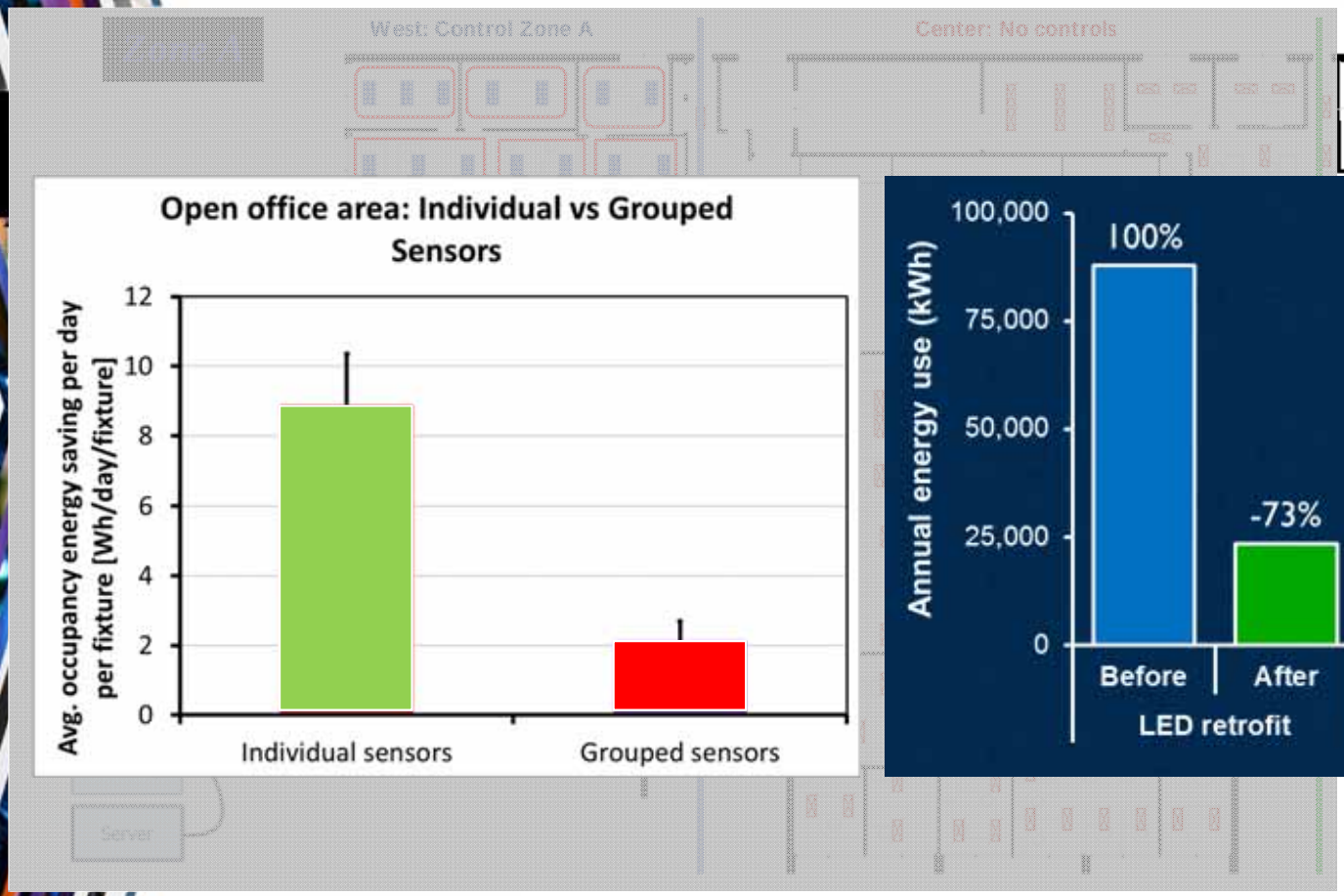
74 sensors
Fixture mounted

10 sensors
Ceiling mounted





Results: Individual vs. grouped sensors



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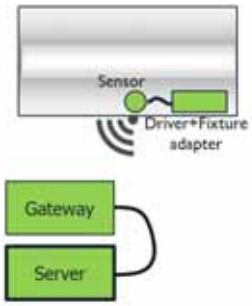


