C&I LIGHTING IN MASSACHUSETTS

Changes to the Linear Market

October 16, 2019
C&I LIGHTING – TECHNOLOGIES

- LED Screw-in lamps
- LED Tubular Linear Lamp (TLED) 4’ and 2’
- U Tube TLED
- LED Linear Fixtures 1’ x 4’, 2’ x 2’, 2’ x 4’
C&I LIGHTING – PRIOR PLAN

► Evaluated Lifetime Savings from 2016 – 2018 Plan

- C&I Electric Savings 2016 - 2018: 60%
- All Program (R, CI, LI) Electric Savings 2016 - 2018: 40%
C&I LIGHTING – CURRENT PLAN

► Planned Lifetime Savings for 2019 – 2021 plan period

Planned C&I Electric Savings 2019 - 2021

All Planned (R, CI, LI) Electric Savings 2019 - 2021

49%

42%
LIGHTING VS. OTHER END USES
STATE OF C&I LIGHTING MARKET

Linear lighting is majority of C&I interior lighting

Screw-in & mogul base lamps

Distribution of lamps by type – interior lighting (MA Commercial Lighting)

DNV GL MA C&I Comprehensive Lighting Inventory 2018
2018: Linear at 26%, Non-linear saturated at 73% LED

**STATE OF C&I LIGHTING MARKET**

DNV GL MA C&I Comprehensive Lighting Inventory (2018)
## LINEAR LIGHTING – CUSTOMER VIEW

<table>
<thead>
<tr>
<th></th>
<th>Market Price</th>
<th>Current Incentive</th>
<th>Customer Cost</th>
<th>Annual $ Savings</th>
<th>Simple Payback (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLED*</td>
<td>$16.25</td>
<td>$7.50</td>
<td>$8.75</td>
<td>$23.13</td>
<td>0.38</td>
</tr>
<tr>
<td>LED Fixture</td>
<td>$55.00</td>
<td>$32.00</td>
<td>$23.00</td>
<td>$35.15</td>
<td>0.65</td>
</tr>
<tr>
<td>LED Fixture w/ Controls</td>
<td>$125.00</td>
<td>$80.00</td>
<td>$45.00</td>
<td>$40.40</td>
<td>1.11</td>
</tr>
</tbody>
</table>

*Sources: Navigant LED Lighting Price Survey; 2019 Upstream Lighting Incentives; EIA MA C&I Electric Rate x MA/RI upstream savings per unit *Average 2.5 lamps per fixture used for TLEDs based on U.S. DOE Lighting Market Characterization (2017)*
LINEAR LIGHTING TECHNOLOGIES

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prismatic Lens: This was the original troffer design. It utilizes a flat lens and is required in clean rooms, food processing areas, and some healthcare applications.</td>
</tr>
<tr>
<td>Parabolic Louvers: The vast majority of troffers in offices are parabolic louvers. The louvers act to reduce glare from fluorescent lamps. When TLEDs are installed, there might be more glare because of differences between the light distribution of the TLEDs and fluorescent lamps.</td>
</tr>
<tr>
<td>Volumetric: These are lensed troffers where the lenses contour around the fluorescent lamps. The term volumetric was coined because these troffers light high on the wall, making the space feel brighter while managing potential glare.</td>
</tr>
<tr>
<td>High Performance: These are next-generation volumetric troffers. The optical system has been maximized for light output while the distribution has been optimized to properly light the space.</td>
</tr>
</tbody>
</table>

**U.S. Department of Energy: LED Retrofit Lighting and Controls Best Practices**

www.ma-eeac.org
LIGHTING CONTROLS OPPORTUNITIES

**Occupancy Sensors**

**Daylight harvesting**

**Task tuning/high-end trim**

**Manual Dimming**
LIGHTING CONTROLS OPPORTUNITIES

Representative Weekday Power Consumption for Pre-Retrofit Baseline and Six Post-Retrofit Lighting Controls Strategies

Baseline
HID
LED
LED w/ occupancy & daylight controls

PG&E Emerging Technologies Program
DesignLights Consortium: Savings Potential from Networked Lighting Controls
BENEFITS TO CUSTOMERS

Net Present Value (NPV) to Customer

- TLED*: $177
- LED Fixture: $253
- LED Fixture w/ Controls: $258
• Asset, manufacturing tracking capabilities
• Security
• HVAC control
• Demand response

