LEDucation

Designers Light Forum

Beyond Lighting: Challenges and Success from Integrating Lighting Controls, HVAC, and Plug Loads

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

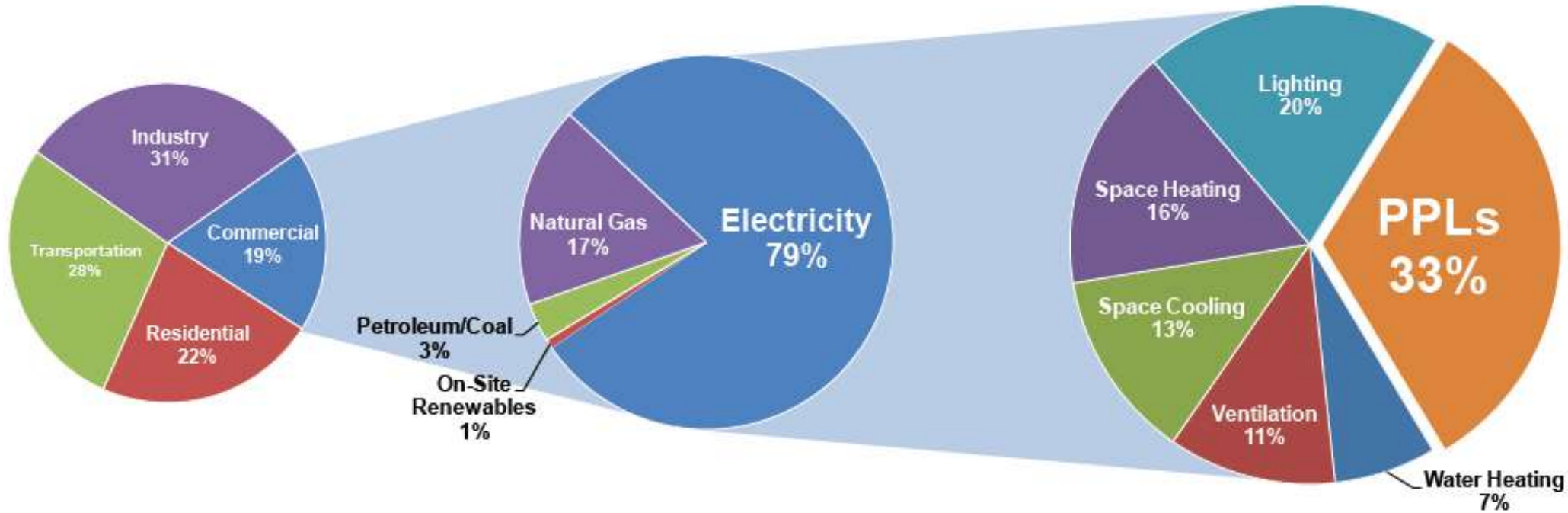
At the end of the this course, participants will be able to:

1. Beyond specifying controls in the fixture, how to specify that the controls actually get installed correctly

2. Characteristics of an ideal HVAC system if the lighting controls are going to operate specific HVAC features

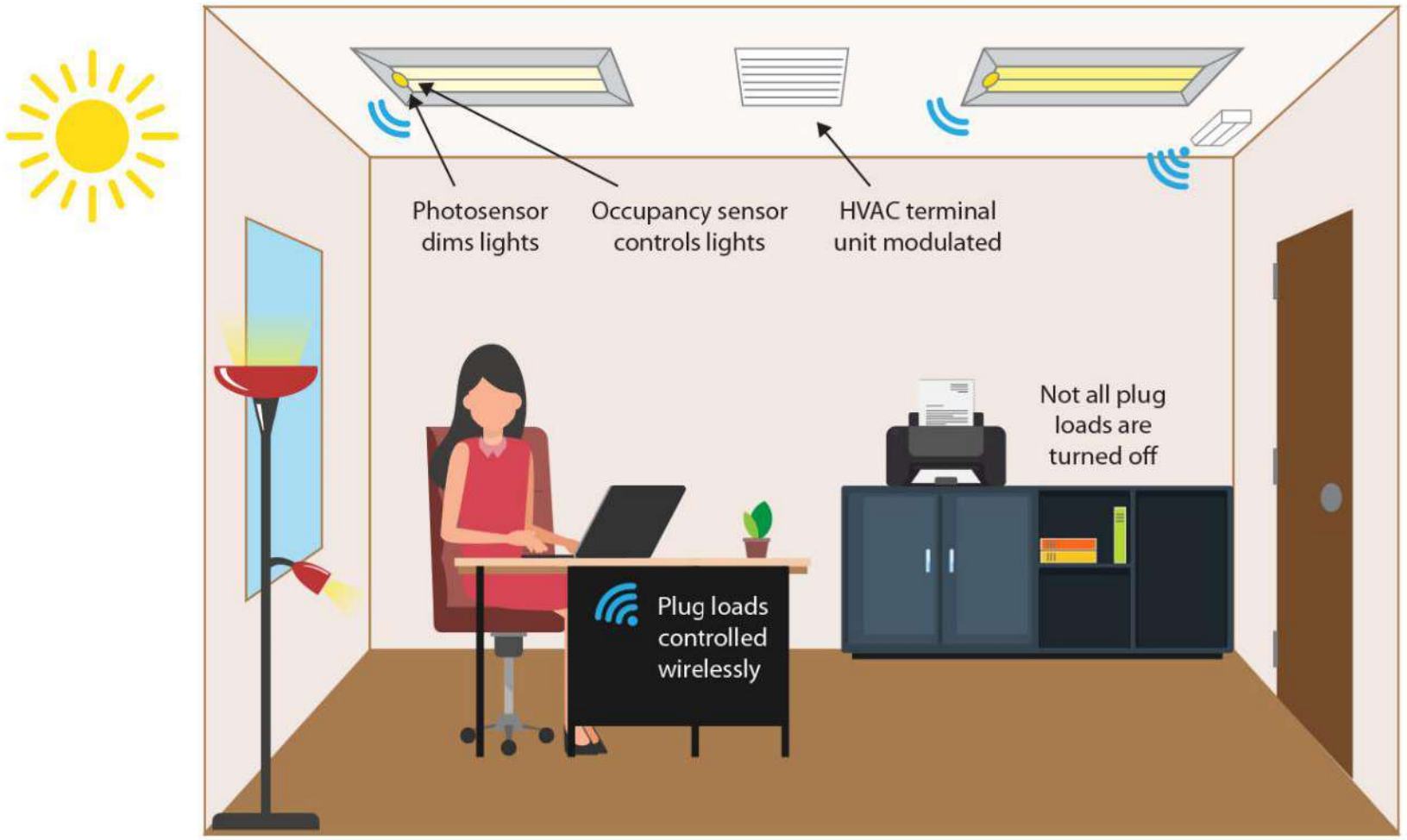
3. If and how receptacle controls can be integrated with lighting occupancy sensors

4. Challenges of using lighting occupancy sensors beyond traditional building systems



Plug and process loads account for 33% of the total energy consumed by commercial buildings. NREL / DOE 2010

