

# Distributed BACnet Lighting Controls

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[www.bacnetinternational.org](http://www.bacnetinternational.org)

# Learning Objective

## Distributed BACnet Lighting Control

For years, BACnet native lighting controls were locked away in the electrical closet. This education session will discuss the industry's movement towards distributed BACnet lighting control devices, and will provide best practices for designing and specifying an open BACnet native distributed lighting control system.

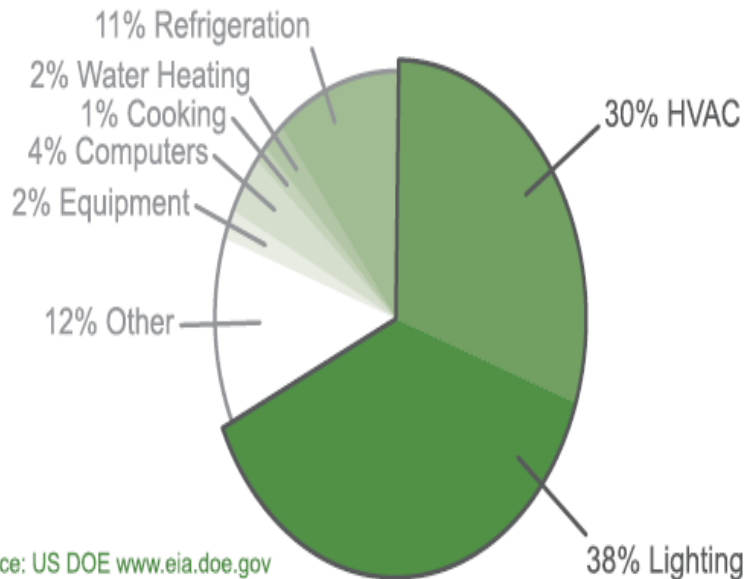
Learning Objectives:

- Discover the benefits of using distributed BACnet lighting controls
- Identify pitfalls in the design, specification and installation of distributed BACnet controls
- Review real world distributed installations and applications

# Commercial Energy Usage

## Lighting & HVAC Over 60%

Commercial Electricity Usage : Aggregate



Source: US DOE [www.eia.doe.gov](http://www.eia.doe.gov)

Commercial Electricity Usage : Building Type

Building Type	HVAC	Lighting	Total
Education	46%	30%	76%
Health Care	33%	42%	75%
Lodging	22%	53%	75%
Retail	32%	42%	74%
Office	27%	39%	66%

# Lighting Control

## Key Considerations

### Market Drivers

#### State Energy Code

- ASHRAE 90.1
- International Energy Conservation Code

#### Green Buildings

- LEED
- Green Globe

#### Increased focus on system performance

- Measurement and verification
- Unified systems
  - HVAC, Lighting, Security, etc.

### Economic Factors

#### Energy savings

- kW
- kWh

#### Payback / ROI

- What is your payback or ROI window?

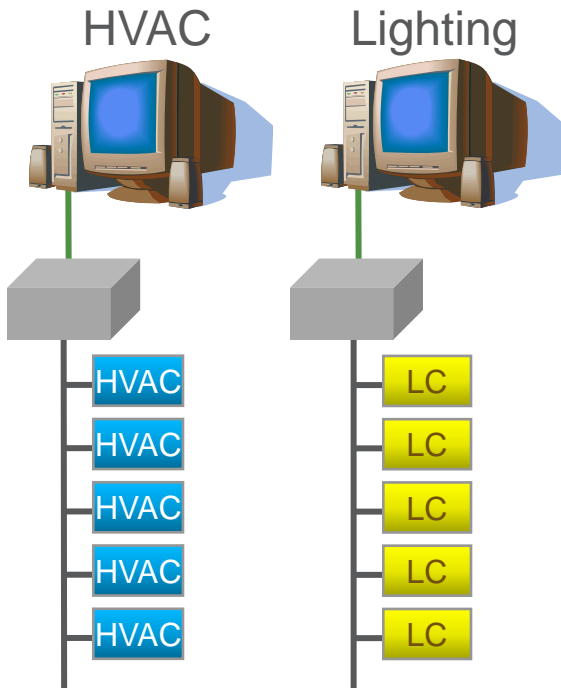
#### Local service and support

- Startup, check-out and training
- System programming and engineering

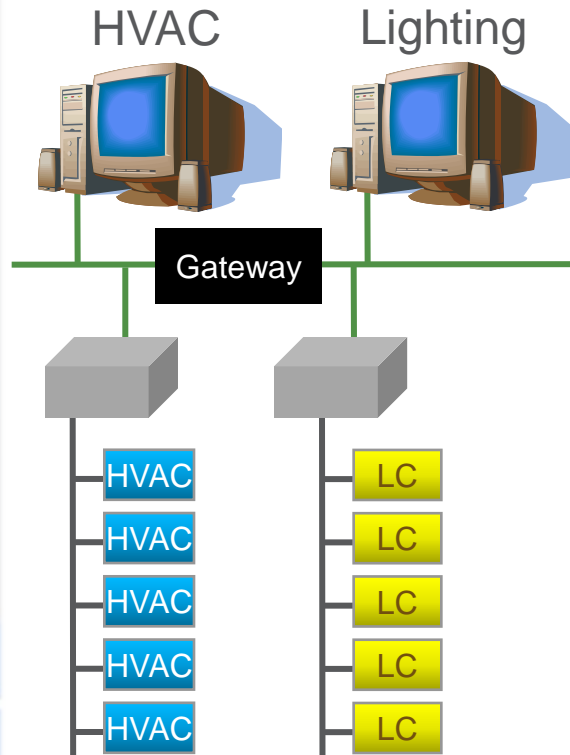
# Unified Lighting Control

## Important Differences

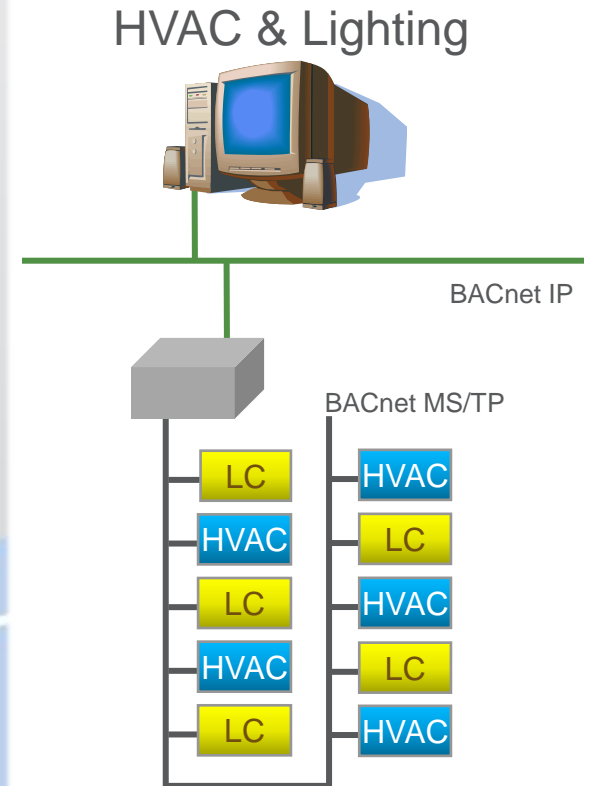
### Stand-Alone



### Gateway Integration

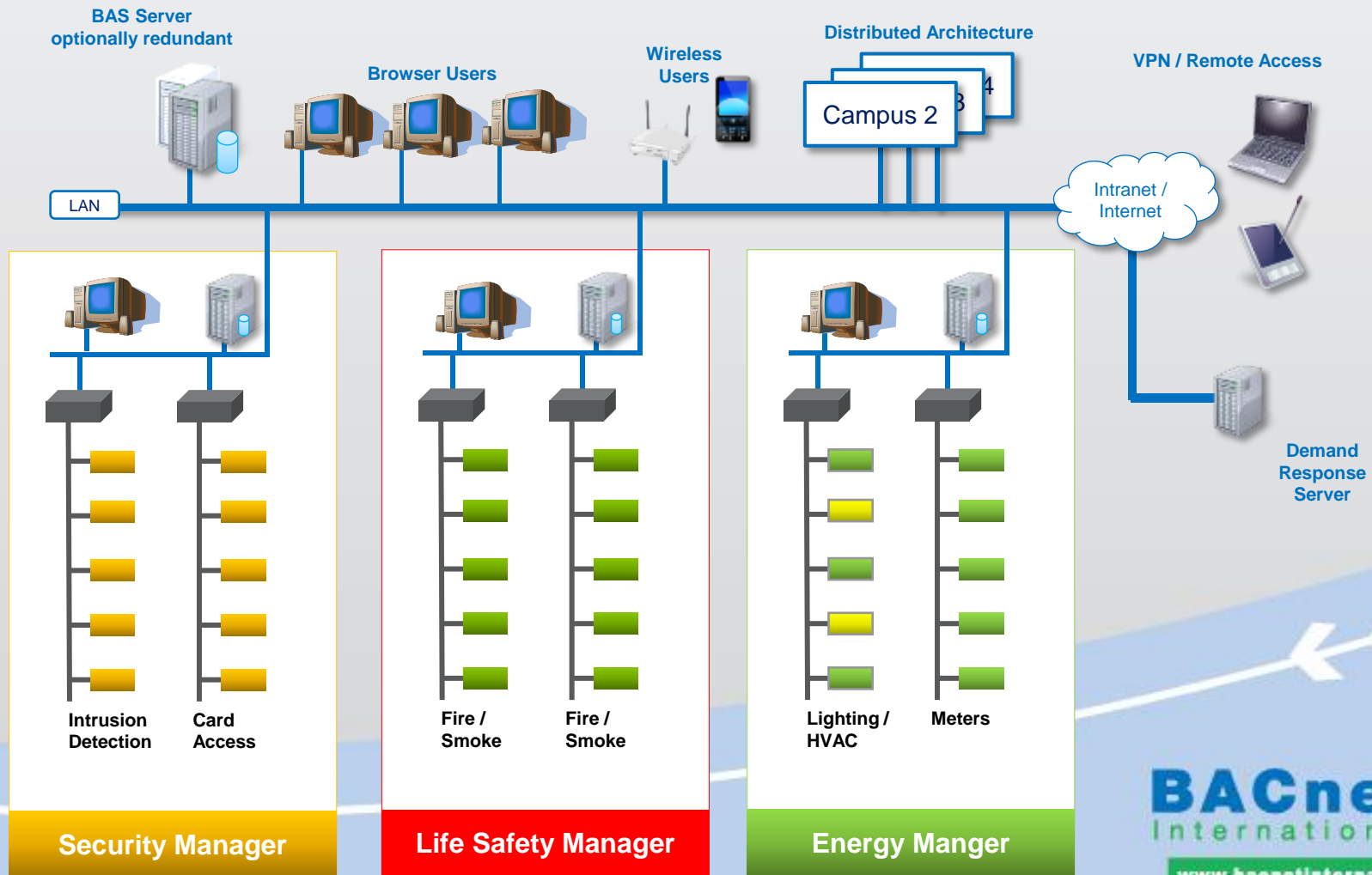


### Unified



# Unified Lighting Control

## Leverages BAS Infrastructure



# Unified Lighting Control

## Leverage Open Standard

BACnet is the Open Standard

- ASHRAE SSPC 135
- ISO Global Standard 16484-5

BACnet enables “Best of Breed”

