LBNL-CA POU 'Beyond Widgets' Project
Task Ambient Lighting Strategy and Occupancy-based Plug Load Controls
Customer Technical Specification

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This document provides a summary description of system selected for the California Publicly-Owned Utilities (CA POUs)-LBNL 'Beyond Widgets' project i.e. plug loads and lighting occupancy controls, with task and ambient lighting retrofits. This document includes the system features, technology packages, site requirements, and likely energy savings impacts. It will be used as the basis for developing detailed technology specifications, savings metrics and M&V approaches and FLEXLAB testing plans.

The target market is currently anticipated to be commercial office space.

1. System Features

The following are features of the proposed systems energy efficiency program package. A suite of technology package options will be developed from these features which will be pursued for testing, validation and program implementation guidance development.

<u>Lighting and Lighting Controls</u>

- Occupancy controls
    - Switches on in response to occupancy
- Dims to specified (background/ambient) level in vacant areas / cubicles of zone
- Daylight dimming
    - Electric lighting output reduces in response to natural light availability
    - Applies to areas within distance from window equal to double window head height
- Task lighting and ambient lighting upgrade
    - Installation of occupancy-controlled task lighting at workstation level
    - Overhead lighting relamping or light fixture replacement to achieve ambient light level condition

<u>Plug Load Controls</u>

- Schedule-based on/off operation
- Occupancy control
    - Operates in response to occupancy at individual workstation or zone level
    - Occupant preferences accommodated via override and sensitivity settings

<u>Networked Controls System</u>

- Lighting and plug load controls based on scheduling, occupancy and (optional) reporting functions

Occupant Feedback System

- Occupant engagement and awareness strategies for persistence of energy savings

The technology packages will be developed to ensure that there is more than one equivalent commercially available product source for each package.

2. Energy Saving Impacts

Title 24 Challenges

The California POUs use California's Title 24 Energy Code as their baseline for comparison for all energy efficiency Demand Side Management Programs. This presents a number of challenges for utilities in the state, since on a prescriptive and component-based level it is difficult to develop technology offerings that are substantially higher energy savings over Title 24 to justify an incentive program. This systems level technology package provides a distinct advantage in this respect, as energy savings are greater at the system level.

The relevant prescriptive elements of California's Title 24 Energy Code are as follows for plug loads and lighting respectively.

Lighting and Lighting Controls

Scheduling, institutional tuning, occupancy based operation to be implemented in office areas. Requirement for daylight dimming depends on installed LPD and extent of lighting system modification.

Plug Loads

Circuit controls for 120-volt receptacles for office workstation equipment (PCs, local printers, task lighting), which incorporate the capability to implement on-off schedules. Plug-in power strips with occupancy based control do not qualify under the current Code.

Proposed Technology Packages Energy Savings

Where appropriate, system modifications that trigger Title 24 shall meet or exceed Title 24 Mandatory Requirements. However, it is clear that energy savings claimed to go forward to calculation of the incentive payment may be based on the existing building condition.

Energy savings arising from advanced lighting controls are expected to reach approximately 38%.[1] Implementing a task ambient strategy are generally expected to surpass this, with measured energy savings of between 30-60% depending on the baseline.

[1] http://eetd.lbl.gov/sites/all/files/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

Energy savings arising from load sensing (proxy occupancy control) and occupancy sensor control of power outlets is indicated as being between 10-23% of connected plug loads[2,3], but may be as high as 50%[4].

HVAC Impacts
In addition to the savings demonstrated within the plug loads and lighting systems, impacts on cooling energy reduction are also of interest. These interactive effects are less well studied in case studies and other technology reports.

3. Systems Performance Specification

a. Ambient (Overhead) Lighting and Lighting Controls

The overhead lighting retrofit should comprise <u>some or all</u> of the following elements:

1. Light fixtures
2. Lamps
3. Dimming ballasts or LED drivers
4. Panel and remote mounted load control relays and dimmers
5. Power supplies
6. Routers, controllers, processors and servers
7. Analog and digital input and output modules
8. Emergency lighting control

The primary objective is to control overhead lighting output by either a) lighting power density de-rating via lamp change-out or b) tuning existing lamps for a lower lumen output. This approach is consistent with a strategy known as task / ambient lighting, where background lighting is provided by ceiling mounting fixtures and task–specific lighting is provided on-demand by personal desktop lamps. Illuminance at the workplane should be based on current IESNA recommendations and user preferences. Primary control shall be in response to occupancy.

