Integrated Controls Package for High Performance Interior Retrofit

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Seminar 63
Facilitating the Operation of Smart Buildings through Instrumentation, Monitoring and Data

ASHRAE 2020
Virtual Conference

slipstream

Learning Objectives

1. Define the different types of energy instrumentation and metering technologies used in smart buildings and explain their use for supporting smart building operations
2. Explain how the various metering, data, and reporting can support new and coming regulatory reporting for various sustainability metrics like EUI, carbon reporting, etc.
3. Define luminaire-level lighting controls (LLLC) and how its use supports providing a range of building-level insights, such as space utilization, operator asset tracking in healthcare or retail buildings, and other use cases
4. Explain what can be done when data collected from meters, sensors, and/or instrumentation has missing data, in order for the data to still be usable for providing building insights

Acknowledgements

- Kris Evans, Cree Lighting
- Michael Myer, Pacific Northwest National Lab
- Harold Jepsen, Legrand
- David Podorson, Xcel Energy

Agenda

1. What are integrated controls?

2. Our pilot sites

3. Best practices

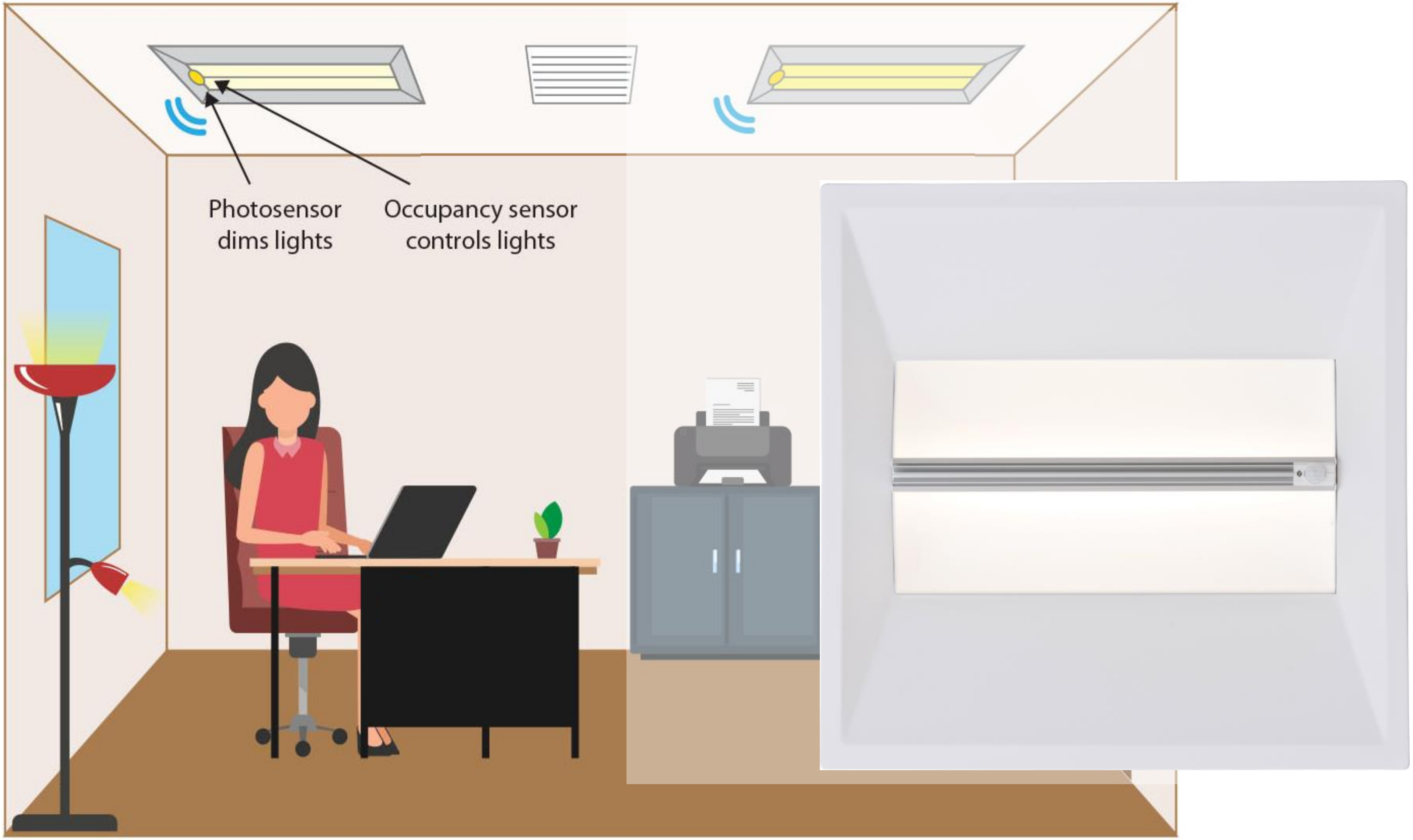
4. Preliminary conclusions

Traditional Energy Retrofit

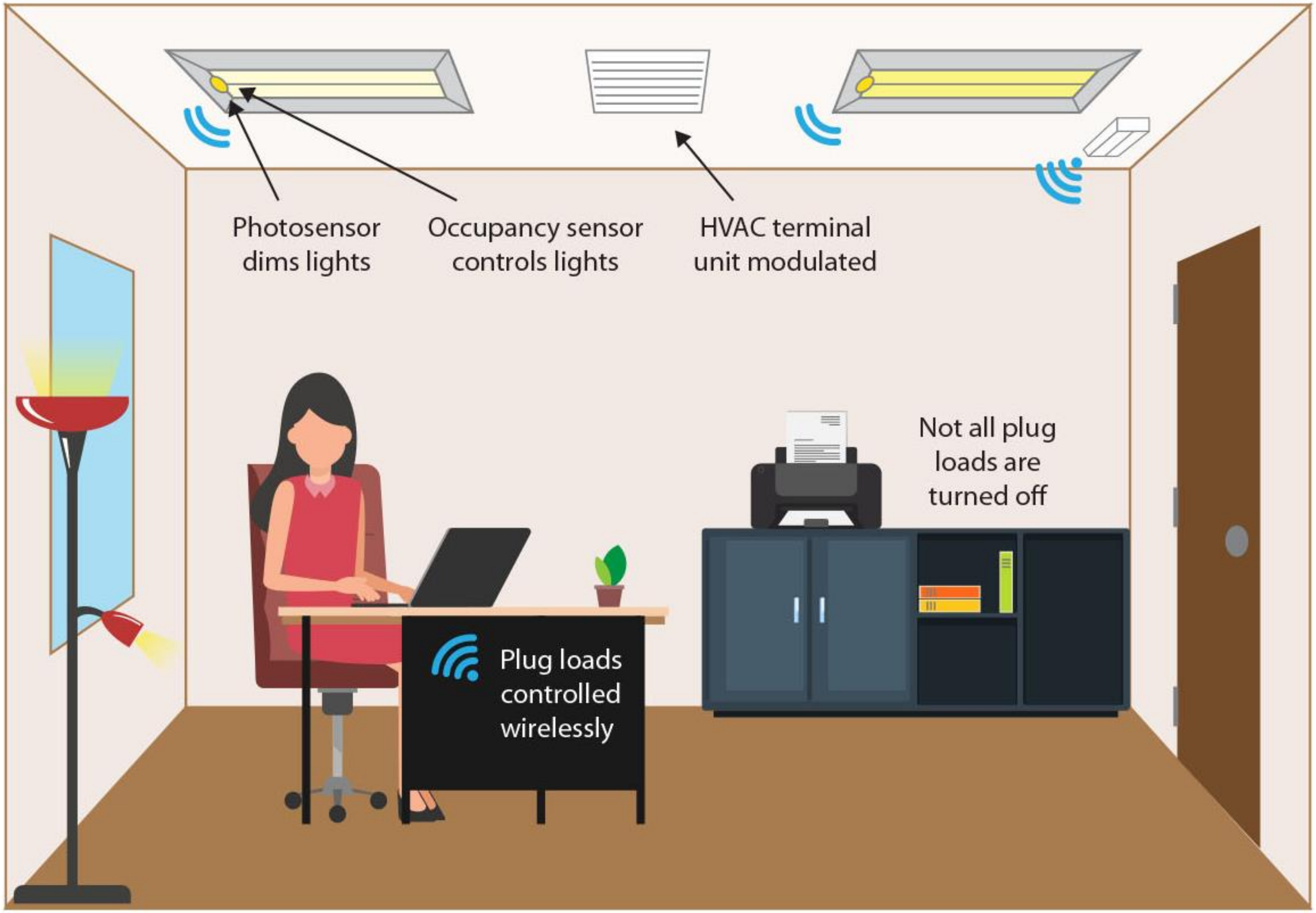
~50% lighting savings

3-8% total building energy savings

Luminaire Level Lighting Controls



Fully Integrated Controls



15-32% total building energy savings

Energy Savings

Type	Measure
Traditional Lighting Retrofit	Efficient LED Lighting
Advanced Lighting Control	Occupancy / Vacancy
	Daylighting
	Task Tuning
	Personal Tuning
Integrated Control - Plug	Workstation Plug Load Control