- Easily replace legacy controls
- Sustainable platform

BACnet Tools for System Designer

- Protocol Implementation Conformance (PIC) Statement
- BACnet Interoperability Building Blocks (BIBBs)



[www.bacnet.org](http://www.bacnet.org)



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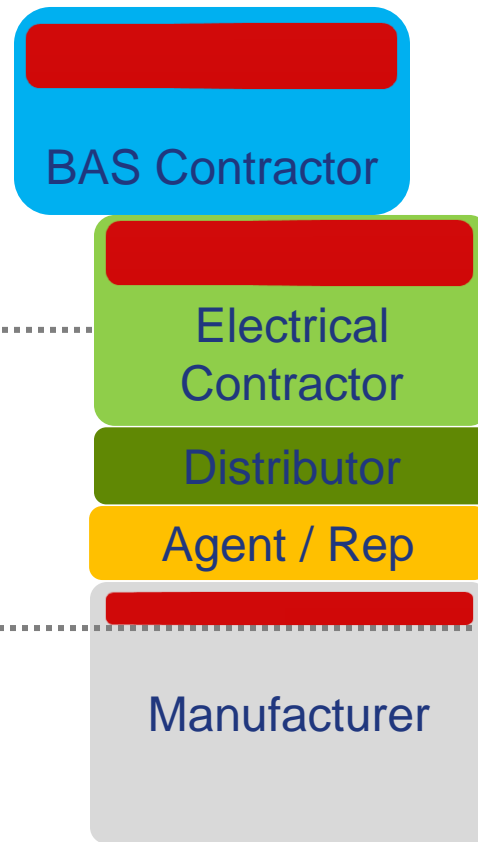
# Unified Lighting Control

## Important Cost Differences

### Stand-Alone

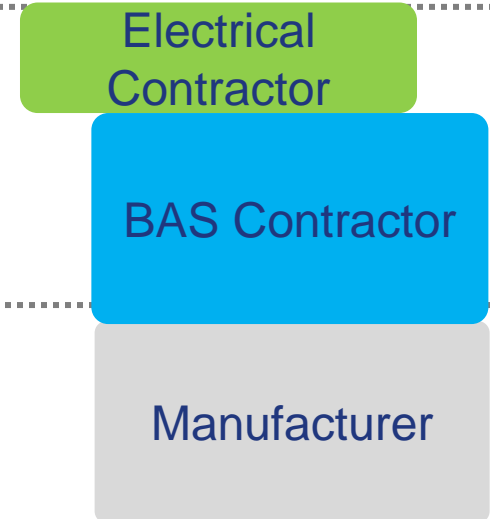


### Gateway Integration



■ = Integration Uncertainty \$\$\$

### Unified



Division 16 / 26 Furnished

Division 25 Furnished



# Unified Lighting Control

## Alignment Critical to Success

Accountability requires the alignment of responsibility with expertise

### Simply stated

BAS Controls Contractor provides the lighting control

And, the Electrical Contractor installs the lighting control

### Benefits

Lowest risk delivery method

Local resources assist with control system design, quickly resolve difficulties

Leverages everyone's expertise

CSI	Furnish	Install / Rough-in	Low Voltage	Line Voltage	Integration	Start-up	Training
1995	17	16	16	16	17	17	17
2004	25	26	26	26	25	25	25

# Unified Lighting Control

## Improved Delivery and Alignment

### CSI 1995

Division 15 - Mechanical  
Mechanical Equipment  
DDC / HVAC Controls

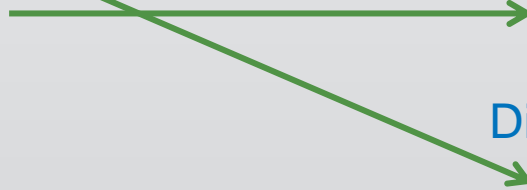
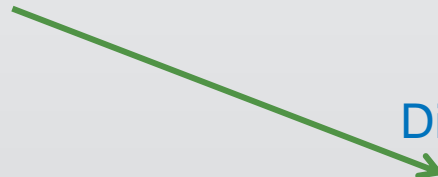
Division 16 - Electrical  
Lighting Equipment  
Lighting Controls

### CSI 2004

Division 23 – HVAC  
Mechanical Equipment

Division 25 – Integrated Automation  
DDC / HVAC controls  
Lighting Controls

Division 26 – Electrical  
Lighting Equipment



# Unified Lighting Control

## The Big Picture

### One System

- Lighting and HVAC controls on same network
- Leverage BIBB's for distributed operation

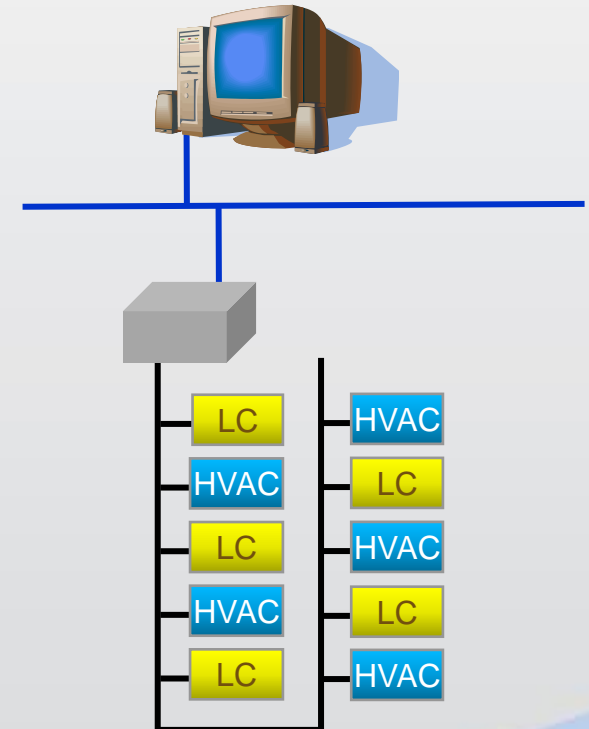
### One User Interface

- Same front-end software for lighting & HVAC
- No gateways or extra networks

### One Point of Accountability

- Align responsibility with core competencies
- BAS Controls Contractor provides and supports
- Electrical Contractor installs

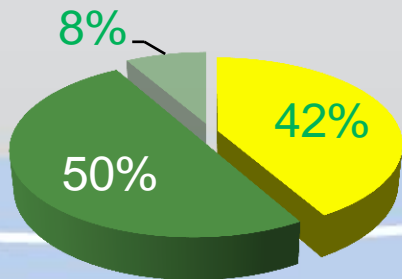
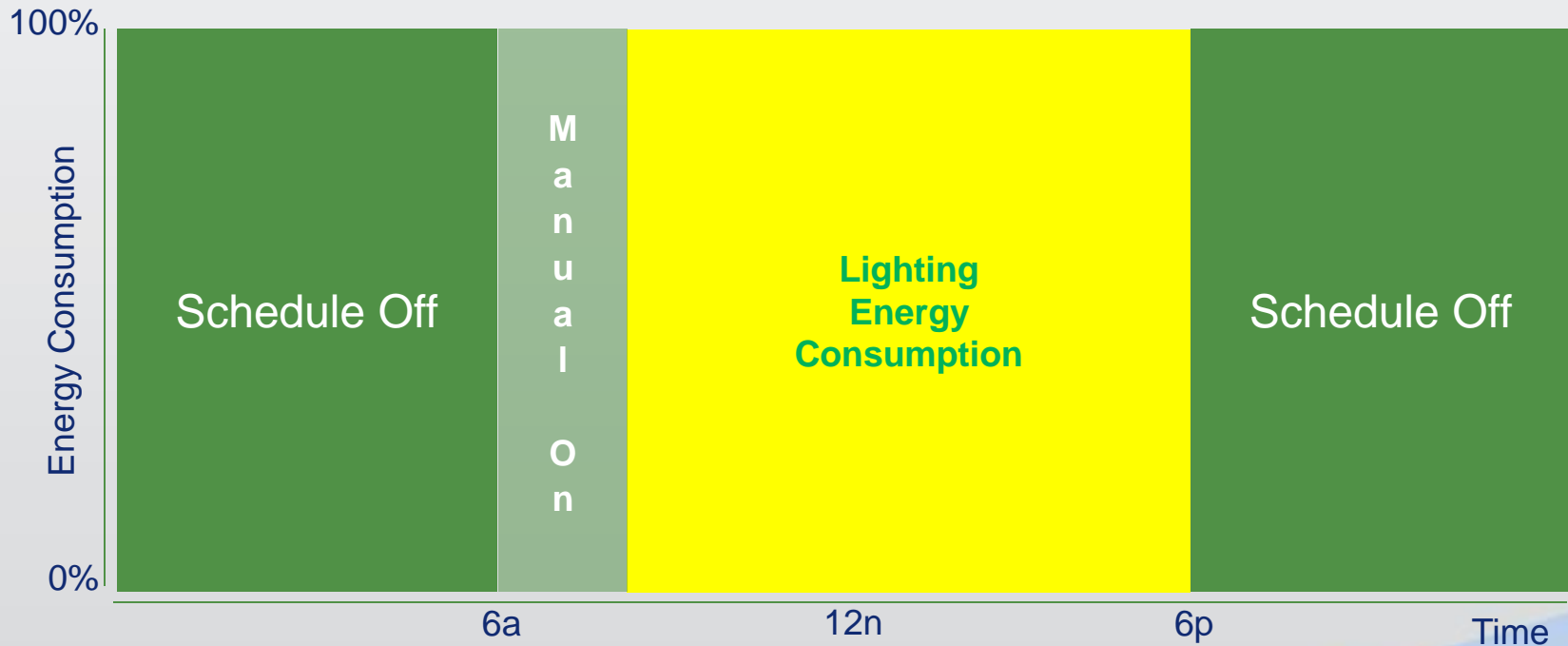
HVAC & Lighting