Additional specific requirements:

1. Light fixture (or luminaire) may be either in-ceiling or surface-mounted 'troffer' (available in various dimensions) or ceiling hung 'pendant' fixture
2. Lamps for use in retrofit projects should have a minimum rated lamp life of 68,000 hours[5]

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[2] http://www.gsa.gov/portal/mediaId/197383/fileName/GPG_Plug_Load_Control_09-2012.action - includes all common office equipment items, excluding kitchen area appliances.
[3] http://aceee.org/files/proceedings/2012/data/papers/0193-000277.pdf
[4] http://www.gsa.gov/portal/mediaId/197383/fileName/GPG_Plug_Load_Control_09-2012.action
[5] L_{70} (LED) or based on 12-hour start with instant start ballast (fluorescent)

3. Minimum initial delivered lumens will vary according to number of lamps, but a rough guide should be for 1' x 4' to provide 1500 initial lumens, and for 2' x 4' to provide 3000 initial lumens. 2' x 2' fixtures should provide 2000 initial lumens. The minimum Luminaire Efficacy Rating (LER) should be at least 110 lm/W.
4. Where drivers are installed or replaced, efficiency rating for driver technologies should be 0.83 (digital ballasts) and >80% (LED drivers)
5. For projects that incorporate dimming elements of lighting controls, related to institutional tuning, daylight dimming and demand response, electronic ballasts or LED drivers shall be capable of providing flicker-free dimming from 100% to 5%. Step dimming from 100% to at least one present level between 70% and 10% should be an available option TO support appropriate tuning according to site requirements / user preferences. There should be no phase-cut dimming. Communications protocols such as DALI, DMX/RDM, Zigbee and EnOcean are among the viable options
6. For systems with integrated lighting controls, this may comprise some or all of: occupancy sensors, photosensors (daylight dimming), lumen management and load shedding capability
7. Where implemented, all networked system sensors and controls shall be programmed to ensure minimal lamp cycling (and associated reduced lamp life and occupant distraction) and should be capable of easy recalibration to accommodate changes in environment/preferences. They should be calibrated to ensure that IES guidelines[6] are maintained. The control system should be capable of controlling multiple zones using the input from a single sensor, allowing separate adjustable settings for each control zone. The system should allow for variable target setpoints. The location and number of the photo sensors should be optimized by the control system supplier.

b. Occupancy-based Plug Load Control, including Task Lighting

Plug load control and occupancy-based task lighting shall comprise the following elements:

1. Block of controllable electrical sockets
2. Resettable circuit breaker
3. Power-on indicator light
4. Desktop LED task light

The primary objective is to control plug loads according to usage patterns defined by a) user / building operating schedules and / or b) occupancy at individual work locations. The objective is to minimize operating hours for office plug loads, particularly desktop equipment such as computers and monitors. Provision of task lighting powered via the smart outlet aims to meet task level illuminance requirements while allowing lower ambient lighting LPD.

Additional specific requirements:

1. The block of sockets should consist of at least two power outlets per block and assumes a minimum of two blocks for each location (therefore 4 outlets that can be controlled) – this will

[6] For example, for commercial offices, 30 footcandles on the workplane.

enable management of all common desk-based plug loads (computer / laptop, monitor, task light) The instructions for installation and operation should be intuitive and simple to understand – it should be possible for someone not previously familiar with the technology to make modifications to control settings.

2. Optional - Remote access and control may be provided for smart outlets via a web-based interface, and will allow programming of individual outlets according to user preferences, including, but limited to schedule.
3. Control options shall include one or more of the following:
    a. Schedule / timer
    b. Remote manual switch
    c. Remote occupancy sensor - this sensor could either be a) part of the smart outlet package or b) utilize occupancy signals from the appropriate sensor that is part of the overhead lighting controls package.
4. The LED task light should have a manual on-off switch

Note that the impact on HVAC systems operation will be estimated / measured, however, integration and optimization of HVAC performance with the system described above <u>is not</u> an objective for this project's system.

c. Technology Packages

The intent is to allow a range of different component technology options that meet the system features described above. The program incentives would be paid based on system performance rather than component performance or features. The technical requirements for each component are summarized below, followed by technology packages that will be selected for testing.

At least two packages are being considered, for review and feedback from the California POUs – a package that targets lower cost, minimally invasive installation, such as localized wireless or other stand-alone controls interventions, and another package that targets medium cost technologies that might be slightly more involved to install, but could unlock deeper energy savings, such as networked controls and feedback.