	Common Area Equipment Control
Integrated Control - HVAC	Thermostat Setback (Airside, Waterside, Baseboard)
	VAV Box Turndown (including off)
	Aggressive Pressure/Temperature Reset
	Ventilation Reset
	Demand Control Ventilation

HVAC Control: Guideline 36

Per Section 5.1.11, all *hardware points can be overridden through the BAS. Each of the following points is interlocked so that they can be overridden together at a zone-group level, per Section 5.4.5.*

For example, the commissioning authority (CxA) can check for leaking dampers by forcing all VAV boxes in a zone group closed and then recording airflow at the AHU.

5.5.9 System Requests

5.5.9.1 Cooling SAT Reset Requests

a. If the zone temperature exceeds the zone's cooling set point by 3°C (5°F) for 2 minutes and after suppression period due to set point change per Section 5.1.19, send 3 requests.

b. Else if the zone temperature exceeds the zone's cooling set point by 2°C (3°F) for 2 minutes and after suppression period due to set point change per Section 5.1.19, send 2 requests.

c. Else if the cooling loop is greater than 95%, send 1 request until the cooling loop is less than 85%.

d. Else if the cooling loop is less than 95%, send 0 requests.

5.5.9.2 Static Pressure Reset Requests

a. If the measured airflow is less than 50% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 3 requests.

b. Else if the measured airflow is less than 70% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 2 requests.

c. Else if the damper position is greater than 95%, send 1 request until the damper position is less than 85%.

d. Else if the damper position is less than 95%, send 0 requests.

If the minimum ventilation rate is more than 25% or so of the cooling maximum, or demand-controlled ventilation is used, a reheat box is recommended to avoid overcooling.