Integrated Controls



Integrated Controls

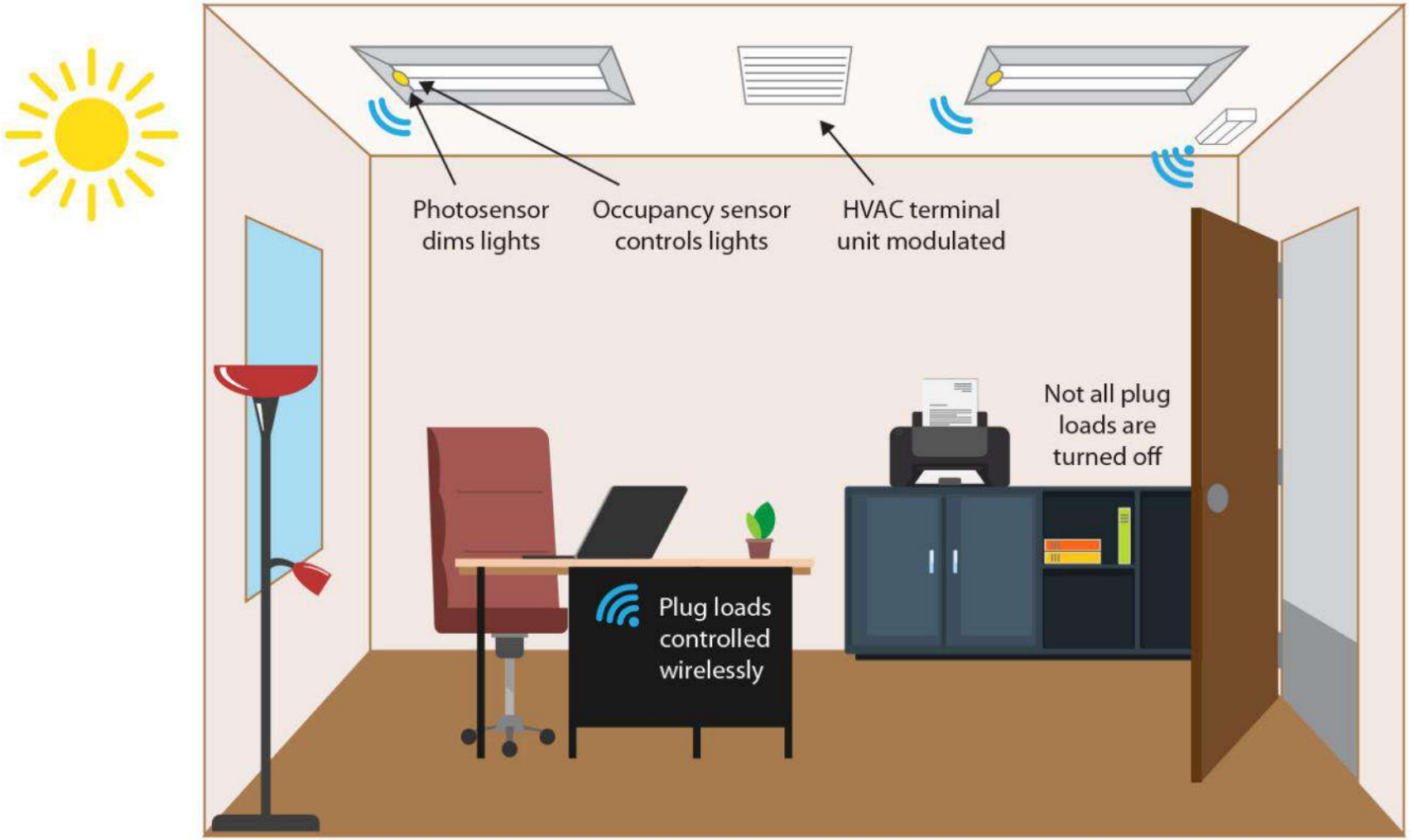
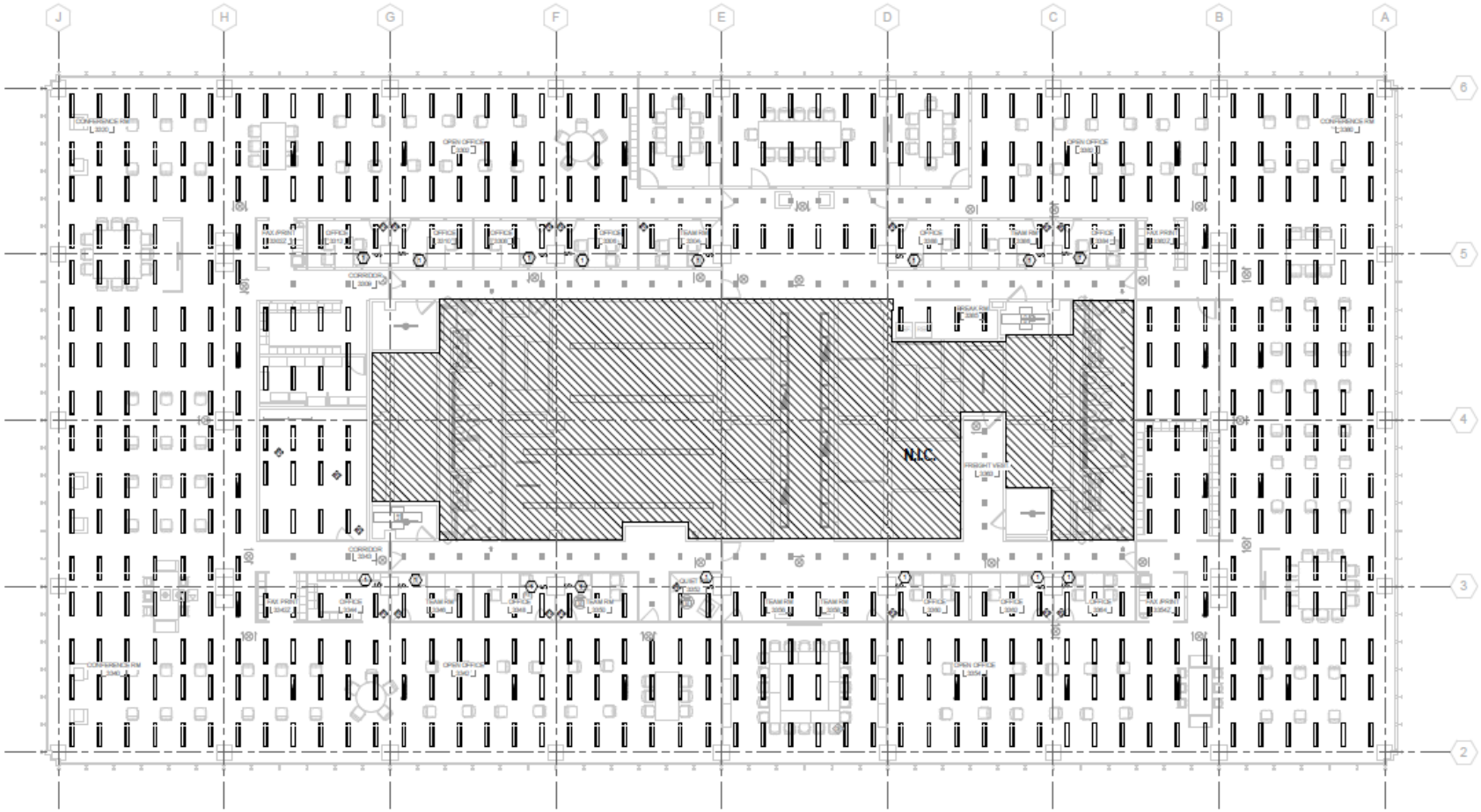


Photo: M. Myer / PNNL



Original Lighting: Linear fluorescent 6” x 4’ | Large control zones controlled via switch

New Lighting: LED retrofits 6” x 4’ | Individual daylight + occupancy sensors per fixture

Lighting Controls

Typical fluorescent systems

- Area lighting controls
- Large groups
- Centrally located
- 20,000 square feet floor → ≈ 10 – 60 sensors

Luminaire Level Lighting Controls

- Many, many, sensors
- 500 fixtures → 500 sensors
- Lighting design matters
- Sensor orientation

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Granularity

- 3 – 20,000 square foot floors
- Different spaces, each floor is NOT the same
- Energy savings
- Feeding data for space utilization
- Other possible non-energy benefits
- Commission fixtures to glow when no occupancy

Kitchenette

- Coordination between interior design and lighting design can already be hard
- Guidance provided: orient sensors on south end of fixture
- More sensors → harder
- Change fee to rotate fixtures 180 degrees so the sensors are not over the cabinets

Lobby

- Guidance provided: orient sensors on south end of fixture
- Sensors are along feature wall of lobby and do not turn on when people enter the space
- Change fee to rotate fixtures 180 degrees so the sensors are not along the feature wall
- Include a sensor footprint while doing fixture layout to visually track the zone covered by the sensor

Other Lobby

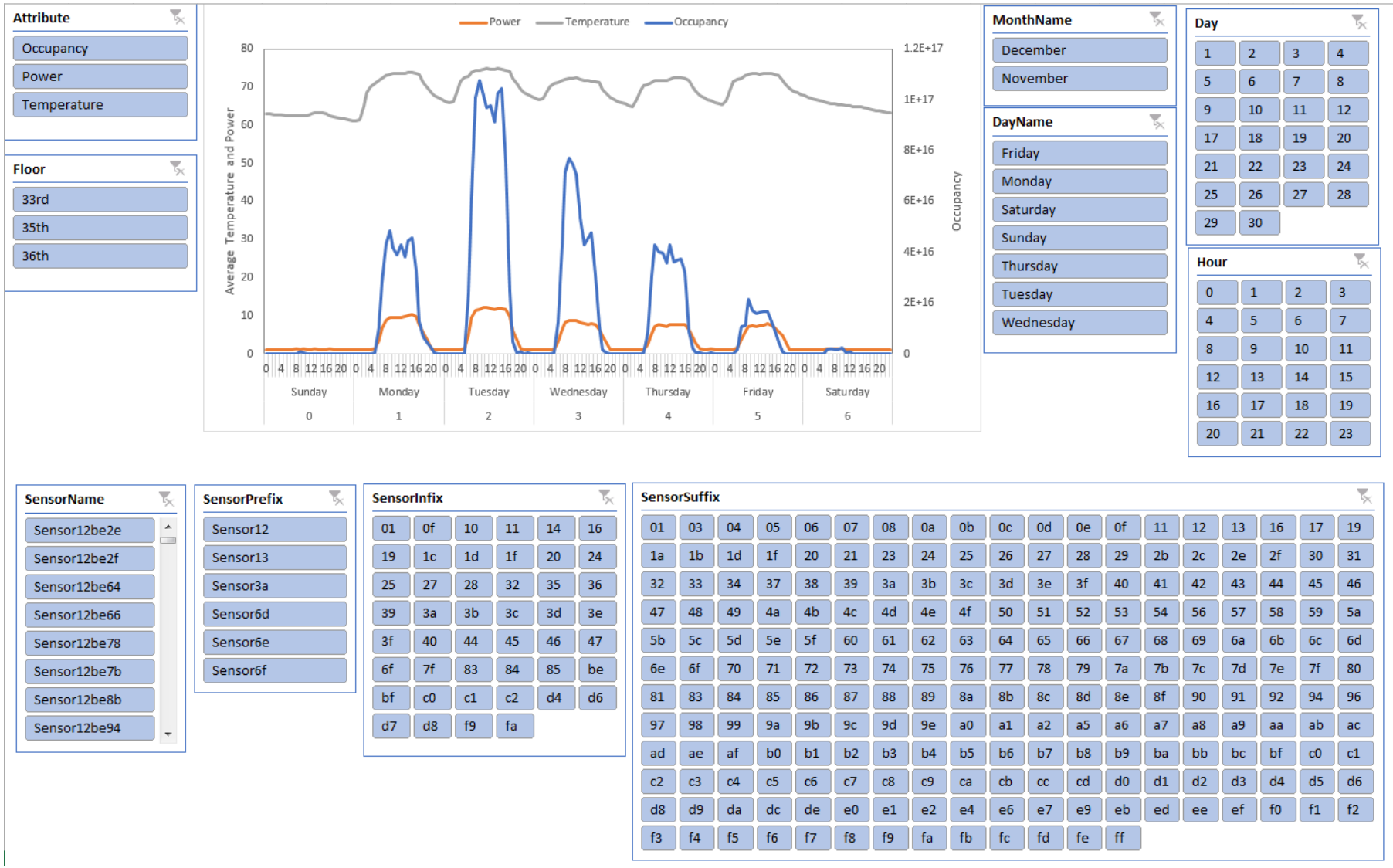
- More sensors → harder
- Show sensor coverage of every fixture in all spaces to avoid coverage issues
- Need a drawing with sensor coverage zone.
- Coverage zones similar between sensor vendors? Coverage affected by settings in the field?