Summary

- LED savings – largest contribution (73%)
  - in this application, controls added a small percentage (2%)
- In some applications, end users may not agree to have lights dim or turn off automatically based on occupancy
- High-end trim is an advantageous feature but difficult to implement in large open office areas with conflicting requests
- At the time of the study (2017-18) systems were not quite ready to deliver all features promised
  - Continuous development of software (primarily) and hardware; updates, firmware, potential for lack of compatibility after updates

Lessons learned

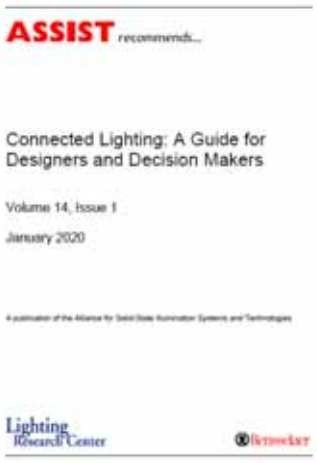
- Check for compatibility within and between systems
- Commissioning can take long time (initial setup of layout)
- Anticipate programing issues – settings do not stick in memory, instabilities, exception handling
- Sensor commissioning can be difficult
- Hardware failures do occur – keep spare parts in stock
- High cost compared to additional energy savings
- Updates may be necessary, could render equipment incompatible with other components in the system
- Software has a steep learning curve
  - too many options, too complicated for most applications
  - settings are not intuitive (daylight and occupancy sensor sensitivity)

Lessons learned

- Benefits of connected lighting
  - High-end trim and task tuning – adjusting light levels per area
  - Scheduling in areas with clear patterns of use
  - Zoning changes (add, remove, replace switching locations; 3-way switching)
  - Scene programming for different space functions (standard working, all on, cleaning, night light, etc.)
  - Are sensors really needed?
    - Depends on application
    - Grouped vs. individual

Key questions to ask

- Is a connected lighting system needed?
  - Can other control options provide the features required in the application?
  - What information is reported back by the system?
- System operation
  - Connected to the Building Management System or standalone?
  - Cloud vs. local server
  - Software updates? Necessary, forced, automatic? Effect on hardware?


ASSIST recommends...

Connected Lighting: A Guide for Designers and Decision Makers

Volume 14, Issue 1

January 2020

Lighting Research Center

www.lrc.rpi.edu/programs/solidstate/assist/recommends.asp

Key questions to ask

- Warranty and service agreements
  - Who do you call if fixtures fail, or if the lighting is not acting as expected?
  - Light fixture warranty, how long and what does it cover?
  - Control system, how long, and what does it cover?
  - What is the response time from tech support if needed?
- Maintenance stage
  - What happens if a sensor, a wall control, a gateway, or the energy manager fail?
  - Will future parts be compatible with existing parts? Will updates to software or firmware render any part of the system unusable? What is the useful life of the components? Will hardware need replacement to maintain performance?
  - What is the process to add/remove components from the system due to failure – discovery process, commissioning, re-imaging, etc.

Additional Resources

- Field Test DELTA Snapshots
  - Sensor-Controlled Lighting in Multi-Family Corridors
  - www.lrc.rpi.edu/programs/DELTA/pdf/DELTAMultiFamilyCorridors.pdf
  - Sensor-Controlled Bi-Level Lighting for Parking Lots
  - www.lrc.rpi.edu/programs/DELTA/pdf/DELTA2019.pdf

- ASSIST recommends
  - Connected Lighting: A Guide for Designers and Decision Makers
  - www.lrc.rpi.edu/programs/solidstate/assist/recommends.asp

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