5.6 VAV Terminal Unit with Reheat

5.6.1 See "Generic Thermal Zones" (Section 5.3) for set points, loops, control modes, alarms, etc.

5.6.2 See "Generic Ventilation Zones" (Section 5.2) for calculation of zone minimum outdoor airflow.

5.6.3 See Section 3.1.2.2 for zone minimum airflow set points Vmin, zone maximum cooling airflow set point Vcool-max, zone maximum heating design airflow set point Vheat-max, and the maximum DAT rise above heating set point MaxΔT.

5.6.4 Active maximum and minimum set points shall vary depending on the mode of the zone group the zone is a part of (see Table 5.6.4).

These sequences use different maximum airflow set points for heating and cooling. This dual-max logic allows the minimum airflow set point to be lower than in a conventional sequence where the minimum airflow equals the heating airflow.

Heating is nonzero in cooldown to allow for individual zones within a zone group that may need heating while the zone group is in cooldown.

The warm-up and setback minimum set point is set to zero to ensure spaces that do not want heat during these modes receive no air; because the supply air temperature can be warm in these modes if the AHU has a heating coil, any minimum could cause overheating. The heating minimum is set to

HVAC Control: Basic single zone equipment

Next Big Thing(s)

Paybacks are currently a challenge

- HVAC and plug load integration help (current project)

- Capturing additional non-energy benefits will improve economics through value stacking (proposed) …

Other functions

1. Asset Tracking
2. Space Utilization
3. Security and Smart Systems
4. Demand Response and Load Shedding
5. More IoT capabilities…

Non-Energy Benefits

- Occupant satisfaction
- Improved IEQ and health
- Simplified maintenance
- Better space utilization