Doors

- IR sensors do not transmit through glass, so sensor was NOT triggered as people walk past conference room
- Sensor opposite side of door swing of conference room
- Change fee to rotate fixtures 180 degrees so the sensors was over the door swing
- Do a comparison of door swings and sensor coverage area while in design

Sensor Data

- Request data from manufacturer early to see how it can be accessed / managed
- Example from Excel interface comparing a trove of data
- Manage sensor nomenclature in software



Lessons Learned

- One sensor per fixture means even more design coordination
- Do a controls drawing showing all sensor coverage zones
- Develop a good naming system for sensors
- Access to the controls system can be limited on site limiting access to the data or making interface changes

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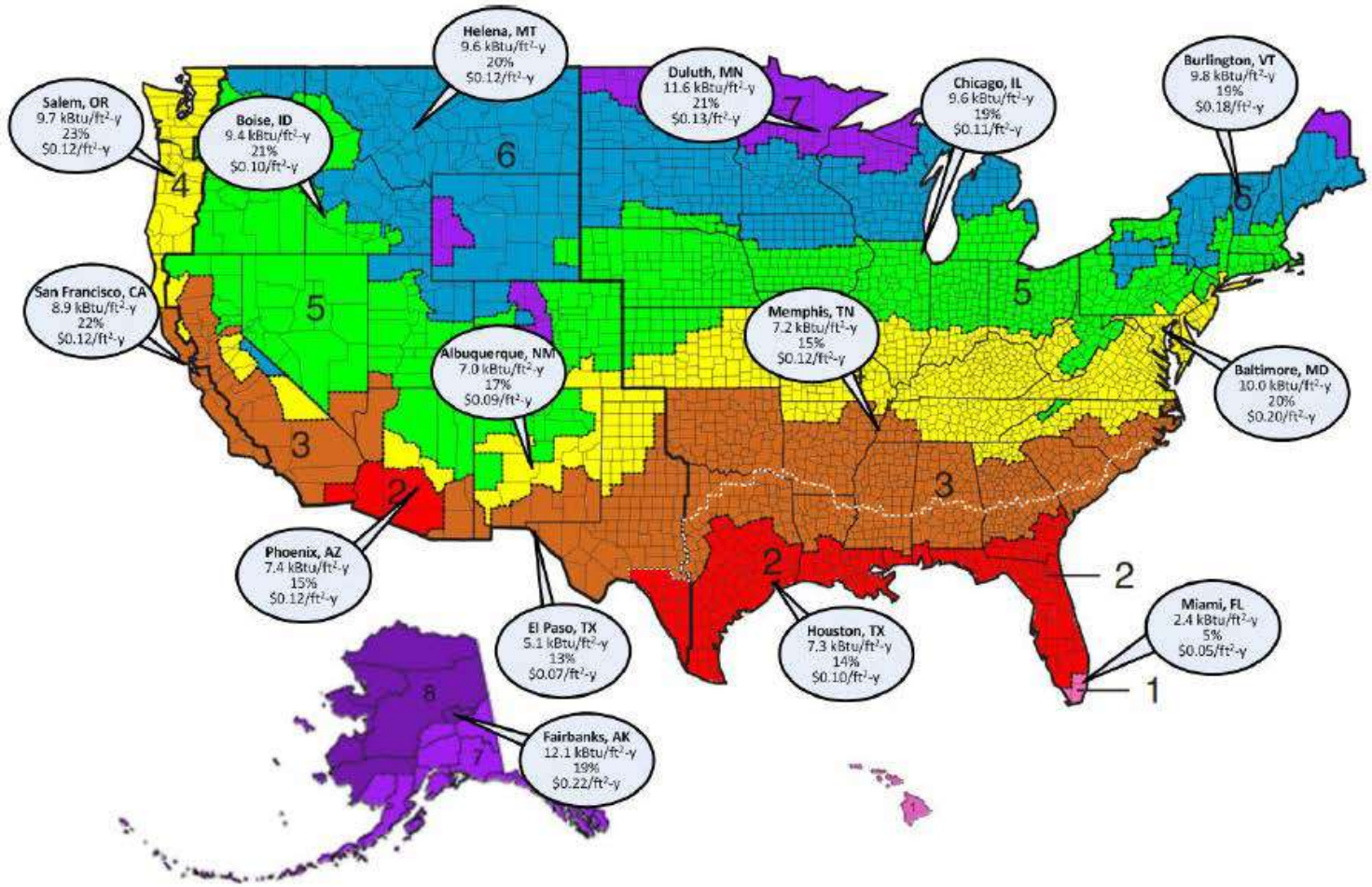
Lighting + HVAC Occupancy Sensors



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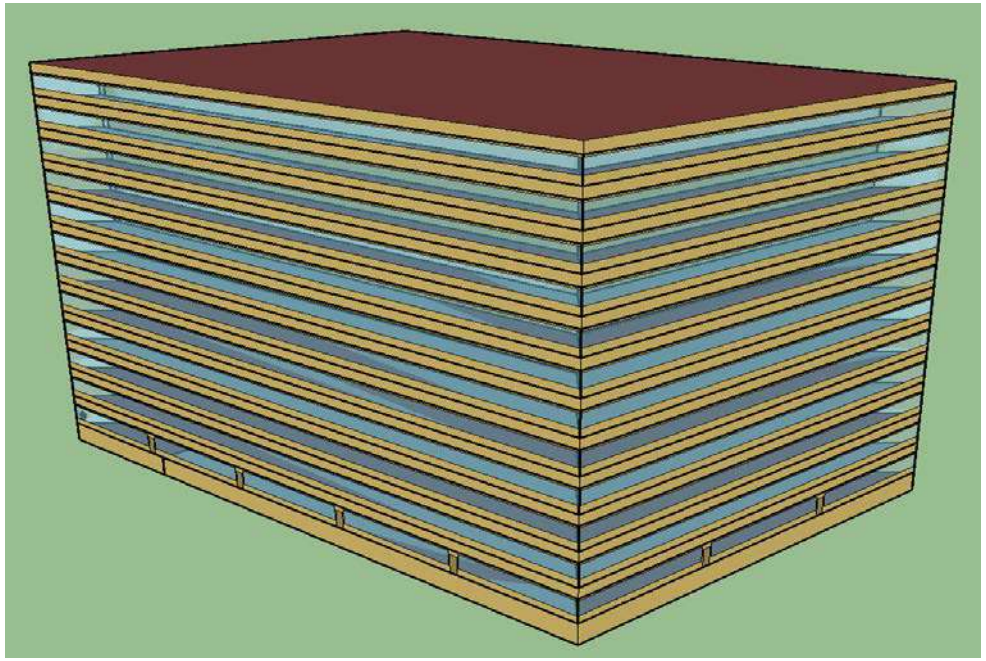
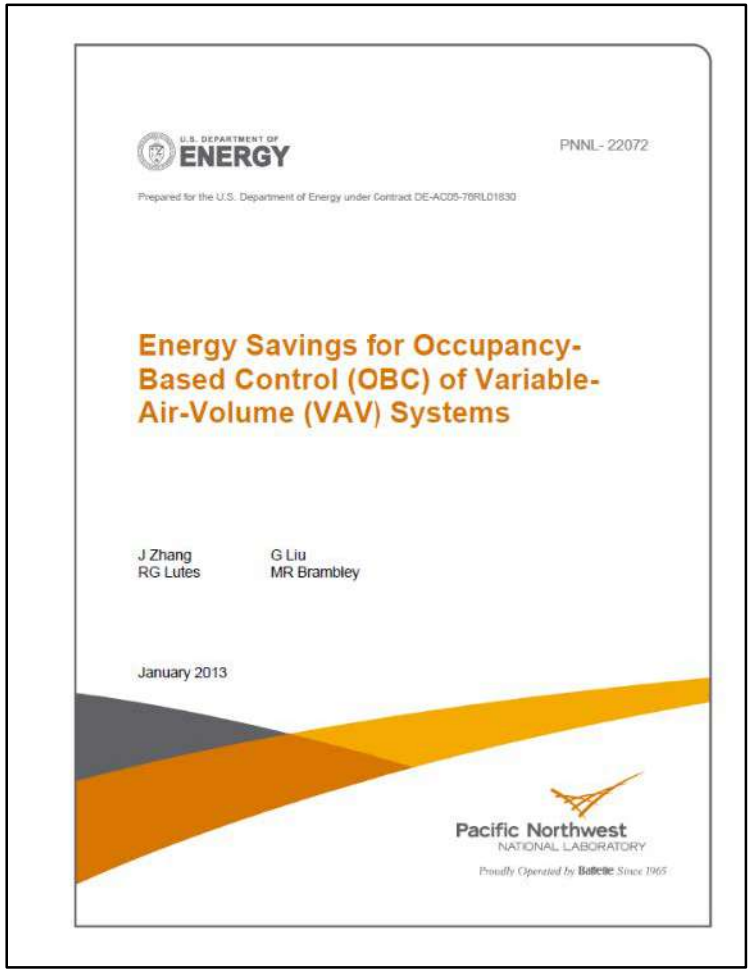
Lighting + HVAC Occupancy Sensors