# Unified Energy Management Strategies

# Control the Bookends

## Up to 58% Savings



Annual Savings

Period	Load (kW)	Hours Saved per Day	Days per Period	Total Savings (kWh)	Total Savings (\$)
Work Week	1.0	12	250	3,000	240.00
Weekends	1.0	24	104	2,496	199.68
Holidays	1.0	24	11	264	21.12
<b>Total - Schedule Off</b>			<b>365</b>	<b>5,760</b>	<b>460.80</b>
Manual On	1.0	2	250	500	40.00
<b>Total - Combined</b>				<b>6,260</b>	<b>500.80</b>



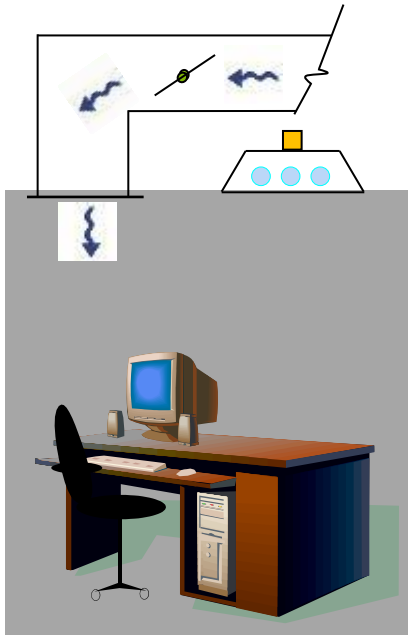
Base upon \$0.08 per kWh (National Average)

# Control the Bookends

Save up to 58%

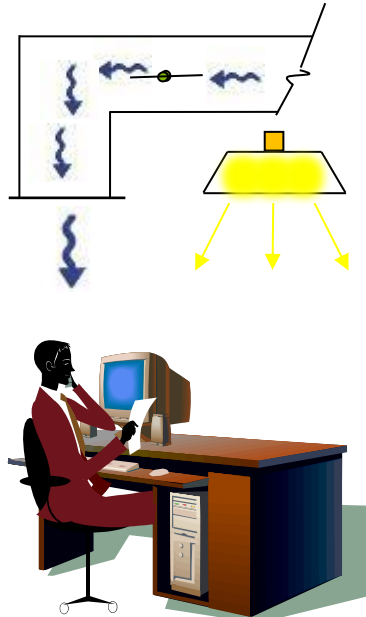
## Morning

BAS Schedule: **Occupied**  
Local Override: **Off, Timer Disabled**  
Lights: **Off**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**



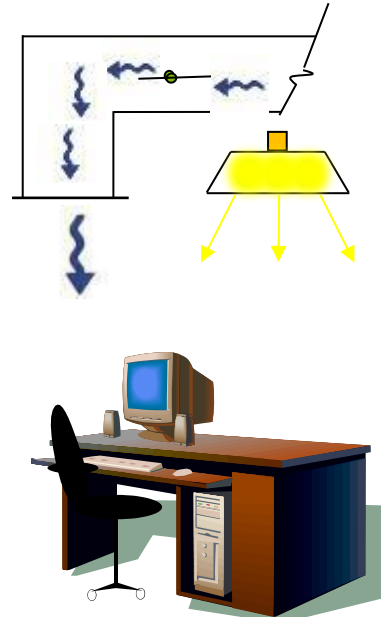
## Mid-day

BAS Schedule: **Occupied**  
Local Override: **On**  
Lights: **On, manually**  
HVAC Temp: **Set Point**  
Ventilation: **Full**



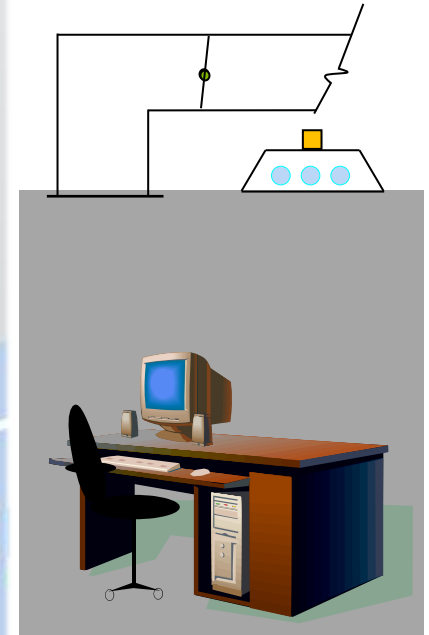
## Late Afternoon

BAS Schedule: **Occupied**  
Local Override: **On**  
Lights: **On, manually**  
HVAC Temp: **Set Point**  
Ventilation: **Full**



## Night

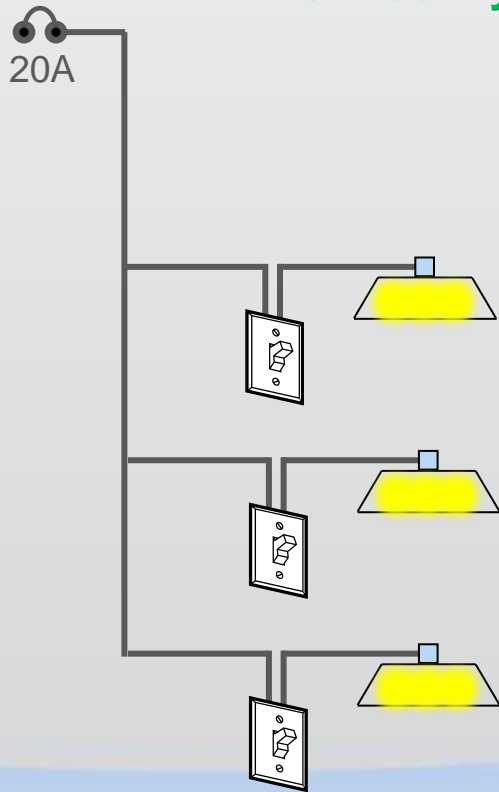
BAS Schedule: **Unoccupied**  
Local Override: **Off, Timer Enabled**  
Lights: **Off, sched w/ blink warn**  
HVAC Temp: **Night Set Back**  
Ventilation: **Off**



# Control The Bookends

## Existing Buildings

### The Reality



### Considerations

Existing circuiting does not always meet desired control zones

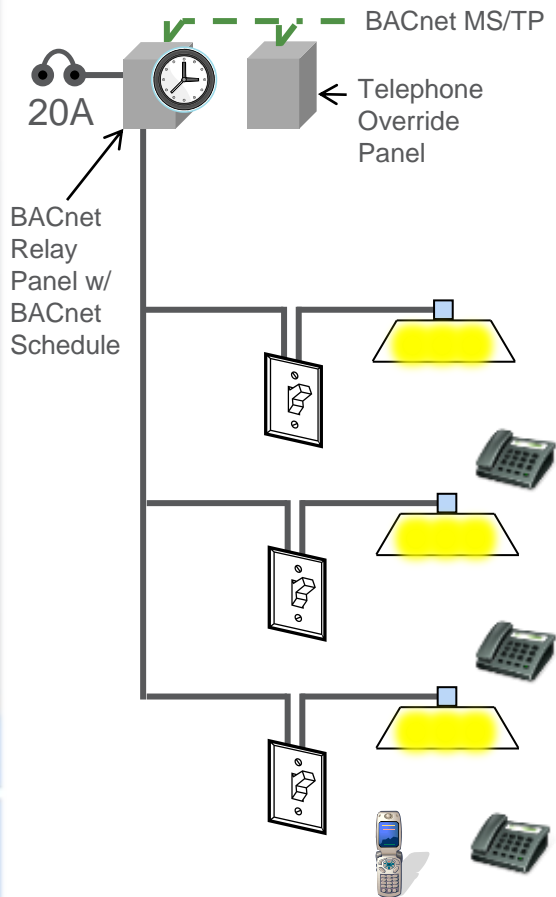
Re-wiring to add centralized control is not an effective solution

