

### Integration of Lighting Systems

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PNNL is operated by Battelle for the U.S. Department of Energy





Effective savings formulas are nominal savings and actual savings will probably be lower because of interactive effects not accounted for in formulas

## Integrating networked lighting systems can add value & assist with cost recovery

Automatic Receptacle Controls

Pacific

Northwest



- Required by virtually all energy codes in U.S.
- Lighting sensors / schedule allow for control
- Dual-use of controls reduces costs

**HVAC** Integration



- Temperature, fans, etc. setback in empty spaces
- ≈20 30% mechanical energy savings (more valuable than lighting)
- Dual-use of sensors reduces costs

Internet of Things (IoT)



- Using sensors for nonlighting & non-energy purposes
- Real estate & human costs
  > energy costs
- Dual-use of sensors reduces costs

### **Government office (60,000 ft<sup>2</sup>) lighting integrated** with IoT and attempted to integrate with HVAC Northwest



Pacific

74.4-year lighting only simple payback



#### 82.3-year lighting + HVAC simple payback

Lighting	<b>HVAC</b> Integration	Plug	Total
\$8.76 / ft <sup>2</sup>	\$0.92 / ft <sup>2</sup>		\$9.68

## Military base office and high bay industrial space (21,000 ft<sup>2</sup>) lighting integrated with HVAC & plugs



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45% faster cost recovery from integration



18.7-year lighting only simple payback

10.3-year lighting + HVAC + plug simple payback

Lighting	HVAC Integration	Plug	Total
\$3.96 / ft <sup>2</sup>	\$0.39 / ft <sup>2</sup>	\$0.43 / ft <sup>2</sup>	\$4.78



University of Minnesota mixed use academic building (25,000 ft<sup>2</sup>) lighting integrated with HVAC & attempted plug integration



30% faster cost recovery from integration



17.6-year lighting + HVAC + plug simple payback

Lighting	HVAC Integration	Plug	Total
\$4.64 / ft <sup>2</sup>	\$0.37 / ft <sup>2</sup>	\$0.28 / ft <sup>2</sup>	\$5.29

25.3-year lighting only simple payback



# Fitness center & outpatient medical office (11,000 ft<sup>2</sup>) lighting integrated with HVAC & attempted plug integration



56% faster cost recovery from integration





63.2-year lighting only simple payback

28.1-year lighting + HVAC + plug simple payback

Lighting	<b>HVAC</b> Integration	Plug	Total
\$8.93 / ft <sup>2</sup>	\$1.60 / ft <sup>2</sup>	\$0.55 / ft <sup>2</sup>	\$11.08



# Light industrial state transportation facility (17,000 ft<sup>2</sup>) lighting integrated with HVAC & plug integration



39.9-year lighting only simple payback

85% faster cost recovery from integration



5.8-year lighting + HVAC + plug simple payback

Lighting	HVAC Integration	Plug	Total
\$7.00 / ft <sup>2</sup>	\$0.38 / ft <sup>2</sup>	\$0.20 / ft <sup>2</sup>	\$7.58



Need low-cost solutions to provide feedback back to lighting or building system

Automatic Receptacle Controls

- Occupancy sensor tells receptacle that space is empty
- Receptacle sends no information to lighting or building system
- Building manager does not know if receptacle is being used or load being managed
- Building manager does not know if receptacle is turning off when not occupied



## Low data signal is single direction: Multiple steps to determine and track integration



During a cold week, occupants manually changed the temperature and that caused the integration to stop, but unknown to building until we analyzed the data

## Need snippets of code or examples for HVAC integration



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Mechanical Systems:

- Take lighting signal (shown below)
- Building modifies HVAC sequence based on signals in BMS
- Building "trends" the related data points of the mechanical system in BMS
- Most buildings will need 3<sup>rd</sup> party software / tools to evaluate trended data to then determine if integration was successful
- Need logic to determine if / when integration may have stopped



#### Recommendations

- 25,000 ft<sup>2</sup> buildings: fixed costs and staffing needs suggest not ideal situation currently
- 50,000 ft<sup>2</sup> buildings: should consider integration
- Plug loads: integrating with plug loads helps with energy code compliance, but may be hard to recover costs (controlled receptacles are expensive)
- HVAC integration: can reduce cost recovery time of the connected lighting system by 30% or more
- Integrator: consider having an integrator assist on the project
- Tools: need more tools to track integration over time



### **Additional Information / Assistance**

- Integrated Lighting Campaign
  - https://integratedlightingcampaign.energy.gov
  - Recognition and support campaign
  - Cal State Dominguez Hills recognized in 2021
- Next Generation Lighting Systems
- DOE Better Buildings Programs