2013 modeling Analysis of 500,000 square foot building



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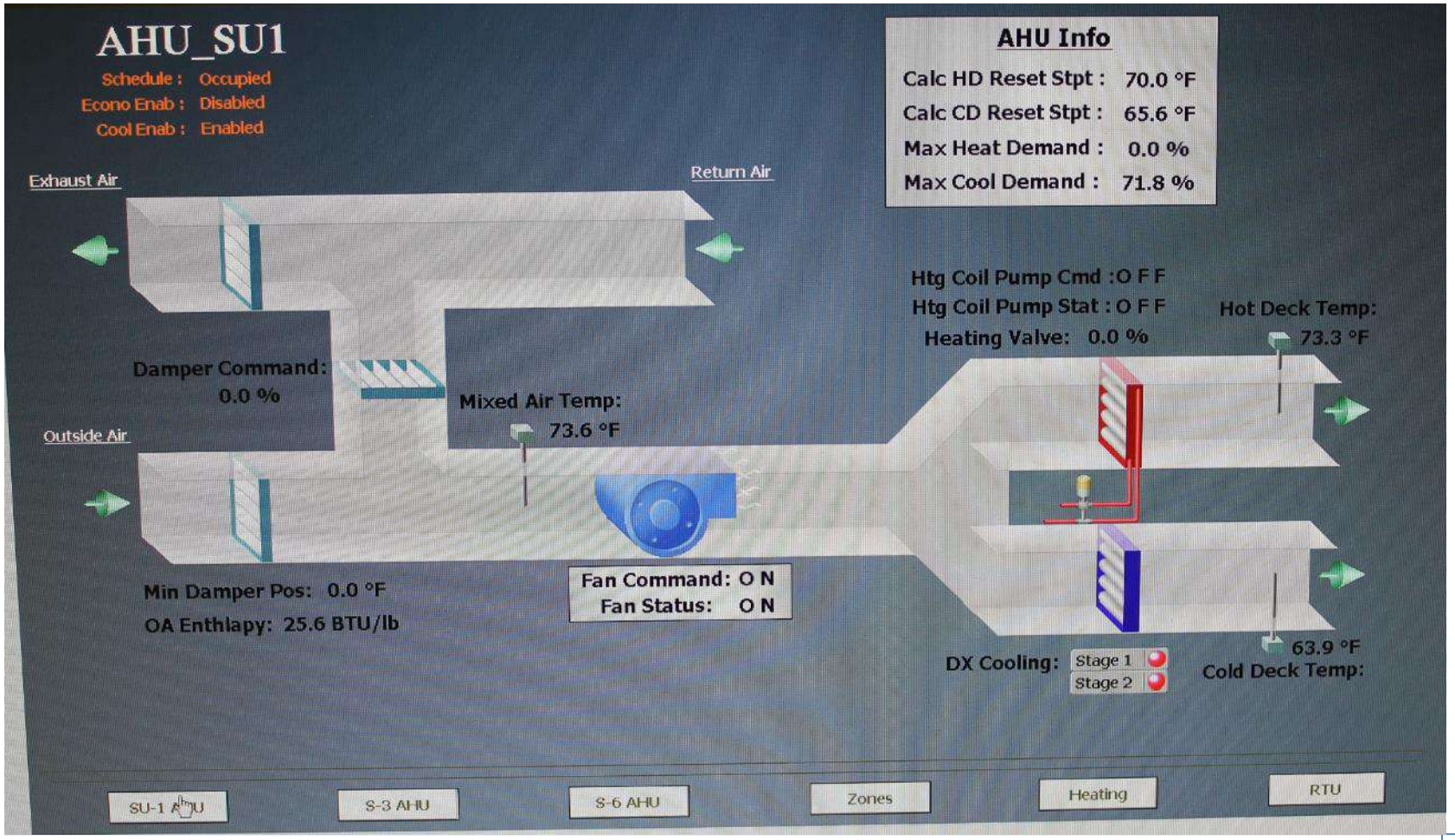
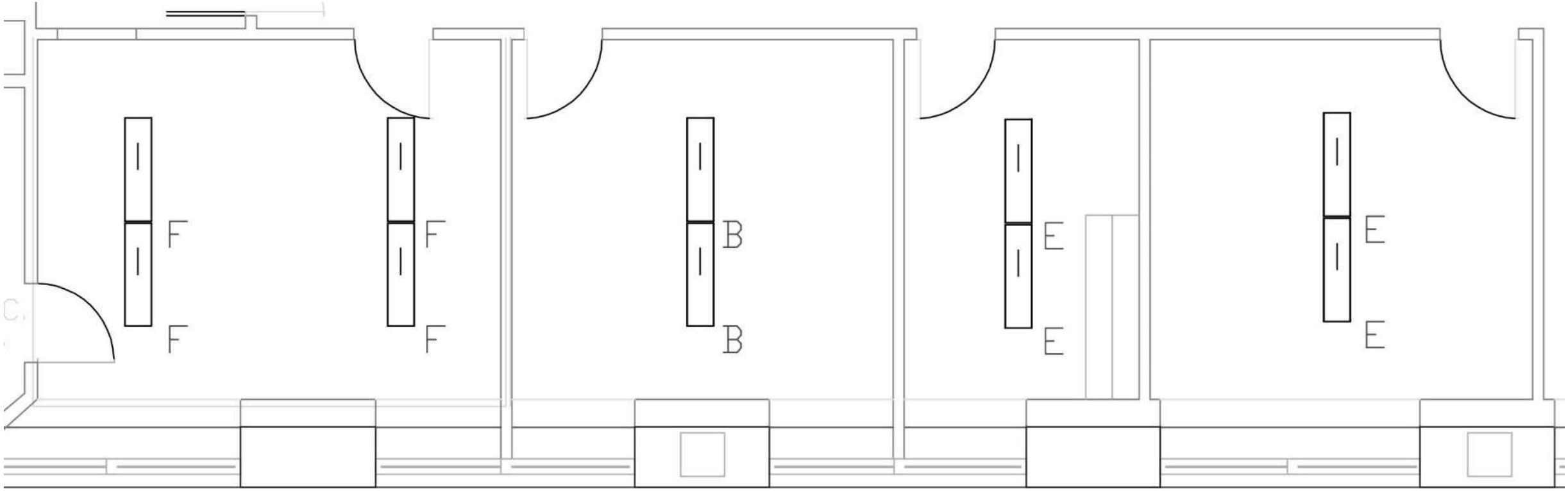
BMS Screen Capture

- Temperature – savings comes from changing temperature setback when space is unpopulated
- Fan speed – savings from reducing fan speed when space is unpopulated