How do the occupants initiate after hours override

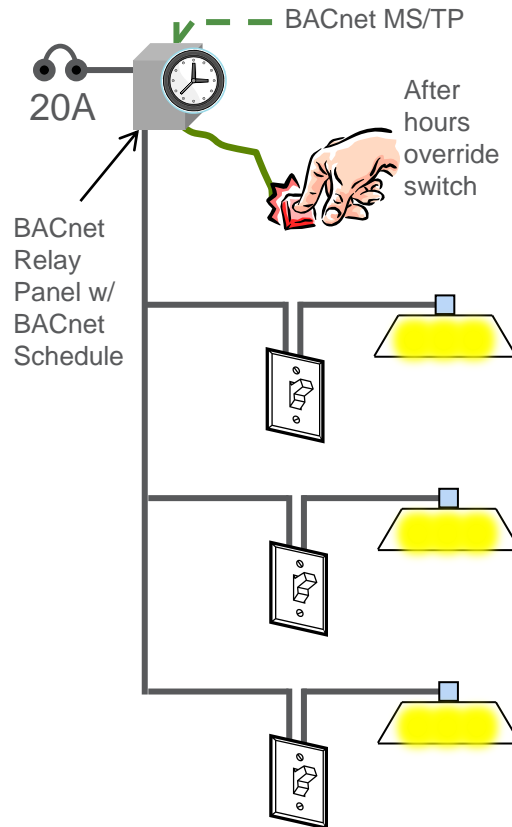
# Control the Bookends

## Options to Consider

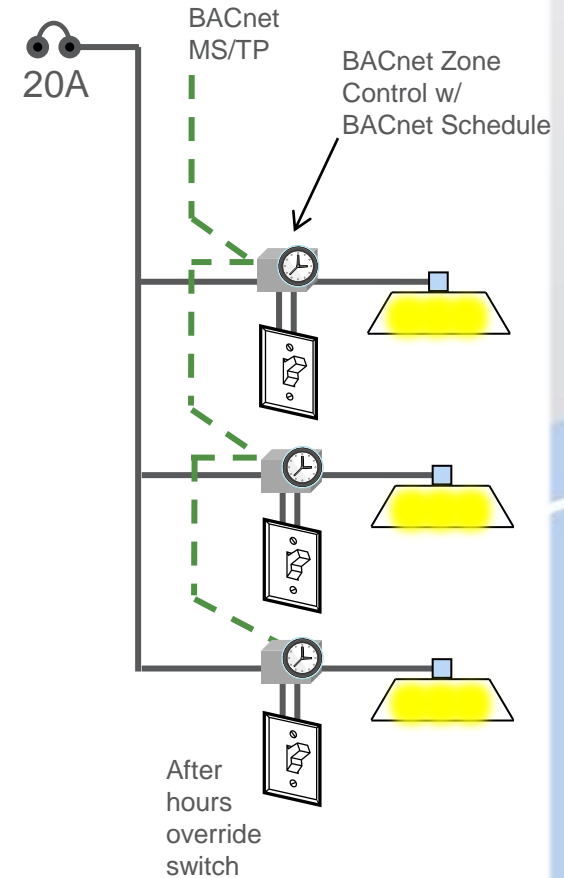
### Good



### Better



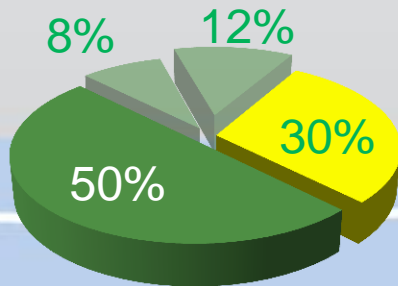
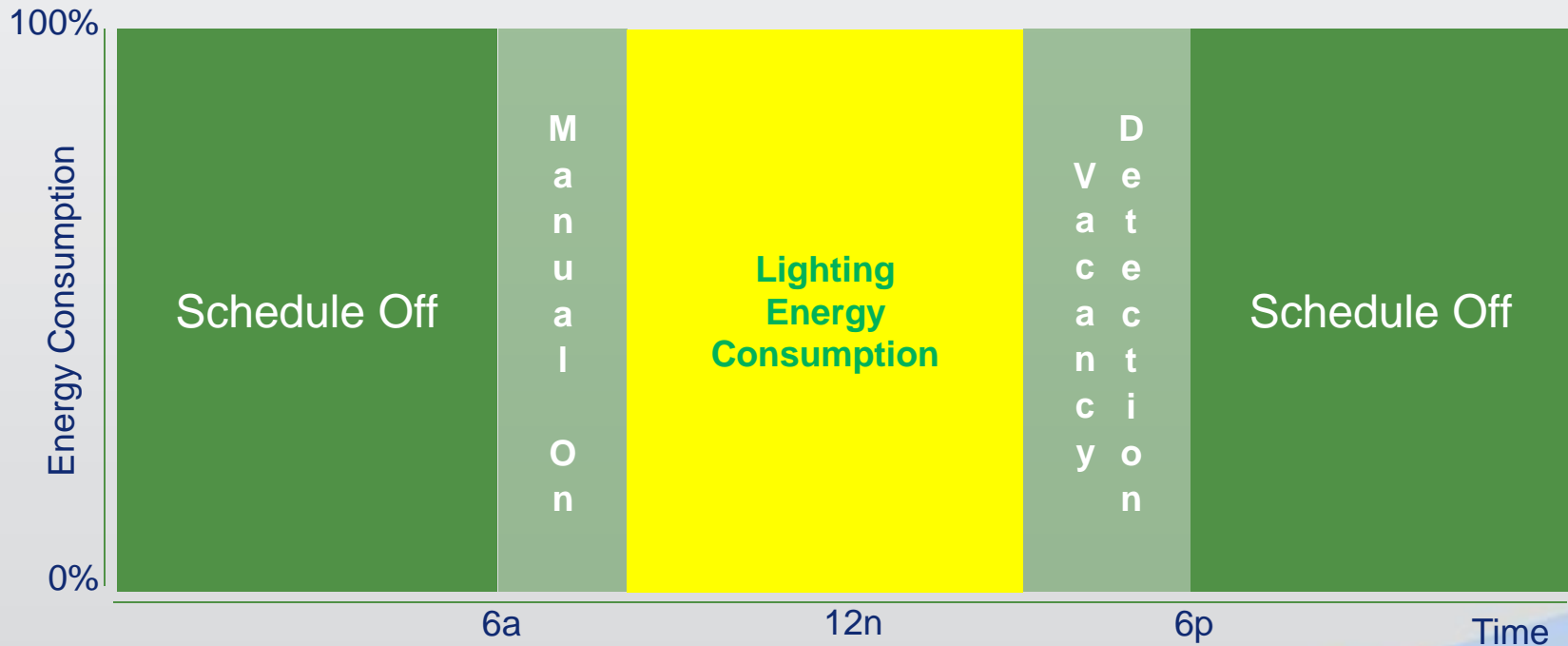
### Best





# Add Vacancy Detection

## Up to 70% Savings



Annual Savings

Period	Load (kW)	Hours Saved per Day	Days per Period	Total Savings (kWh)	Total Savings (\$)
<b>Total - Schedule Off</b>	1.0	N/A	365	5,760	460.80
Manual On	1.0	2	250	500	40.00
Vacancy	1.0	3	250	750	60.00
<b>Total - Combined</b>				<b>7,010</b>	<b>560.80</b>



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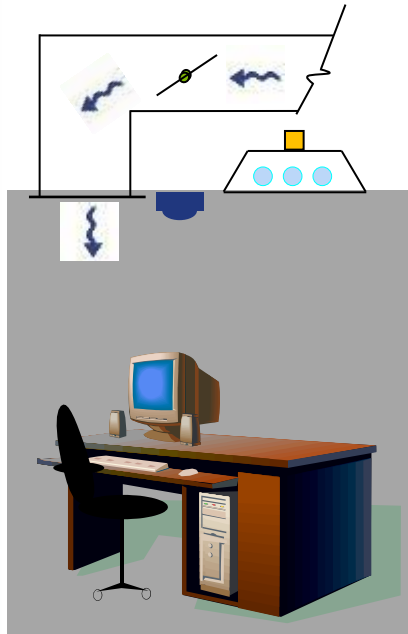
Base upon  
\$0.08 per  
kWh  
(National  
Average)

# Add Vacancy Detection

## Save up to 70%

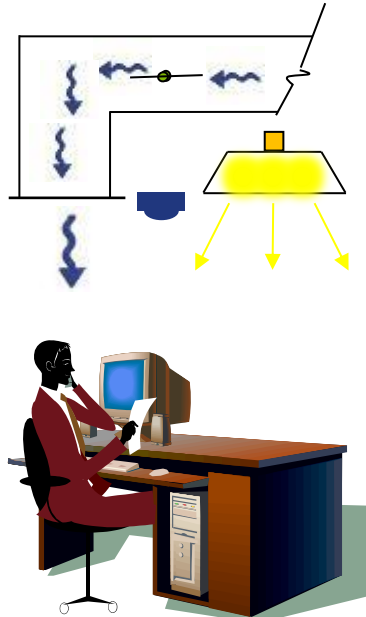
### Morning

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**



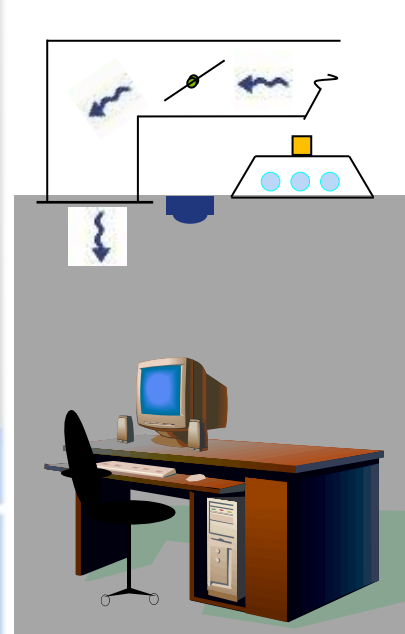
### Mid-day

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **On**  
Lights: **On, manually**  
HVAC Temp: **Set Point**  
Ventilation: **Full**



