2008 Title 24 Non Residential CASE Proposal

Demand Response Controls for Indoor Lighting

Integrated Lighting Concepts
In support of

PG&E Codes & Standards Program
Proposal Scope

- Require Automated Demand Responsive Lighting Controls
- Target Selected Nonresidential Spaces Over 100,000 SQ. FT.
- Provide both Voluntary (economic) and Mandatory Curtailment Scenarios
  - Economic scenario – 4 hour curtailment during ten highest valued days PV$250/kW
  - Mandatory curtailment – 2.5 h/yr
  - Economic + Mandatory - PV$661/kW
Focus & Highlights

- **Primary Objective** – Turn Off Non Essential Lighting Loads to Avoid Blackouts

- **Secondary Objective** – Reduce selective lighting loads for Economic Reward and Reduce Strain on Power Grid

- **Two Approaches to Compliance**
  - Low Cost Bare Bones ON/OFF Control (*non-uniform*)
  - Costlier Comprehensive Control (*uniform*)
Benefits

- **Energy Benefits**
  - LPD Curtailment to Avoid BLACK-OUTS
  - Uniform System Contains Night Adaptive Potential

- **Non-energy Benefits**
  - Cost Avoidance/Savings for Users & Utilities
  - Minimize Potential Damages/Losses associated with a BLACK-OUT
Proposed Approaches and Costs for Demand Response in Spaces w/EMS

- **Bare Bones Control** *(non-uniform)*
  - Basic ON/OF Switching
  - Low Cost Implementation $0.05 to $0.10 Square Foot
  - Temporary Loss In Lighting Quality
  - Comprehensive Controls Not Required

- **Comprehensive Control** *(uniform)*
  - Multi Level Switching, Stepped Illumination, Etc.
  - Higher Cost Implementation $0.20 to $0.25 Square Foot
  - Minimal Loss In Lighting Quality
  - Requires Multi Level Control Prerequisite
Costs and Approach to Demand Response in Spaces without EMS

- **Spaces without Energy Management System**
  - Smaller spaces
  - Offices with occupancy sensor rather than time sweep
  - Warehouse with no bi-level control

- **Bare Bones Control** *(non-uniform)*
  - Same as previous slide
  - Low Cost Implementation $0.20 to $0.25 Square Foot

- **Comprehensive Control** *(uniform)*
  - Same as previous slide
  - Higher Cost Implementation $1.00 to $1.25 Square Foot
Building Types – Partial List

Retail Spaces
- Grocery/Markets
- Electronics & Sports
- Big Box & Discount
- Super Centers
- Drug & Convenience
- Medium Retail
- High End Retail

Office Spaces
- Large Office Complex
- Small Office Suite
- Government Buildings

Hospitality
- Hotel/Motel
- Movie Theaters
- Resorts & Entertainment
- Conference Centers

Utility Spaces
- Warehouse
- Sales & Services
## Potential Load Shed

### Building Types – 100,000 Sq. Ft.

<table>
<thead>
<tr>
<th>Type</th>
<th>Load</th>
<th>DR (non uniform)</th>
<th>DR (uniform)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse</td>
<td>60 KW</td>
<td>1.8 KW (03%)</td>
<td>3.0 KW (05%)</td>
</tr>
<tr>
<td>Large Office</td>
<td>110 KW</td>
<td>15.5 KW (15%)</td>
<td>22.0 KW (20%)</td>
</tr>
<tr>
<td>Big Box A</td>
<td>170 KW</td>
<td>5.1 KW (03%)</td>
<td>8.5 KW (05%)</td>
</tr>
<tr>
<td>Big Box B</td>
<td>170 KW</td>
<td>25.5 KW (15%)</td>
<td>34.0 KW (20%)</td>
</tr>
<tr>
<td>Anchor Store</td>
<td>170 KW</td>
<td>34.0 KW (20%)</td>
<td>42.5 KW (25%)</td>
</tr>
</tbody>
</table>
## Potential Load Shed
### Building Types – 25,000 Sq. Ft.