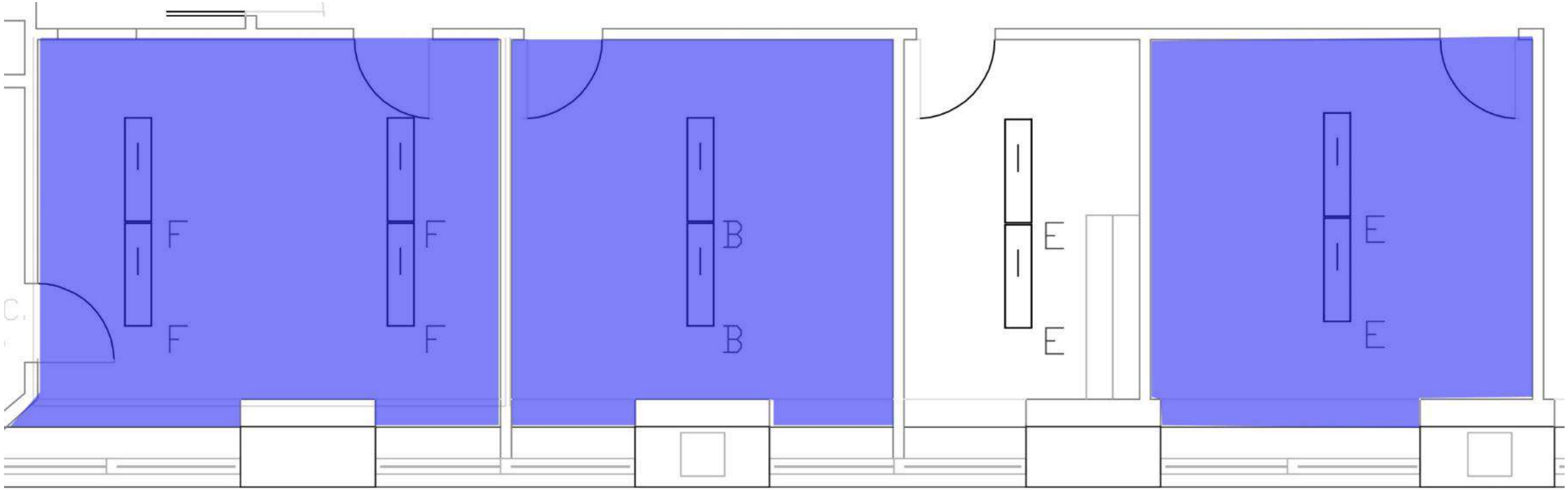


Lighting + HVAC Zoning



- 1 VAV serving multiple offices
- Only 1 real thermostat – others fake

Lighting + HVAC – Sensor Zoning / Logic



- Option 1: No movement by ALL of occupancy sensor
- Option 2: Percentage based – XX% sends signal space is empty

Lighting + HVAC

Zone Type	Occupied		Unoccupied	
	Heating	Cooling	Heating	Cooling
VAV	21° C (70° F)	24° C (75° F)	16° C (60° F)	32° C (90° F)
Mech/Elec Room	18° C (65° F)	29° C (85° F)	18° C (65° F)	29° C (85° F)

- For spaces with at least 1 occupancy sensor:
  a) "Standby setting" - Unpopulated for 5 minutes during the Occupied Mode, active heating setback by 0.5° C and cooling setback by 0.5° C
  b) Recommendation – include zone averaging
  c) Recommendation – if multiple offices served by 1 VAV, only include the occupied offices in the zone average calculation

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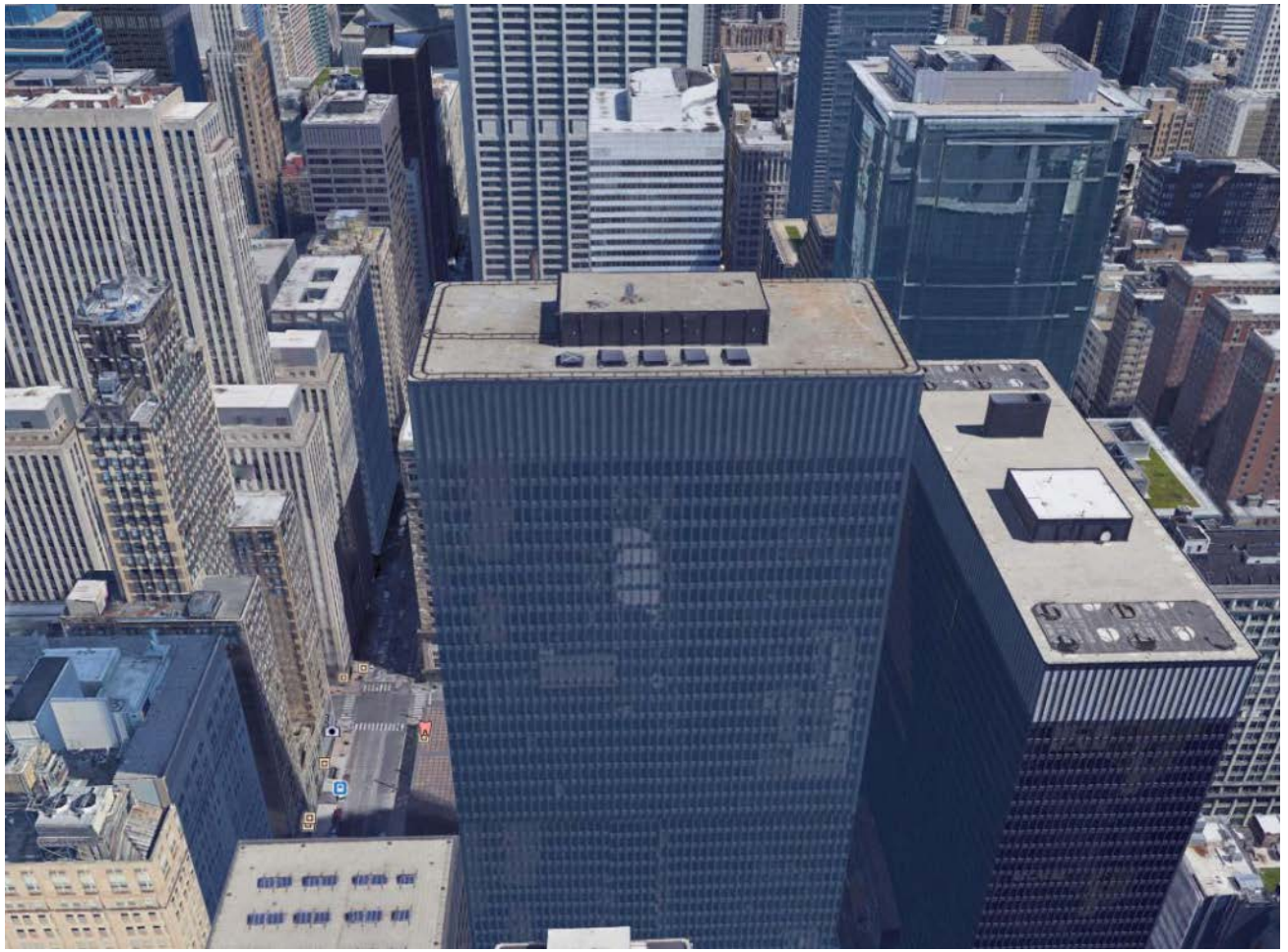
HVAC Temperature Setpoint Barrier

The “HVAC Operating Criteria” shall be the following (i) cooling season indoor temperatures are not in excess of 74° F to 76° F from 7:00 am to 7:00 pm.

- Many commercial real estate clients have temperature standards that only allow temperature drift a few degrees
- Some building manager concerns if an empty conference room drifted beyond the standard
- Connection to the cost of energy is not made

Lighting + HVAC Example

- Building built in the 1960s
- AHUs serve multiple floors and other existing HVAC conditions limit energy savings potential from occupancy sensors
- Some conference spaces and radiant heating on perimeter were connected via the occupancy sensors



Lighting + HVAC

- Conference room with new LED fixtures
- Occupancy sensors controlling HVAC system
- However, more supplies and returns had to be added to the space because existing system and room configuration required modifications

Lighting + HVAC

May require more equipment

Additional HVAC equipment added

HVAC

- Space also has radiant heating
- 1 zone per column bay
- Lighting system to connect with radiant panels
- Zoning logic for occupancy sensor & radiant heating?