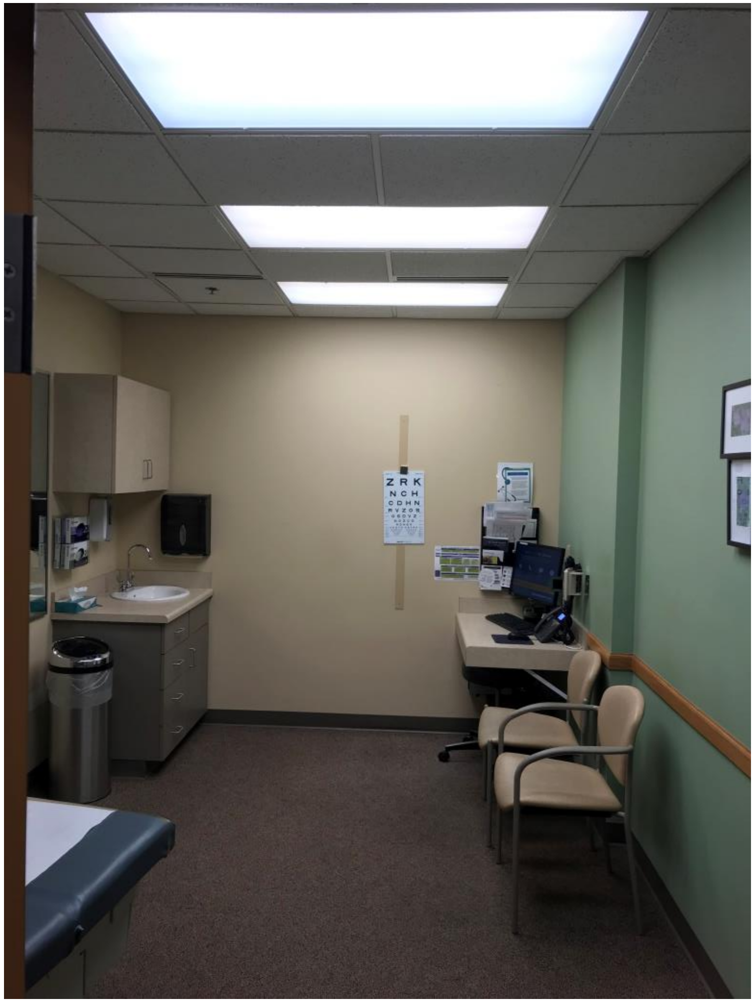
Retrofit Pilot

Retrofit Sites: MN DoT truck facility

Pre-retrofit

Retrofit Sites: CentraCare clinic

Pre-retrofit



Retrofit Sites: City of St. Paul office

Pre-retrofit

Retrofit Sites: Hennepin County fitness center + clinic

Pre-retrofit

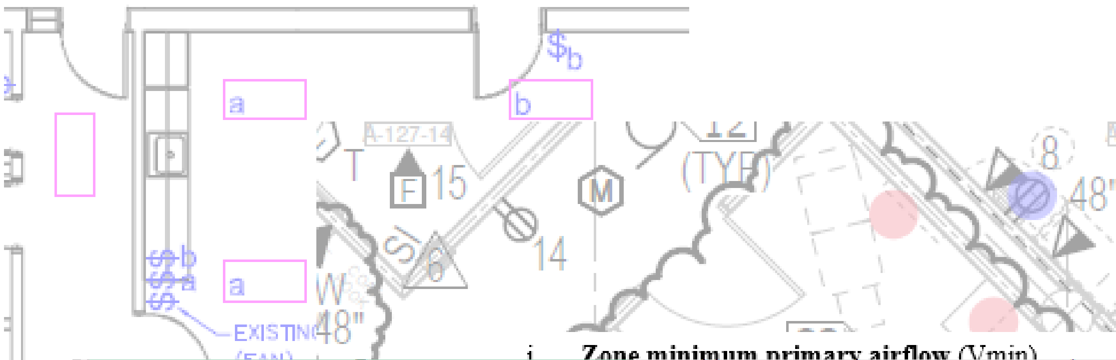
Retrofit Sites: Univ. MN

Pre-retrofit

Post-retrofit

Best Practices

Design



i. Zone minimum primary airflow (Vmin)