<table>
<thead>
<tr>
<th>Type</th>
<th>Load</th>
<th>DR (non uniform)</th>
<th>DR (uniform)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Office</td>
<td>5.1 KW</td>
<td>0.77 KW (15%)</td>
<td>1.2 KW (20%)</td>
</tr>
<tr>
<td>(5000 Feet)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug &amp; Service</td>
<td>42.5 KW</td>
<td>4.25 KW (10%)</td>
<td>8.5 KW (20%)</td>
</tr>
<tr>
<td>Medium Retail</td>
<td>50.0 KW</td>
<td>7.5 KW (15%)</td>
<td>12.5 KW (25%)</td>
</tr>
<tr>
<td>High End Retail</td>
<td>55.0 KW</td>
<td>11.0 KW (20%)</td>
<td>16.5 KW (30%)</td>
</tr>
</tbody>
</table>
Economic & Societal Values of Demand Response Participation

- Economic Value PV$/kW = $250.00
- Emergency Value PV$/kW = $366.00
- Combined Emergency & Economic Value PV$/kW = $616.00
Big Box Retail A & B
Prototype Lighting Layout – 100,000 Sq. Ft.

48 Circuits all on – No DR or Day Light

Lighting Criteria & Specifications
- 75 FC (maintained ave. target)
- 400-400W Metal Halide Luminaires
  (425W per luminaire – electronic ballast – 277V)
- Lighting Power: 170,000W (170 KW)
- Total Lighting Load on 48 Circuits
  (8-9 fixtures per circuit)

Demand Response Performance
- Demand Response: 0
- Maintained Light Level: 75 FC
- KW Curtailed: 0
- Maintained Uniformity: NA
- Implementation Cost: $0.00
- B/C Ratios: NA
Big Box - B \textit{(no daylight)}

Non Uniform Demand Response Control

Lighting Criteria & Specifications
- 75 FC \textit{(maintained ave. target)}
- 400-400W Metal Halide Luminaires
  \textit{(425W per luminaire – electronic ballast – 277V)}
- Lighting Power: 170,000W \textit{(170 KW)}
- Total Lighting Load on 48 Circuits
  \textit{(8-9 fixtures per circuit)}

Demand Response Performance
- Demand Response: 15%
- Maintained Light Level: 64 FC
- KW Curtailed: 25.5
- Maintained Uniformity: Potential Poor
- Implementation Cost: $5,000.00
- Economic B/C Ratio: \textbf{1.28}
- Combined B/C Ratio: \textbf{3.14}

48 Circuits with 7 Off – DR
Big Box – A *(Day lit)*

Non Uniform Demand Response Control

Lighting Criteria & Specifications
- 75 FC *(maintained ave. target)*
- 400-400W Metal Halide Luminaires *(425W per luminaire – electronic ballast – 277V)*
- Lighting Power: 170,000W *(170 KW)*
- Total Lighting Load on 48 Circuits *(8-9 fixtures per circuit)*

Demand Response Performance
- Demand Response: 3%
- Maintained Light Level: 64 FC
- KW Curtailed: 5.1
- Maintained Uniformity: Potential Poor
- Implementation Cost: $5,000.00
- Economic B/C Ratio: 0.26
- Combined B/C Ratio: 0.63

Note: Most general lighting already turned off during hot summer afternoons
Big Box - B Retail *(no daylight)*

**Uniform Demand Response Control**

**Lighting Criteria & Specifications**
- 75 FC *(maintained ave. target)*
- 400-400W Metal Halide Luminaires *(425W per luminaire – electronic ballast – 277V)*
- Lighting Power: 170,000W *(170 KW)*
- Total Lighting Load on 48 Circuits *(8-9 fixtures per circuit)*

**Demand Response Performance**
- Demand Response: 20%
- Maintained Light Level: 60 FC
- KW Curtailed: 34.0
- Maintained Uniformity: Very Good
- Implementation Cost: $20,000.00
- Economic B/C Ratio: **0.43**
- Combined B/C Ratio: **1.05**

**Note:** Uniform control design also suited to night-time adaptive lighting scheme
BIG BOX RETAIL-B
Control Potential: Non-Uniform & Uniform

Non-Uniform:
15% lights OFF

Uniform:
76% lights at 66% = 20%+
Medium Retail
Prototype Lighting Layout – 25,000 Sq. Ft.