Lighting + HVAC

Early 20th Century Building

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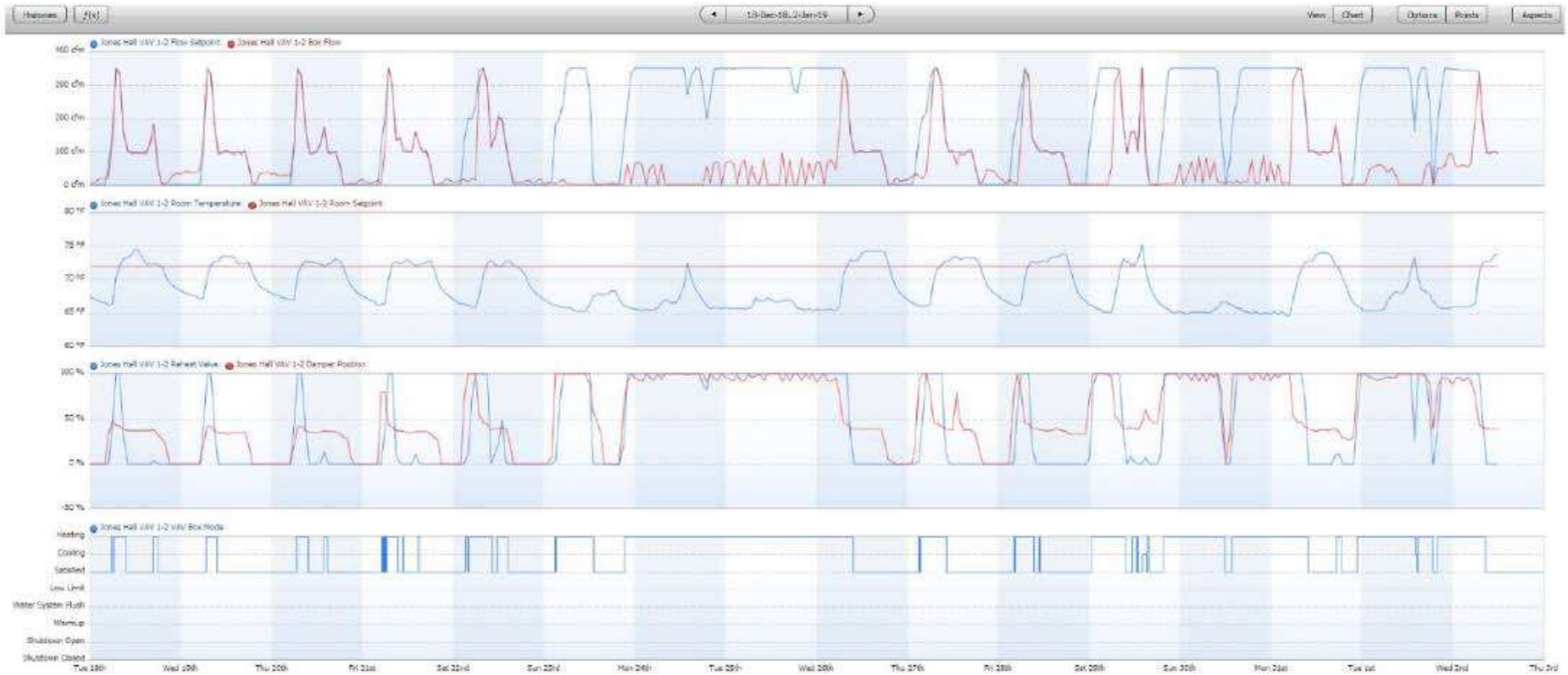
Baseline HVAC



Post HVAC

M&V

- ≈ 10,000 ft^2 space of 16,000 ft^2
- 66 measurement points that trend over time for HVAC

Equipment ID	Point Description	Data Source	Sample Interval
	Zone 6		
AHU-S6	Zone Active Heating Setpoints (Qty. = 4)	BMS	15 Minutes or COV
AHU-S6	Zone Active Cooling Setpoints (Qty. = 4)	BMS	15 Minutes or COV
AHU-S6	Zone Damper Position (Qty. = 4)	BMS	5 Minutes
AHU-S6	Zone Temperature (Qty. = 4)	BMS	5 Minutes
AHU-S6	DX Compressor Status Stage 1	BMS	COV
AHU-S6	DX Compressor Status Stage 2	BMS	COV
AHU-S6	AHU Fan Status	BMS	COV
AHU-S6	Heating Coil BTU	BMS	5 Minutes
AHU-S6	Hot Deck Supply Air Temperature	BMS	5 Minutes
AHU-S6	Hot Deck Supply Air Temperature Setpoint	BMS	5 Minutes
AHU-S6	Cold Deck Supply Air Temperature	BMS	5 Minutes
AHU-S6	Cold Deck Supply Air Temperature Setpoint	BMS	5 Minutes
AHU-S6	Mixed Air Temperature	BMS	5 Minutes
AHU-S6	Return Air Temperature	BMS	5 Minutes
AHU-S6	Return Air Humidity	BMS	5 Minutes
AHU-S6	Max Heat Demand	BMS	5 Minutes
AHU-S6	Max Cool Demand	BMS	5 Minutes
AHU-S6	Outdoor Air Enthalpy	BMS	5 Minutes
AHU-S6	Heating Coil Entering Temperature	BMS	5 Minutes
AHU-S6	Heating Coil Leaving Temperature	BMS	5 Minutes
AHU-S6	Outside Air Damper Position	BMS	5 Minutes
AHU-S1	Zone Active Heating Setpoints (Qty. = 4)	BMS	15 Minutes or COV
AHU-S1	Zone Active Cooling Setpoints (Qty. = 4)	BMS	15 Minutes or COV
AHU-S1	Zone Damper Position (Qty. = 4)	BMS	5 Minutes
AHU-S1	Zone Temperature (Qty. = 4)	BMS	5 Minutes
AHU-S1	DX Compressor Status Stage 1	BMS	COV

Lessons Learned: Lighting + HVAC

- Mixing electrical/lighting and mechanical requires more coordination
- Combined sensor technology is not ideal for every building
- Consider control / zoning logic while in design phase
- May need a longer delay for HVAC than for lighting from the sensor
- M&V involves many points

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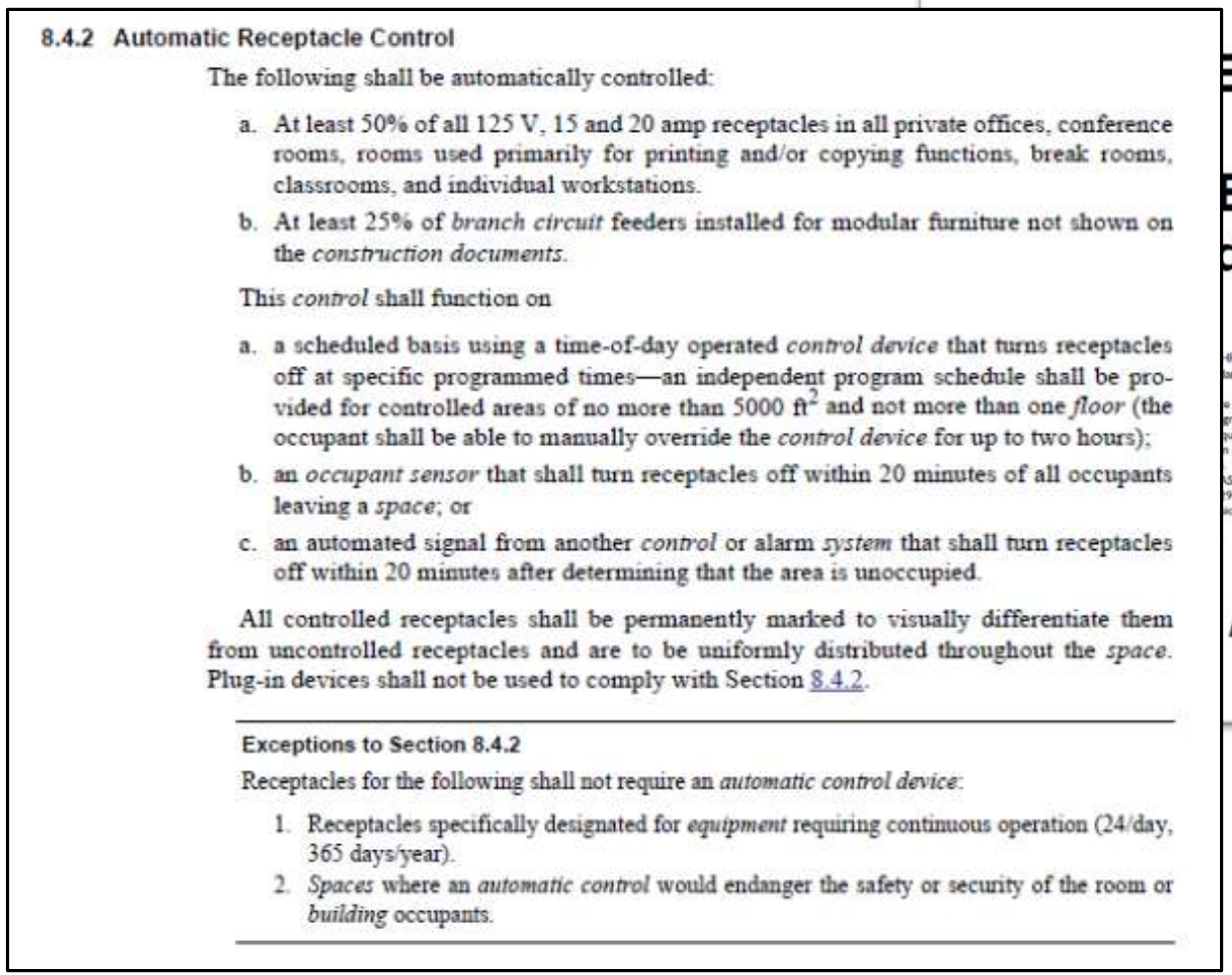
Switched Receptacles

- Codes only require in certain spaces (e.g., offices, copy rooms, classrooms)
- Hard and costly to retrofit, but can be accomplished wirelessly with new occupancy sensors and receivers



8.4.2 Automatic Receptacle Control

The following shall be automatically controlled:

a. At least 50% of all 125 V, 15 and 20 amp receptacles in all private offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, classrooms, and individual workstations.

b. At least 25% of *branch circuit* feeders installed for modular furniture not shown on the *construction documents*.