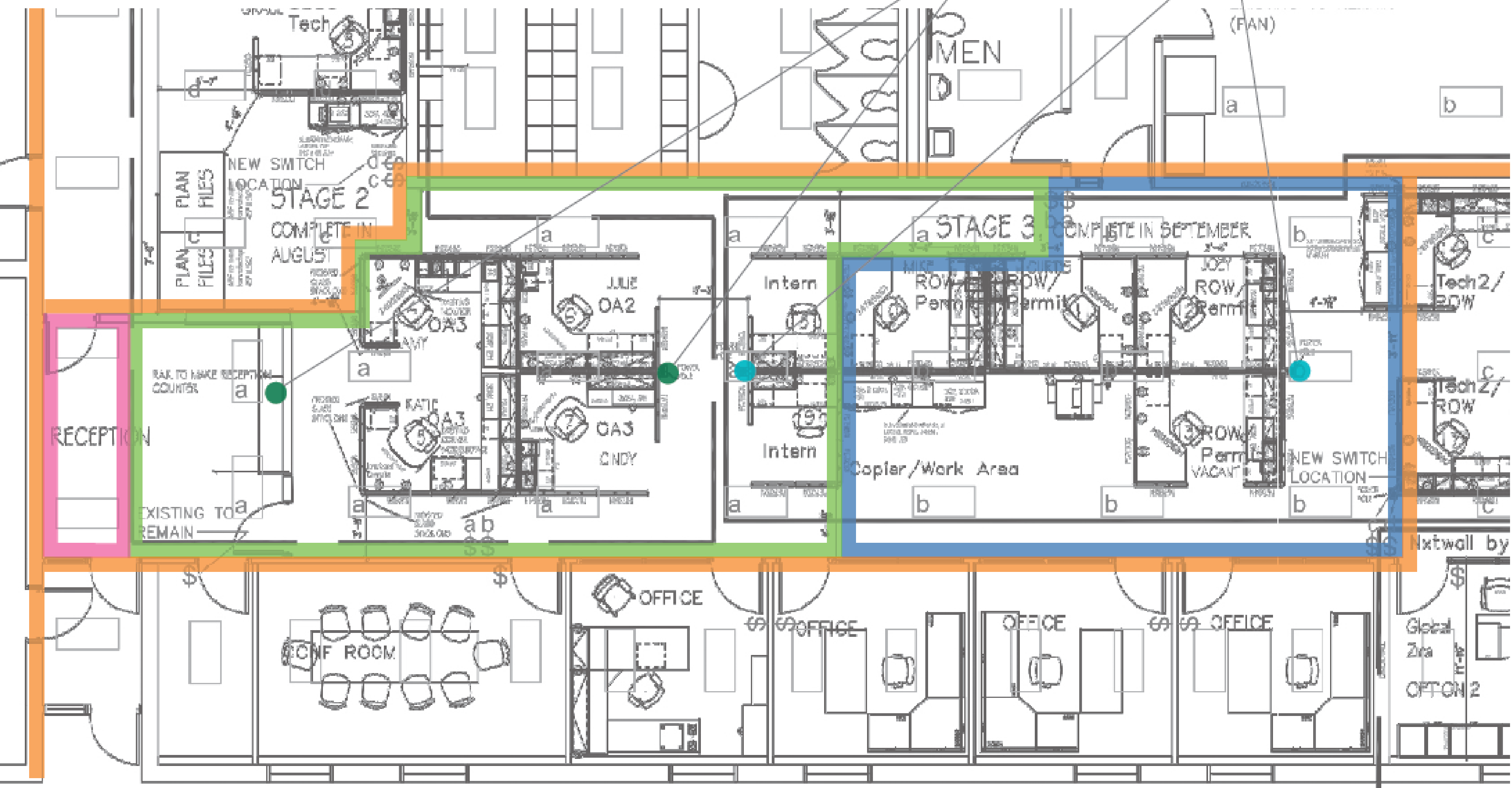
	Switch Group Qty	Occupancy Group Qty	Control Mode	Occupancy Sensitivity	Occupancy Timeout	Daylight Min Setpoint	Existing Average Illuminance
Be Well Clinic							
Exam Room (typical)	2	1	Manual On, Auto Off (default)	High (default)	10 mins	5% (default)	50
Accupuncture (typical)	2	1	Manual On, Auto Off (default)	High (default)	20 mins	5% (default)	50
Chiropractic	2	1	Manual On, Auto Off (default)	High (default)	10 mins	5% (default)	50
Lab (general ambient)	1	1	Auto On 50%, Auto Off	High (default)	10 mins	5% (default)	40
Blood Draw	1	1	Auto On 50%, Auto Off	High (default)	10 mins	5% (default)	50
Pharmacy (general ambient)	1	1	Auto On 50%, Auto Off	High (default)	10 mins	5% (default)	--
[illegible]	[illegible]	[illegible]	Auto On 50%, [illegible]	High [illegible]	10 mins	5% [illegible]	