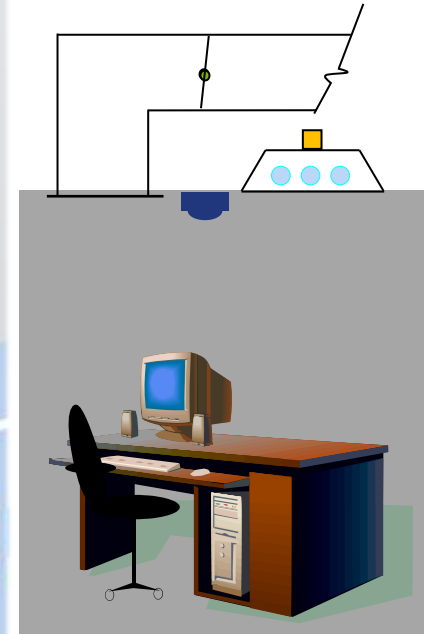
### Late Afternoon

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**



### Night

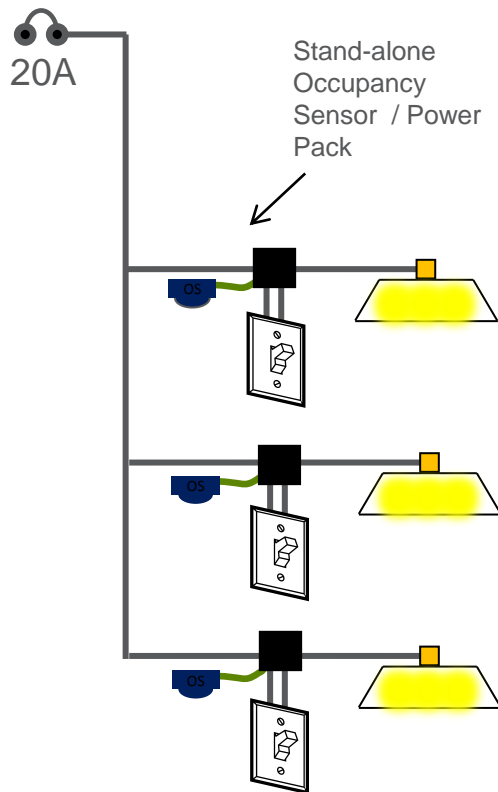
BAS Schedule: **Unoccupied**  
Sensor Timer: **10 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Night Set Back**  
Ventilation: **Off**



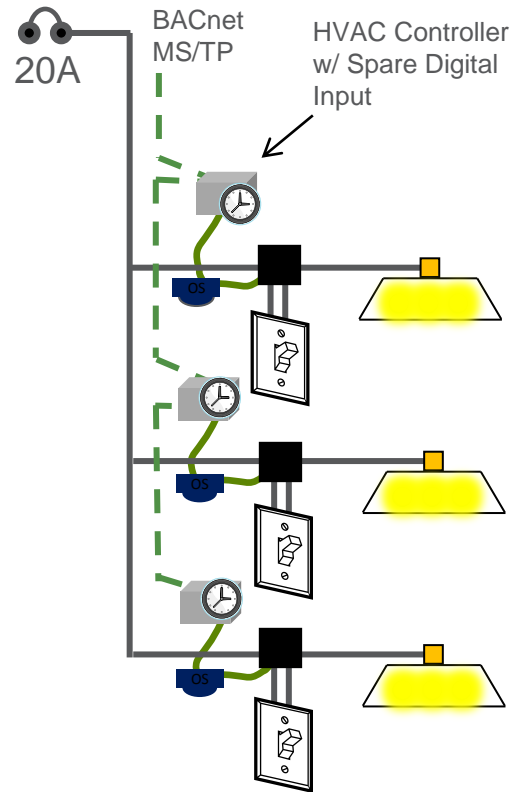
# Add Vacancy Detection

## Making Occupancy Sensors Better

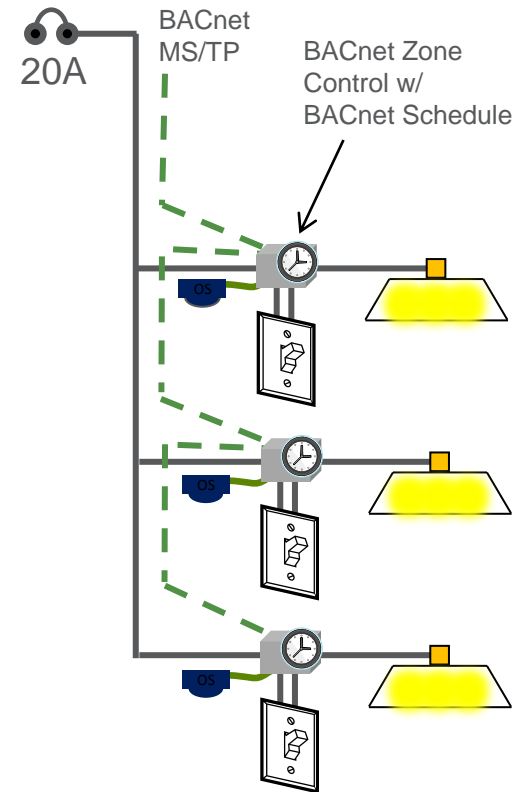
### Stand-alone



### Integrated



### Unified



# Add Vacancy Detection

## Make Occupancy Sensors Better

### Unified Solutions

Better performance and verified energy savings

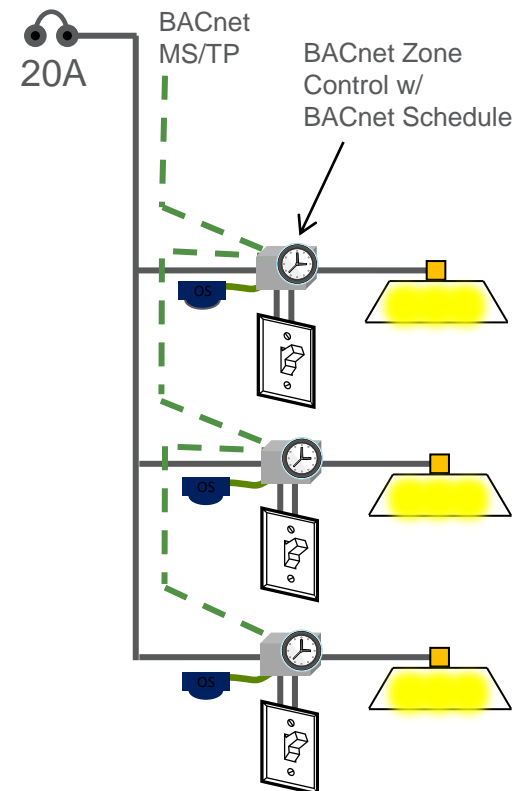
#### Better Performance

- Reduced complaints
  - Timer managed from BAS, easily modify
  - Manual On, eliminate false On from walk-by
  - False Off grace period, sensor able to re-activate lights
- Control can be customized and monitored
  - Based upon occupied / unoccupied status
  - Add manual control
  - Add level control / dimming
  - Add daylight harvesting
- Increase HVAC savings
  - Share sensor status for set-back

#### Verification

- Sensor and relay status shared

### Unified



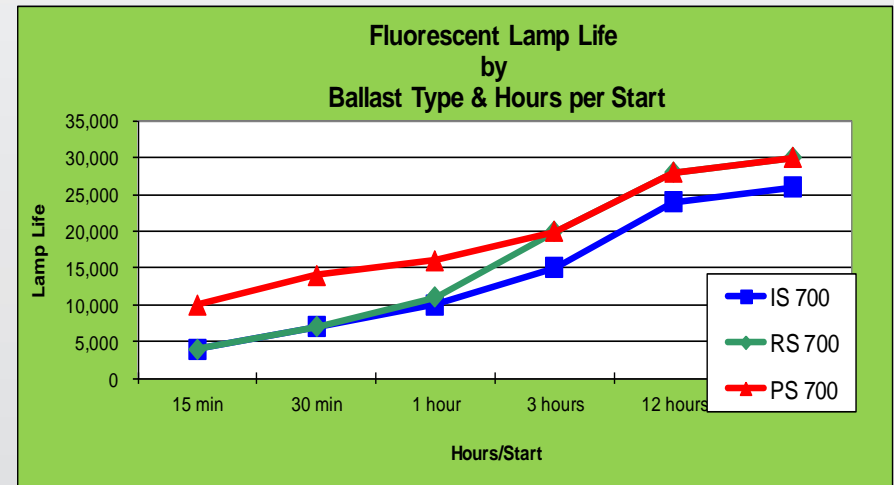
# Add Vacancy Detection

## Track and Optimize Lamp Life

### Unified Solutions

Monitoring and customization enables a balance between equipment life and energy savings

- Track actual performance
- Fluorescent lamp life can be dramatically reduced by short sensor timers and increased cycles
- Especially important for those that do spot lamp replacement
- US DOE spot re-lamp cost = \$9.00 / lamp
  - \$2.00 material (T-8 lamp)
  - \$7.00 labor