This *control* shall function on

a. a scheduled basis using a time-of-day operated *control device* that turns receptacles off at specific programmed times—an independent program schedule shall be provided for controlled areas of no more than 5000 ft^2 and not more than one *floor* (the occupant shall be able to manually override the *control device* for up to two hours);

b. an *occupant sensor* that shall turn receptacles off within 20 minutes of all occupants leaving a *space*; or

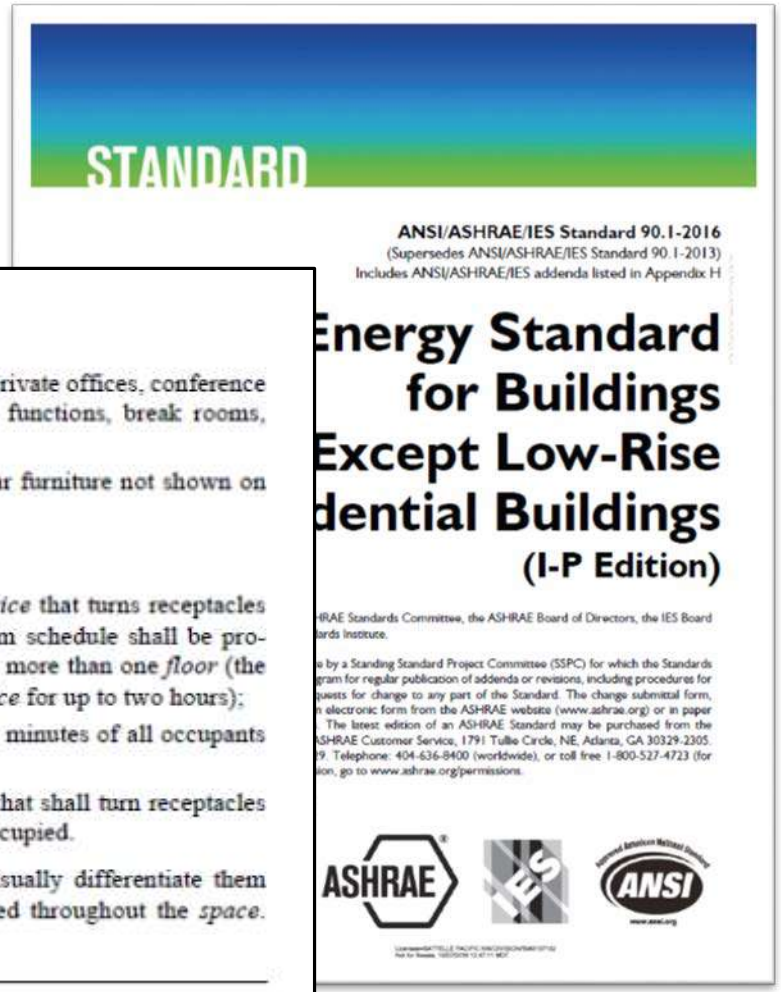
c. an automated signal from another *control* or alarm *system* that shall turn receptacles off within 20 minutes after determining that the area is unoccupied.

All controlled receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles and are to be uniformly distributed throughout the *space*. Plug-in devices shall not be used to comply with Section 8.4.2.

Exceptions to Section 8.4.2

Receptacles for the following shall not require an *automatic control device*:

1. Receptacles specifically designated for *equipment* requiring continuous operation (24/day, 365 days/year).
2. *Spaces* where an *automatic control* would endanger the safety or security of the room or *building* occupants.



STANDARD

ANSI/ASHRAE/IES Standard 90.1-2016
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2013)
Includes ANSI/ASHRAE/IES addenda listed in Appendix H

Energy Standard for Buildings Except Low-Rise dential Buildings
(I-P Edition)

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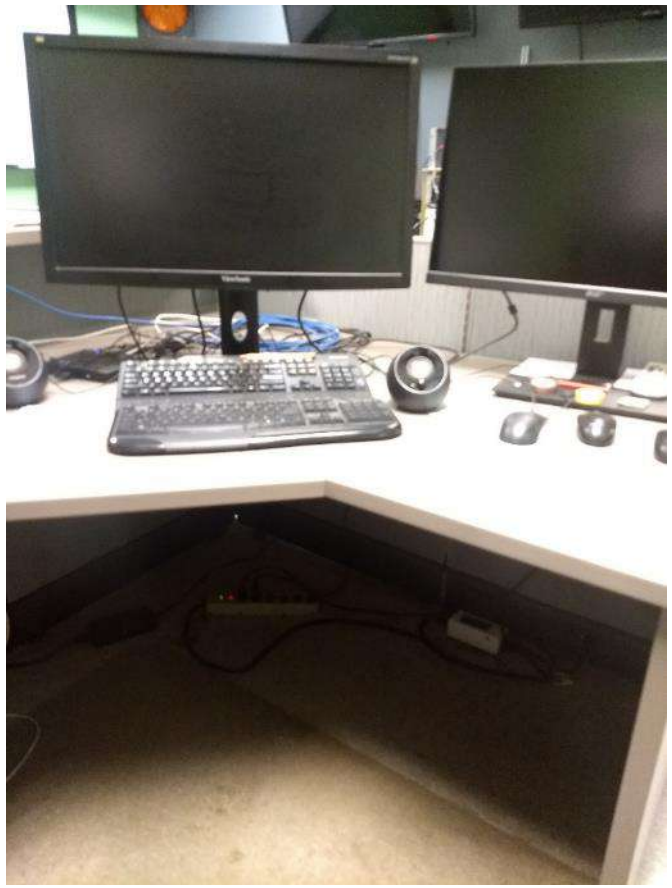
s by a Standing Standard Project Committee (SSPC) for which the Standards gram for regular publication of addenda or revisions, including procedures for quests for change to any part of the Standard. The change submittal form, n electronic form from the ASHRAE website (www.ashrae.org) or in paper . The latest edition of an ASHRAE Standard may be purchased from the SHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. 9. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for ion, go to www.ashrae.org/permissions.

ASHRAE IES ANSI

Sample Plug Loads



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Sample Plug Loads

Plug Loads

Uncontrolled

- Desktop PCs
- Refrigerators
- Coffee hot plates
- Large battery chargers
- Devices that need to remain overnight

Controlled

- Monitors
- Laptops (pay attention to charging)
- Fans
- Space heaters
- Radios
- Printers
- Speakers
- Televisions

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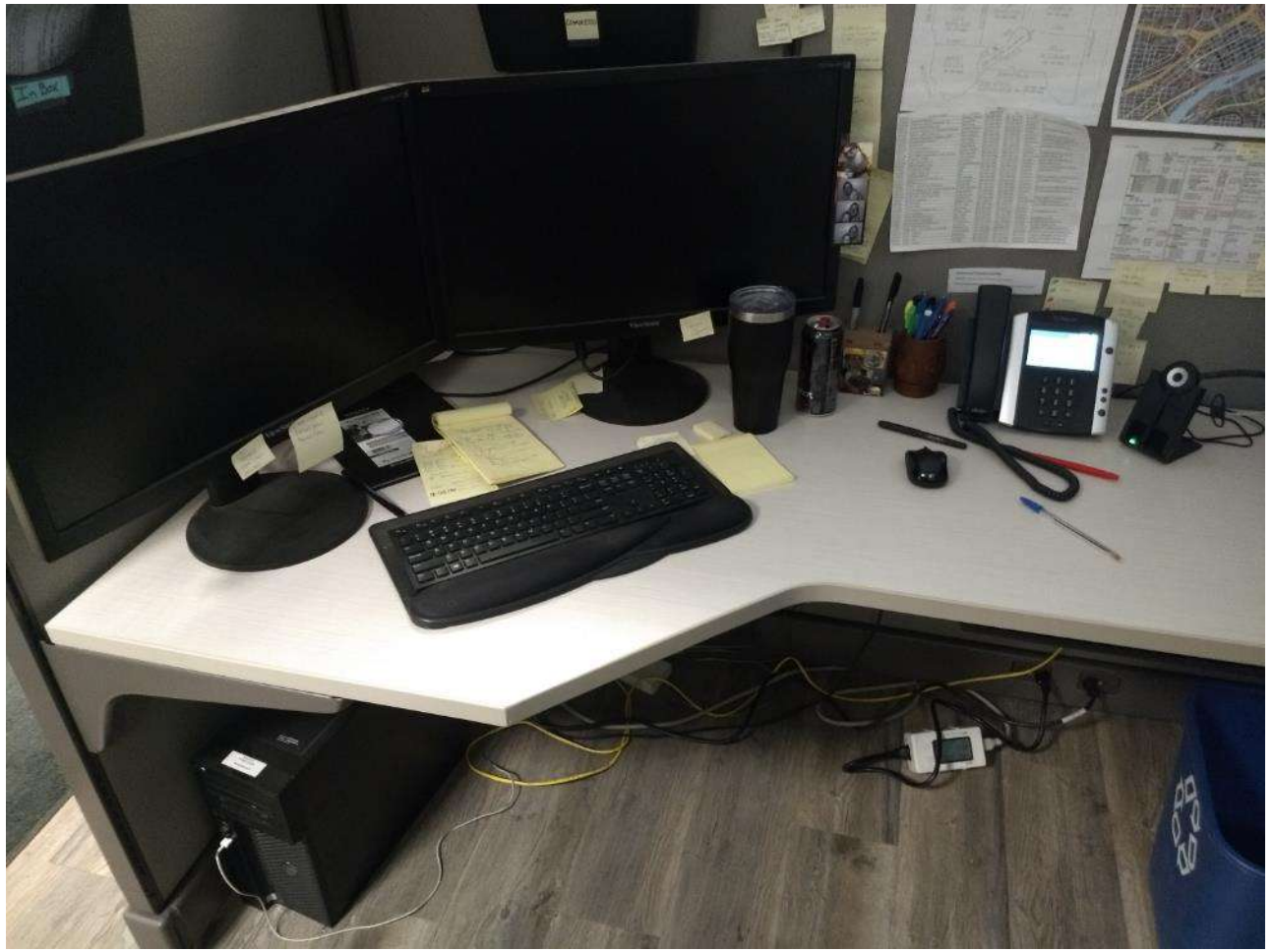
Lighting + Plug Loads