OSRAM EINSTONE Track & Trace Solution deployed in a hospital
DesignLights Consortium: Energy Savings Potential of DLC Commercial Lighting and Networked Lighting Controls
OPPORTUNITY COSTS

Saturation of linear LED market predicted to go from 29% to 69% during current three-year plan

_DNV GL: Massachusetts C&I Linear Lighting Market Forecast_
OPPORTUNITY COSTS

Linear LEDs end of 2018

Linear LEDs end of 2021
OPPORTUNITY COSTS OF NO CONTROLS

- Fixtures with controls avoid stranded savings
- Measure mixture for 2018 and 2019 is unknown
Annual stranded savings potential of 1.5M MWh = Annual generation of Kendall Square Station

Kendall Square Station – Cambridge, MA
SMALL BUSINESS/TURNKEY PATHWAY

Current plan shows minimal lighting control savings (<1%) from small business direct install program

![Chart showing planned lighting savings 2019-2021]

- 2019: 0.34%
- 2020: 0.44%
- 2021: 0.59%
“Performance Lighting” offers tiered incentives based on Lighting Power Density.

TA available from lighting design professionals balancing performance with human needs of each project.

Currently small part of lighting portfolio; room to grow.

### TIER 1 - PERFORMANCE LIGHTING:

<table>
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<tr>
<th>Area Category</th>
<th>Incentive $ above 10% minimum reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior or Exterior (watts per sq.ft. or linear ft.)</td>
<td>$2.00 per watt saved</td>
</tr>
</tbody>
</table>

### TIER 2 - PERFORMANCE LIGHTING (Tier 1) with Smart LED Interior Fixtures with Integral Controls:

<table>
<thead>
<tr>
<th>Area Category</th>
<th>Incentive $ above 10% minimum reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior or Exterior (watts per sq.ft. or linear ft.)</td>
<td>$3.00 per watt saved</td>
</tr>
</tbody>
</table>

### TIER 3 - PERFORMANCE LIGHTING (Tier 1) with a Networked Lighting Control System:

<table>
<thead>
<tr>
<th>Area Category</th>
<th>Incentive $ above 10% minimum reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior or Exterior (watts per sq.ft. or linear ft.)</td>
<td>$4.00 per watt saved</td>
</tr>
</tbody>
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UPSTREAM PATHWAY

► Upstream most representative of the market uninfluenced
► No direct customer interactions
► High standards for qualifying products are essential
  - Lag between standard improvements and stocking patterns

DRAFT 2: DLC SSL Technical Requirements Version 5.0
Released for comment September 30, 2019

<table>
<thead>
<tr>
<th>Category</th>
<th>General Application</th>
<th>Minimum Light Output (lm)</th>
<th>Minimum Efficacy (lm/W)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DLC Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V4.4</td>
</tr>
<tr>
<td>Linear Replacement Lamps</td>
<td>2’ T8 Lamps</td>
<td>Bare lamp: 800</td>
<td>Bare lamp: 110</td>
</tr>
<tr>
<td></td>
<td>3’ T8 Lamps</td>
<td>Bare lamp: 1,200</td>
<td>Bare lamp: 110</td>
</tr>
<tr>
<td></td>
<td>4’ T8 Lamps</td>
<td>Bare lamp: 1,600</td>
<td>Bare lamp: 110</td>
</tr>
<tr>
<td></td>
<td>4’ T5 Lamps</td>
<td>Bare lamp: 1,600</td>
<td>Bare lamp: 110</td>
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<td>4’ T5HO Lamps</td>
<td>Bare lamp: 3,200</td>
<td>Bare lamp: 110</td>
</tr>
<tr>
<td></td>
<td>8’ T8 Lamps</td>
<td>Bare lamp: 3,200</td>
<td>Bare lamp: 110</td>
</tr>
<tr>
<td></td>
<td>U-Bend Lamps</td>
<td>Bare lamp: 1,400</td>
<td>Bare lamp: 110</td>
</tr>
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RECOMMENDATIONS & CONCLUSIONS

► New Approaches – Lighting as a Service, better integration with demand response, emphasize other benefits

► Program Improvements – Adjust incentives, pre-approval limits, or DLC requirements to push for more efficient options

► Monitor program performance on an ongoing real time basis for success in installing controls, especially Upstream and Turnkey (KPI #4)

► Consider working with evaluation consultants and DPU to change the fixed Net to Gross and Realization Rates for fixtures with controls

► Consider changing the prescribed controls savings of 30% for upstream to match the building specific DLC findings
THANK YOU!