Source: Osram Sylvania

#### Ballast Type

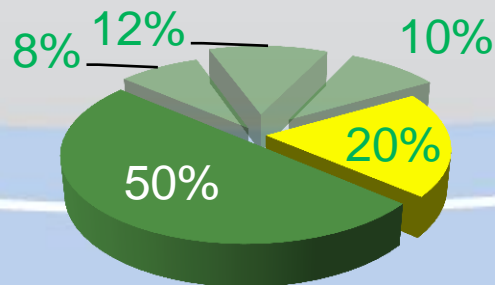
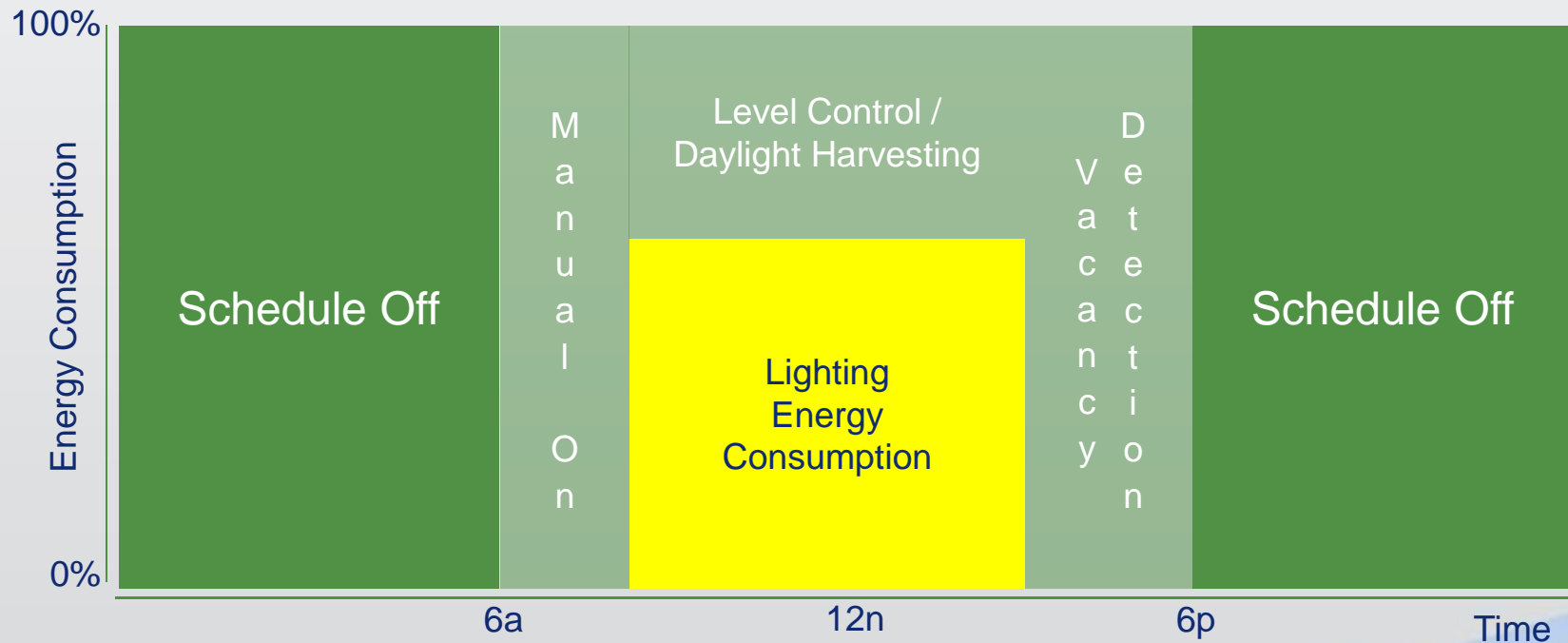
IS = Instant Start

RS = Rapid Start

PS = Programmed Start

# Add Level & Daylight Harvesting

## Up to 80% Savings



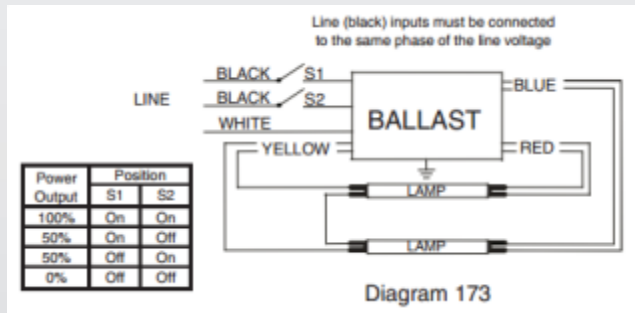
Annual Savings

Period	Load (kW)	Hours Saved per Day	Days per Period	Total Savings (kWh)	Total Savings (\$)
<b>Total - Schedule Off</b>	1.0	N/A	365	5,760	460.80
Manual On	1.0	2	250	500	40.00
Vacancy Detection	1.0	3	250	750	60.00
Level / Daylight Harvesting	0.3	7	250	578	46.20
<b>Total - Combined</b>				<b>7,588</b>	<b>607.00</b>

# Add Level & Daylight Harvesting

## Step or Bi-Level Control

### Step Ballast



Step    B.L.  
100%    100%

66%

50%

33%

0%

0%

### Considerations

Levels:

Step Ballast: 3 levels (100/50/Off)

Bi-level Ballast: 4 levels (100/66/33/Off)

Wiring:

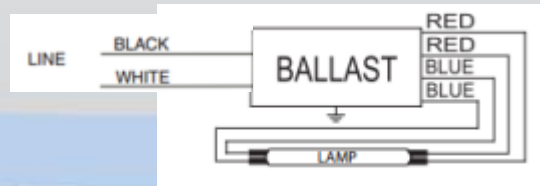
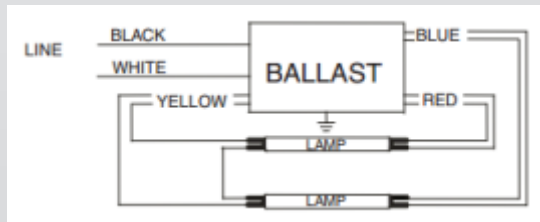
Both utilize two relays for control

Illumination:

Step Ballast: All lamps same level

Bi-level Ballast: Some lamps out

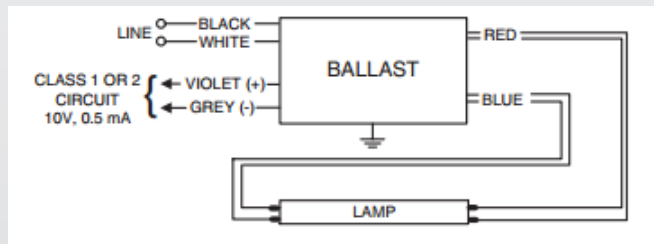
### Bi-Level Ballast

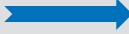


# Add Level & Daylight Harvesting

## 0-10V Control

### 0-10V Ballast



Controller capabilities: 

Max – set limit to allow for task tuning or lumen maintenance

Min. – set limit to allow for load shed limit

100%  
Max.  
  
  
  
  
  
  
  
  
  
Min.  
0%

### Considerations

#### Levels:

Continuous range (Typically 100% - 10%)  
Varies by ballast and lamp type

#### Cost:

Quickly becoming the energy management ballast

- lower price point than architectural dimming ballast

Control method is available for fluorescent (linear & CFL), HID and LED

- Many manufacturers

Light output vs. energy is linear between 100% - 20%

- 50% lighting output = 50% energy

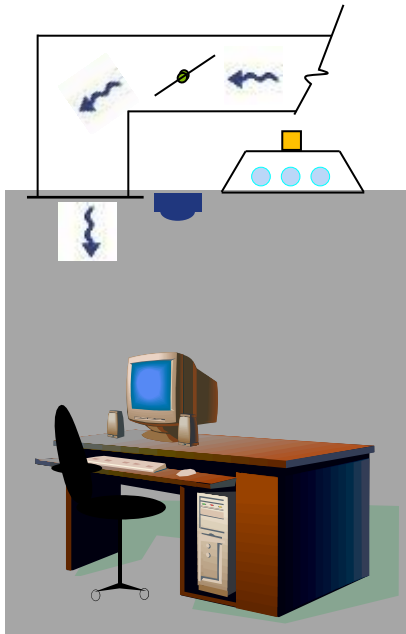


# Add Level Control (Bi-Level)

## Save up to 80%

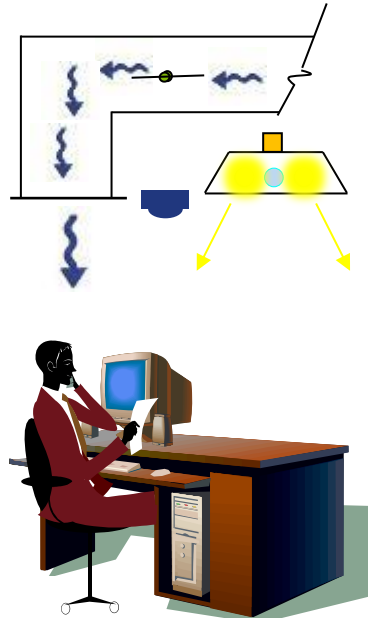
### Morning

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**



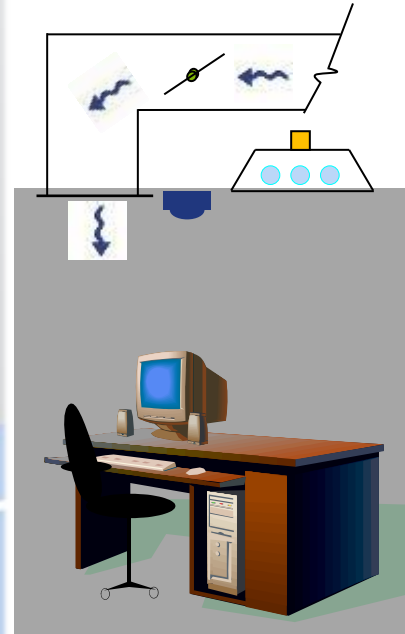
### Mid-day

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **On**  
Lights: **On 66%, manually**  
HVAC Temp: **Set Point**  
Ventilation: **Full**



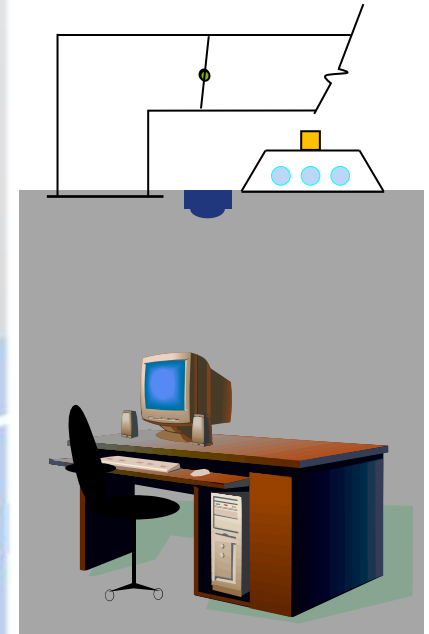
### Late Afternoon

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**



### Night

BAS Schedule: **Unoccupied**  
Sensor Timer: **10 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Night Set Back**  
Ventilation: **Off**