Cooling	Vmin*	0

Design

ZONE TYPE

HVAC | Lighting "a" | Lighting "b" | Lighting | Plug Load "a" | Plug Load "b"

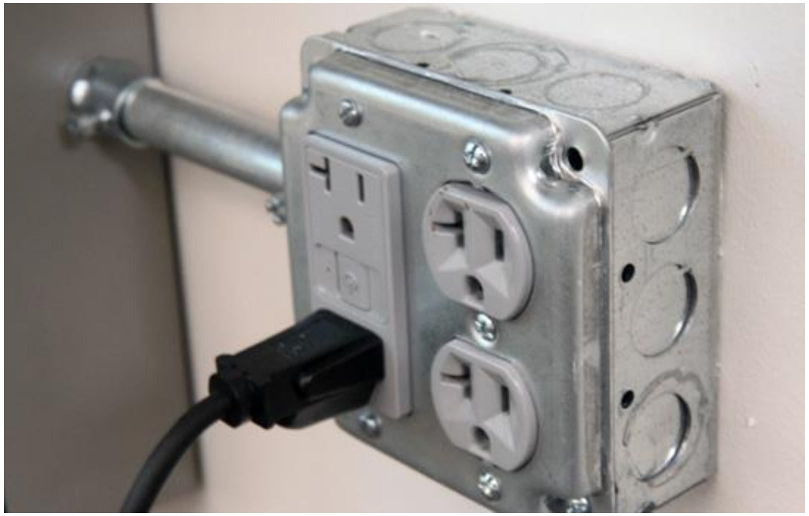


Design and Integration – Lessons Learned

- Work with controls contractor familiar with building
  - Gauge cost-optimal level of control sophistication
- Maintain one-for-one fixture replacement
  - Hard and soft cost savings
- Many critical steps in system integration
  - Developing a template checklist as DOE project deliverable