<u>Technology Package 1</u>

Package 1 provides a low cost option, focusing on stand-alone controls with non-automated means of feedback and savings persistence guidance.

<u>Technology Description</u>
Overhead (ambient) lighting will be a lamp replacement with reduced lighting power density and lower lumen output. Schedules and occupancy-based control of smart power outlets, with task lighting providing required light levels at the task area.

<u>Lighting and Lighting Controls System</u>
The functional performance requirement is for the overhead lighting system to provide ambient / background lighting so that overall lighting energy use is minimized.

Primary control mode shall be in response (in real time) to:

- Schedule only (12-hour operation, on-off)
- Zone-level occupancy control (where ballasts / controls are already in place)

Representative technologies meeting description:

1. Overhead lights – Luxul linear LED lamps with integrated driver
2. LED task lights – Prism TL Energy Star LED Task Light

Plug Load Controls System
The functional performance requirement is plug loads to be controlled at the workstation level so that workstation plug load energy use is minimized. Control shall be implemented via schedule or occupancy sensor control. No overrides at the occupant level are envisioned.

Primary control mode shall be in response (in real time) to:

1. Pre-programmed work schedules
2. Occupancy sensor control

All workstation level occupancy sensors shall be configured to reflect occupancy of workstation specific areas, and installed in a semi-permanent fashion (e.g. affixed to furniture system), to discourage relocation of sensor.

No secondary control inputs are envisioned.

Representative technology meeting description:

- Autani SmartLet controlled power outlet

Targeted Measurements
This technology package will not necessarily automate or trend the collection of controls data. However, measurements will be taken as a result of the package features, including:

- plug load use schedule
- plug load energy
- lighting circuit energy

Technology Package 2

This package provides a medium cost option, focusing on networked controls with automated means of feedback and savings persistence guidance.

Technology Description
Overhead (ambient) lighting will be a lamp or fixture replacement with reduced lighting power density and lower lumen output. Task lighting will supplement illuminance requirements in the work area. Schedules and occupancy-based control of smart power outlets for control of workstation-level equipment, including desktop task lighting.

Lighting and Lighting Controls System
The functional performance requirement is for the overhead lighting system to provide ambient / background lighting levels so that overall lighting energy use is minimized.

Primary control mode shall be in response (in real time) to one or a combination of:

- Schedule only (12-hour operation, on-off)
- Zone-level occupancy control
- Tuning to target ambient illuminance
- Daylight dimming in perimeter zones

Representative technologies meeting description:

- Overhead lights – Luxul linear LED replacement tubes (pendant) or Philips SpaceWise fixture, recessed.
- LED task lights - Prism TL Energy Star LED Task Light

Plug Load Controls System
The functional performance requirement is for occupancy sensors to control plug loads at the workstation level so that workstation plug load energy use is minimized. Control shall be implemented via workstation specific occupancy sensor connected to workstation level plug loads. Occupants may adjust timeout, occupancy sensor sensitivity and direction of sensor viewing angle. No overrides at the occupant level are envisioned.

Primary control mode shall be in response (in real time) to:

- Pre-programmed work schedules
- Workstation level occupancy sensing

No secondary control inputs are envisioned. All workstation level occupancy sensors shall be configured to reflect occupancy of workstation specific areas, and installed in a semi-permanent fashion (e.g. affixed to furniture system), to discourage relocation of sensor.

Representative technology meeting description:

- Telkonet EcoGuard Energy Management Outlet

Targeted Measurements
This technology package will not necessarily automate or trend the collection of controls data. However, measurements will be taken as a result of the package features, including:

- Workstation occupancy
- Plug load use schedule
- Plug load energy
- Lighting circuit energy

4. Candidate Site Requirements

- Standard set of commercial office equipment of 1990's/00's era, e.g. laptops, desktop computers, flat screen monitors, etc.
- 9-10ft floor-to-ceiling height with dropped ceiling/plenum
- Existing overhead lighting system with T8 or T5 light fixtures, either lay-in or pendant hung
- Overhead lighting system zone covers the same area as the workstations incorporating task lighting and plug load controls (i.e. the existing lighting controls don't impact adjacent spaces such as conference rooms)
- Existing switch based or networked lighting controls, without daylight dimming
- Network access to workstations for occupant level feedback software or network access to a common display for workstation area feedback
- Average daily occupancy a minimum of 8 hours a day, 5 days a week

5. References

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