# Add Level Control (0-10V)

## Save up to 80%

### Morning

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**

### Mid-day

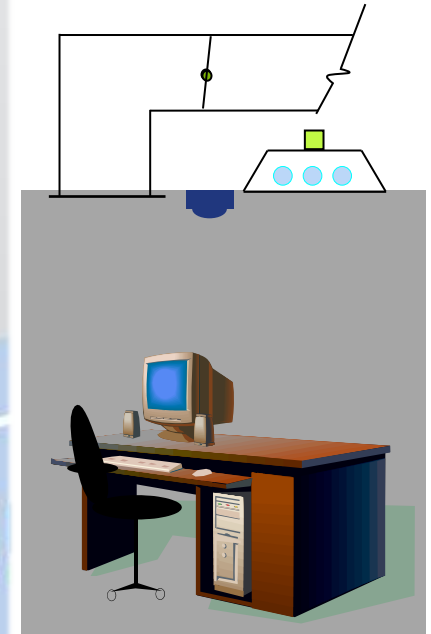
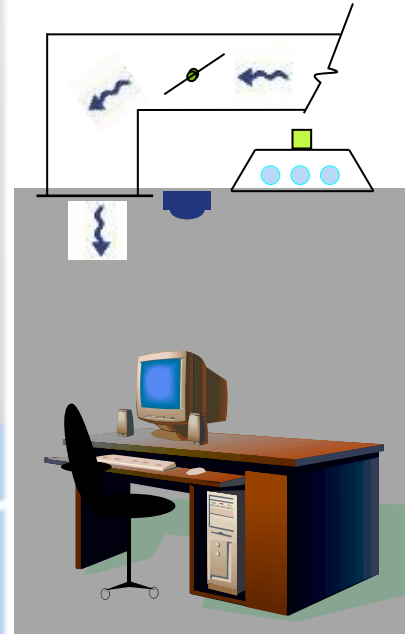
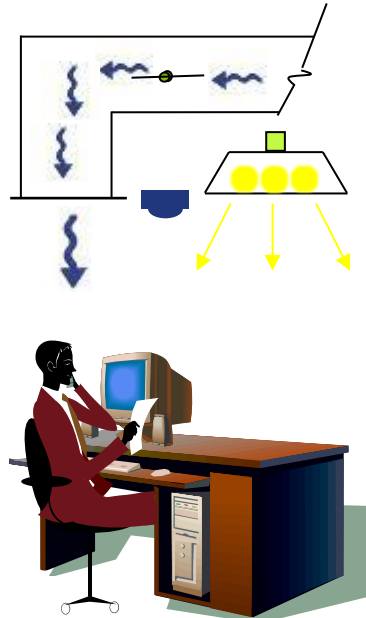
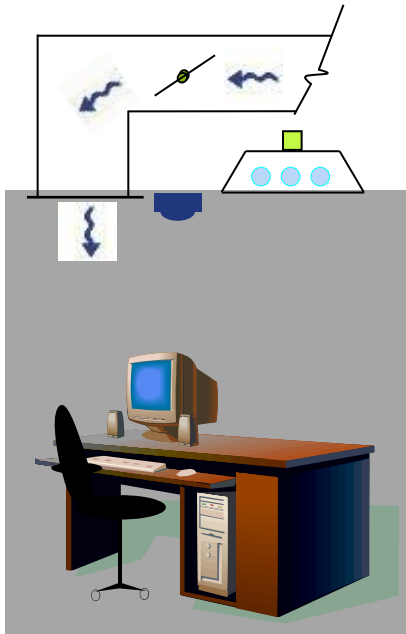
BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **On**  
Lights: **On 66%, manually**  
HVAC Temp: **Set Point**  
Ventilation: **Full**

### Late Afternoon

BAS Schedule: **Occupied**  
Sensor Timer: **30 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Reset**  
Ventilation: **Minimum**

### Night

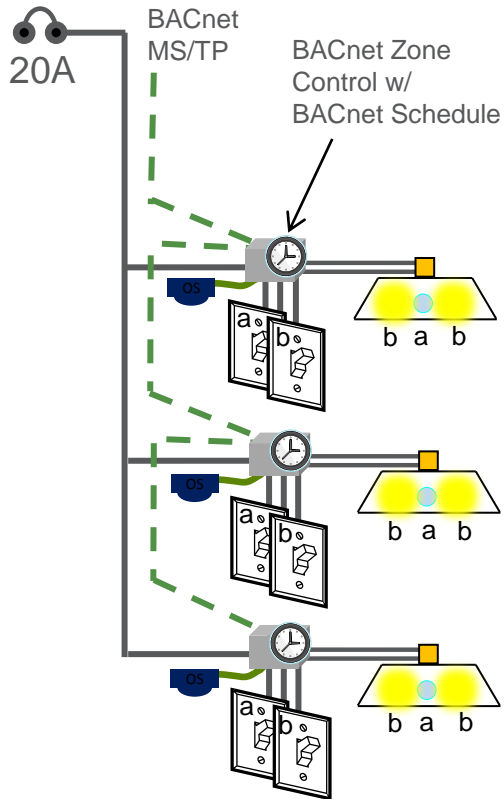
BAS Schedule: **Unoccupied**  
Sensor Timer: **10 min**  
Sensor Status: **Off**  
Lights: **Off, auto by OS**  
HVAC Temp: **Night Set Back**  
Ventilation: **Off**



# Add Level Control

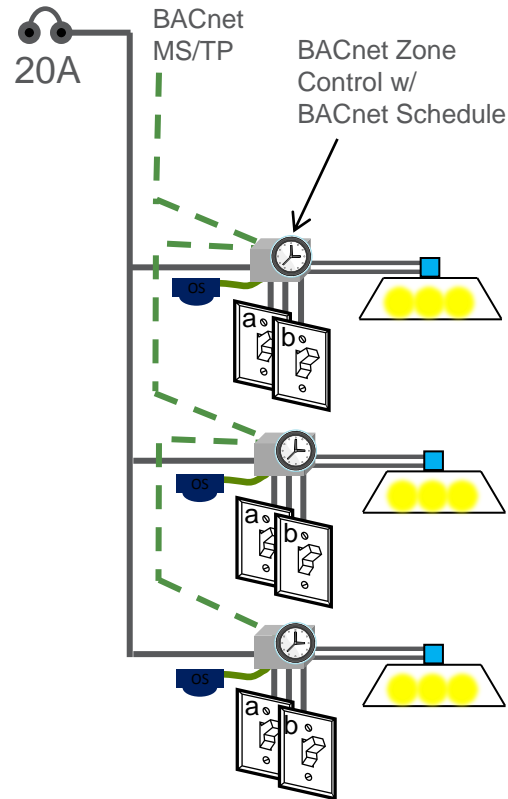
## Options to Consider

### Good



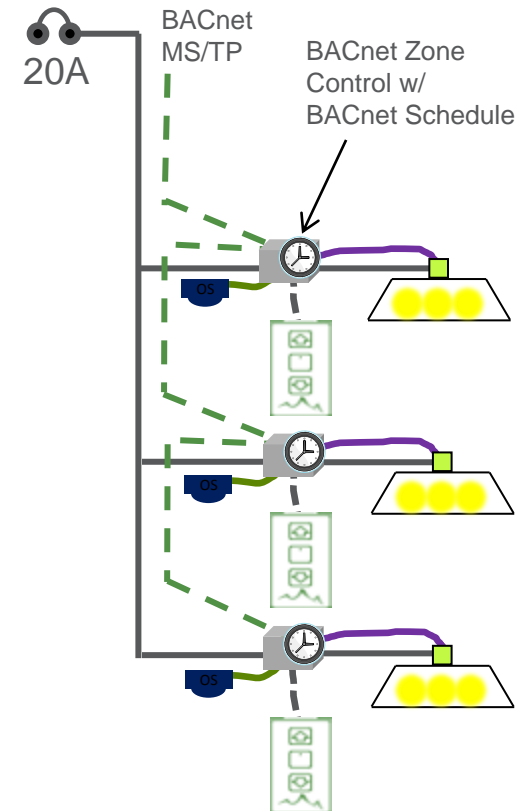
■ Bi-Level Ballast

### Better



■ Step Ballast

### Best



■ 0-10V dc Dimming Ballast

# Add Daylight Harvesting

## Save Up to 80%

### Morning

BAS Schedule: **Occupied**  
 Daylight: **Medium**  
 Lights: **On, 50%**  
 Occupant Set Point: **70%**  
 HVAC Temp: **Set Point**  
 Ventilation: **Full**

### Mid-day

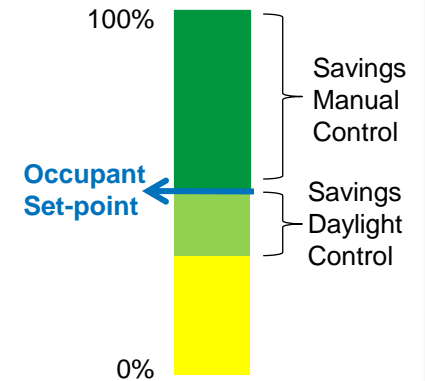
BAS Schedule: **Occupied**  
 Daylight: **High**  
 Lights: **On, 30%**  
 Occupant Set Point: **70%**  
 HVAC Temp: **Set Point**  
 Ventilation: **Full**