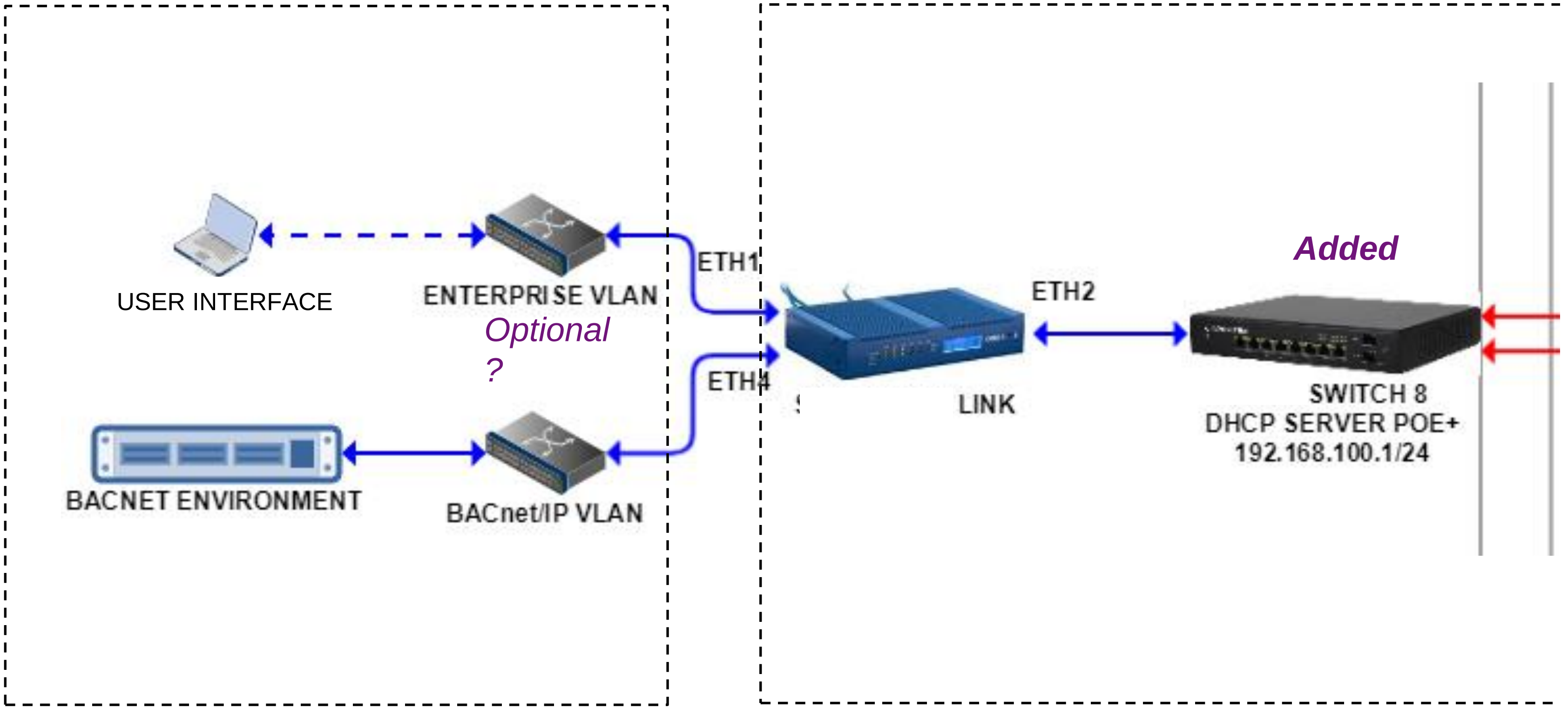
Integration: Plug Loads

Additional lighting-side currently device needed for wireless



IT Needs: None

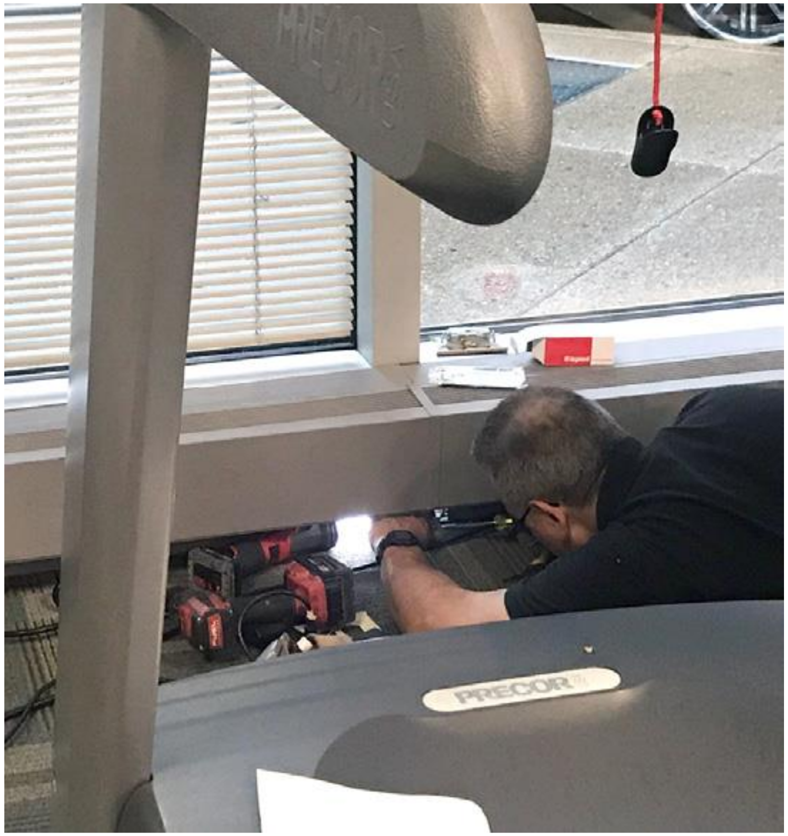
Integration: HVAC



IT Needs: BAS controller port *and network support?*

Integration – More Lessons Learned

- Create a control parameter plan together with office manager
- Time the commissioning of lighting to avoid long uncontrolled periods
- Educating occupants is important
  - Reduce complaints, disabled systems; office manager is important resource