Lighting Criteria & Specifications
- 45 FC (maintained ave. general lighting)
- 150 FC – 175 FC (accent & display)
- 58W Fluorescent & 60W Halogen/IR
- Lighting Power: 50,000W (50 KW)
- Total Lighting Load on 31 Circuits (30-32 fixtures per circuit)

Demand Response Performance
- Demand Response: 0
- Maintained Light Level: 80 FC
- KW Curtailed: 0
- Maintained Uniformity: NA
- Implementation Cost: $0.00
- B/C Ratios: NA
Medium Retail
Non Uniform Demand Response Control

Lighting Criteria & Specifications
- 45 FC (maintained ave. general lighting)
- 150 FC – 175 FC (accent & display)
- 58W Fluorescent & 60W Halogen/IR
- Lighting Power: 50,000W (50 KW)
- Total Lighting Load on 31 Circuits
  (30-32 fixtures per circuit)

Demand Response Performance
- Demand Response: 15%
- Maintained Light Level: 68 FC
- KW Curtailed: 7.5
- Maintained Uniformity: Potential Poor
- Implementation Cost: $2,500.00
- Economic B/C Ratio: 0.75
- Combined B/C Ratio: 1.85
Medium Retail
Uniform Demand Response Control

Lighting Criteria & Specifications
- 45 FC (maintained ave. general lighting)
- 150 FC – 175 FC (accent & display)
- 58W Fluorescent & 60W Halogen/IR
- Lighting Power: 50,000W (50 KW)
- Total Lighting Load on 31 Circuits (30-32 fixtures per circuit)

Demand Response Performance
- Demand Response: 25%
- Maintained Light Level: 60 FC
- KW Curtained: 12.5
- Maintained Uniformity: Excellent
- Implementation Cost: $5,000.00
- Economic B/C Ratio: 0.50
- Combined B/C Ratio: 1.23
MEDIUM RETAIL
Control Potential: Non-Uniform & Uniform

Non-Uniform
15% lights OFF

Uniform
Selected lights off, others with step illumination = 25%+

STEPPED OFF STEPPED OFF
Proposed Code Language

SECTION 101 – DEFINITIONS AND RULES OF CONSTRUCTION

- **DEMAND RESPONSE PERIOD** is a period of time during which the local utility is curtailing electricity loads by sending out a demand response signal.

- **DEMAND RESPONSE SIGNAL** is an electronic signal sent out by the local utility indicating a request to their customers to curtail electricity consumption.

- **DEMAND RESPONSIVE LIGHTING CONTROL** is a control that reduces lighting power consumption in response to a demand response signal.
Proposed Code Language

SECTION 131 – INDOOR LIGHTING CONTROLS THAT SHALL BE INSTALLED

- **(f) Demand responsive lighting controls.** If a retail building has a floor area greater than 100,000 sf and is provided a demand response signal by the local utility, demand responsive lighting controls shall be installed that reduces lighting power consumption by 15% while enabling occupied space activities albeit at lower illumination levels.

- **Exception to 131(f):** Buildings where more than 50% of the lighting power is controlled by daylighting controls.
Acknowledgements

Sponsored by California Ratepayers through Codes & Standards programs at:

- **Pacific Gas & Electric Company**
  - Steve Blanc  SLB4@pge.com

- **Project management by Heschong Mahone Group**
  - Jon McHugh  mchugh@h-m-g.com