### Evening

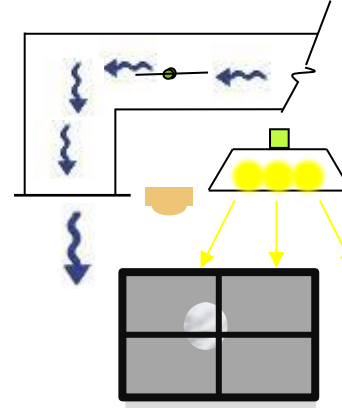
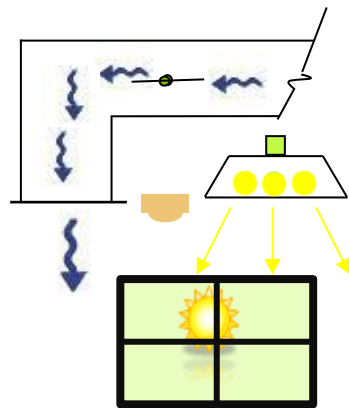
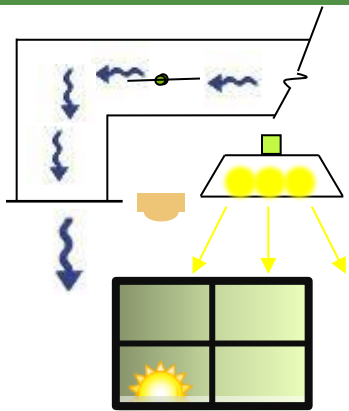
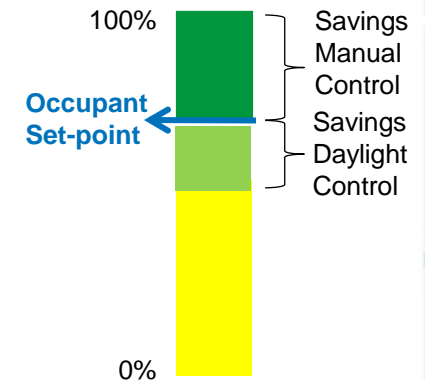
BAS Schedule: **Occupied**  
 Daylight: **Low**  
 Lights: **On, 100%**  
 Occupant Set Point: **70%**  
 HVAC Temp: **Set Point**  
 Ventilation: **Full**

### User Centered Control

#### Computer Task



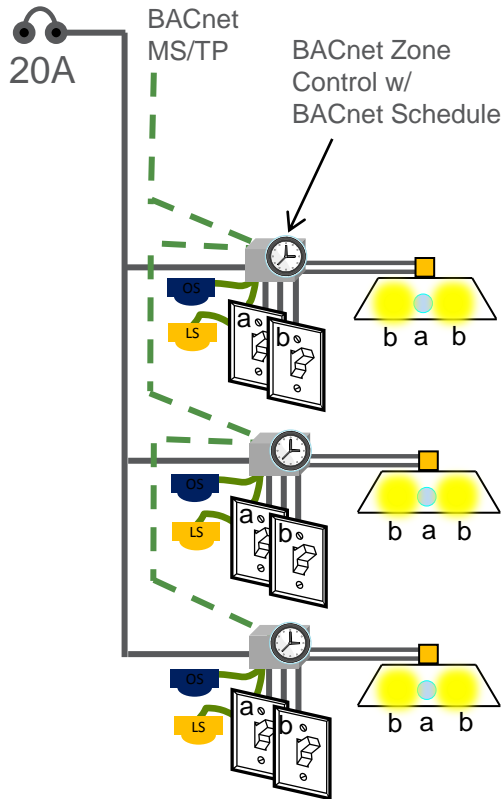
#### Paper Task



# Add Daylight Harvesting

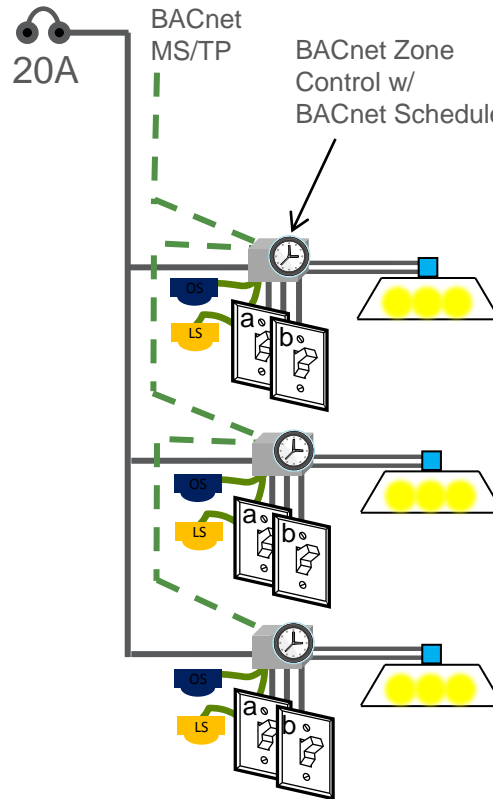
## Options to Consider

### Good



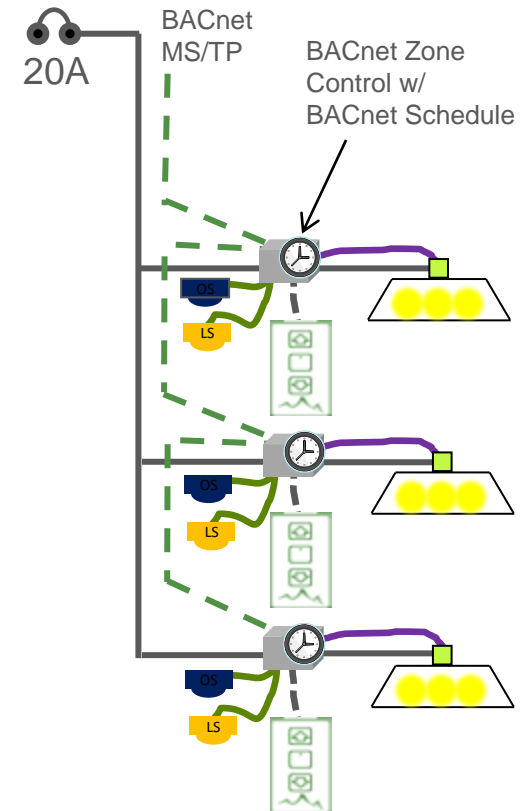
■ Bi-Level Ballast

### Better



■ Step Ballast

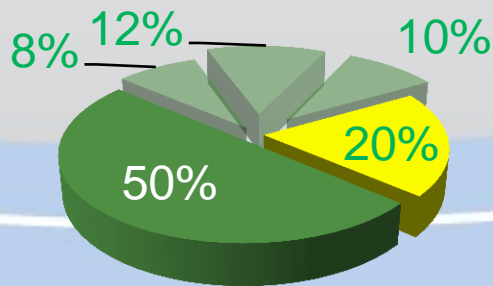
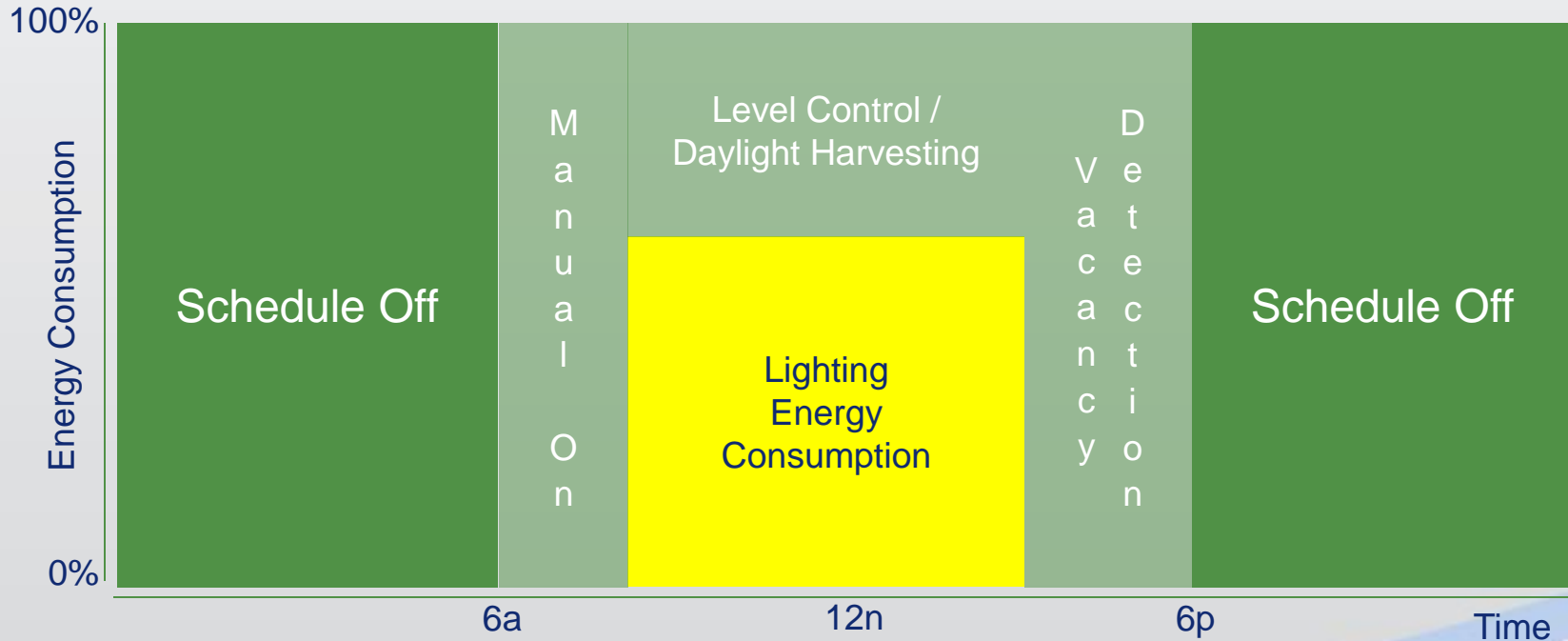
### Best



■ 0-10V dc Dimming Ballast

# Unified Lighting Control

## Up to 80% Savings



### Annual Savings

Period	Load (kW)	Hours Saved per Day	Days per Period	Total Savings (kWh)	Total Savings (\$)
<b>Total - Schedule Off</b>	<b>1.0</b>	<b>N/A</b>	<b>365</b>	<b>5,760</b>	<b>460.80</b>
Manual On	1.0	2	250	500	40.00
Vacancy Detection	1.0	3	250	750	60.00
Level / Daylight Harvesting	0.3	7	250	578	46.20
<b>Total - Combined</b>				<b>7,588</b>	<b>607.00</b>

# Next Step

## Take Action

Develop your Unified Energy Management Strategies

Select Best of Breed BACnet products

Implement

Measure and Verify Performance

Continue to Refine





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