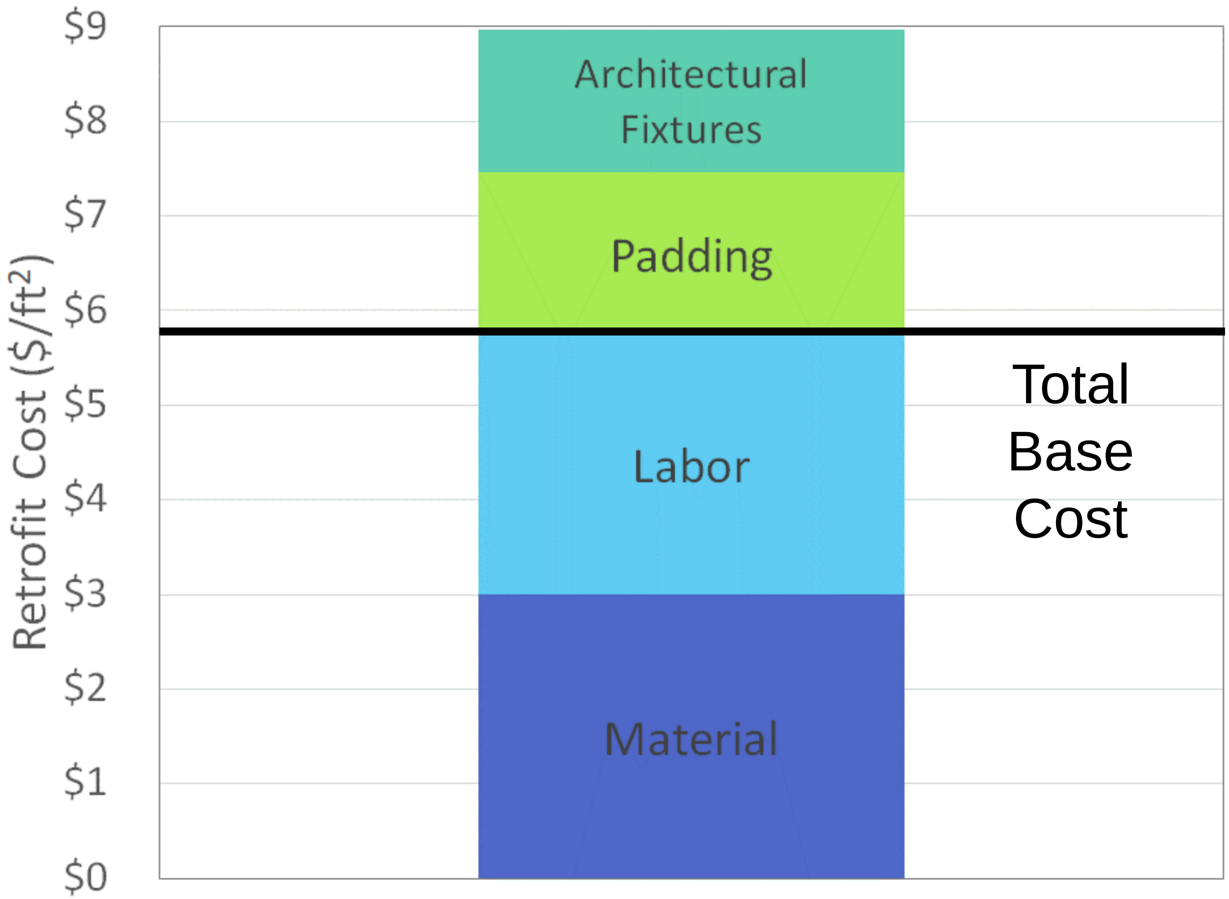


Other Conclusions

Design and Integration - Challenges

- Complexity
  - HVAC: system specific, contractor sophistication (Guideline 36 limitations)
  - Open Office: plug load circuits, associating lighting occupancy zones
- Contractor familiarity with these systems
  - Affects install quality and cost
- Plug load savings comparatively small, need better integration
- Care needed to ensure occupant satisfaction
  - Light levels, computer/printer availability, temperature recovery
- Cybersecurity

Cost: Preliminary Data



Questions?

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