- Need user buy-in in process
- Location of receptacles
- Alay end user concerns



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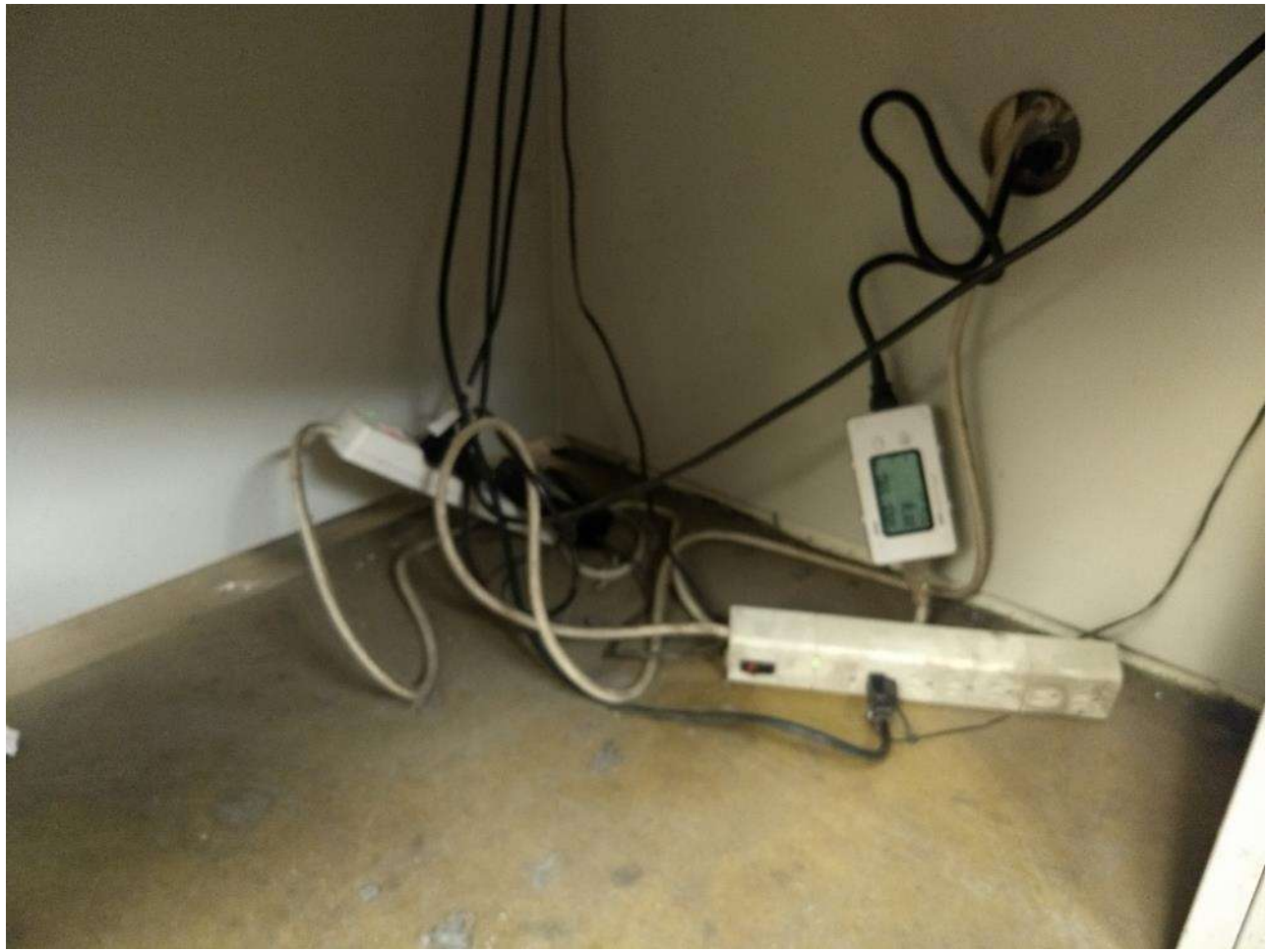
Lighting + Plug Loads

- Plug strips – thwart the process



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Plug Load Switching Challenges

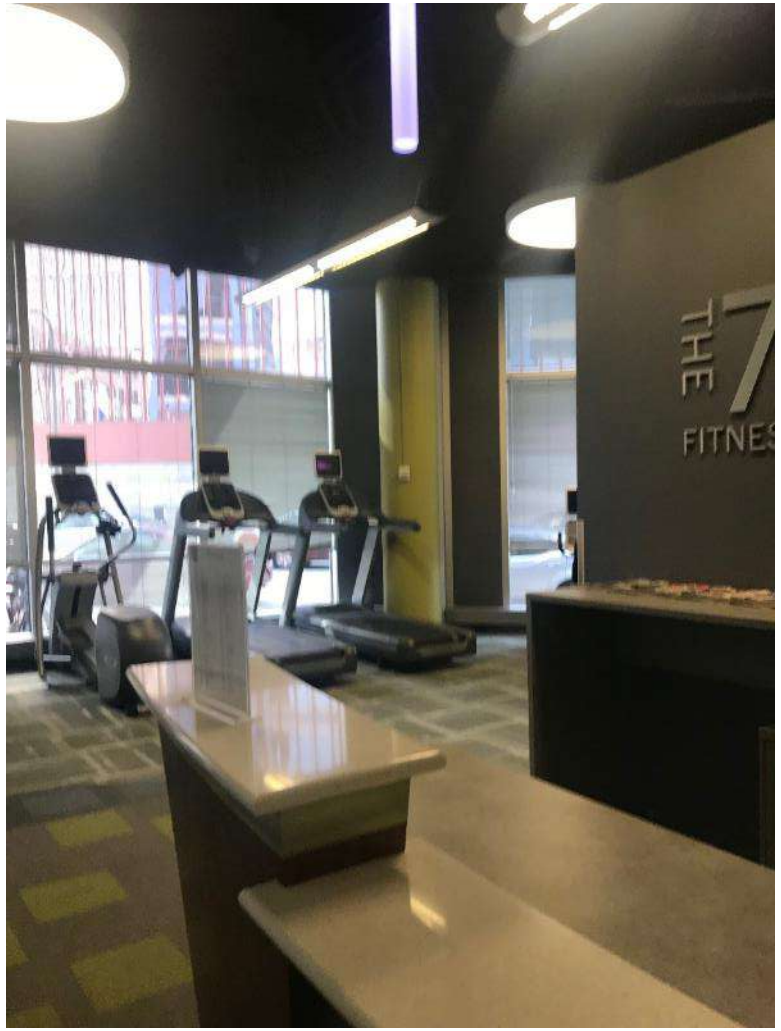
Challenge in retrofit, easier in new construction

Another technology example involved IP-addressable controllers. Computer updates happened at night. IT staff fought technology

Have to plug monitor in controlled outlet and personal computer in a different, uncontrolled outlet

Lighting + Plug Loads

- Zoning challenges
- Fixture + plug controlled together
- Large spaces zoned together
- Not like grocery store that turns on as you walk down the aisle



Lighting + Plug Loads

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Lessons Learned: Lighting + Plug Loads

- Lighting provides good line of site in spaces for technology
- Occupants in the space can be nervous about their loads being switched. Be sure to communicate with space occupants – go beyond facilities team
- A power strip can defeat the switched receptacles
- Test loads and warm up time to see if they can be controlled

Resources

- InteriorLightingCampaign.org

- Published results from field validation studies in the works

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Questions

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