Another Great Outcome

Ranked

No. 1

9th Year in a row

In energy efficiency

#EEscorecard

ACEEE
American Council for an Energy-Efficient Economy
Agenda

▪ C&I Implementation
  ▪ Savings Pathways
  ▪ Engagement Approaches
  ▪ Cross-offering Linkages
  ▪ C&I Portfolio Background
  ▪ 2019 YTD CHP Update

▪ HVAC and Controls
  ▪ Types, Customer Experiences, & PA Support

▪ Lighting and Controls
  ▪ Types, Customer Experiences, & PA Support
C&I Implementation
Savings Pathways

C&I NEW BUILDINGS & MAJOR RENOVATIONS

Whole Buildings Approach

- BUILDINGS 20,000 - 100,000 sq ft
- Developer, Design team, and BA connect early on a project
- Charette with design team and customer to understand customer goals
- Technical assistance vendor models baseline and as designed
- Construct building
- Commission building

Systems Approach

- BUILDINGS 100,000+ sq ft
- Customer uses vendor of their choice
- New construction or major renovation project
- Customer applies for incentive payment
- Savings and project documentation submitted to program administrators for incentive payment

C&I EXISTING BUILDINGS

Existing Building Retrofit

- Customer considering retrofitting facility and/or pursuing energy savings
- Customer offered varied financial incentives and resources
- Turnkey Delivery Path for small business customers

New and Replacement Equipment

- Customer replacing or expanding facility equipment
- P&I provide incentives directly to distributors and manufacturers
- Customer utilizes Mass Save Application Portal (MAP) to apply for incentives

C&I Active Demand Reduction

- Customers may use any technology or strategy at their disposal
- Customers agree to respond to an event call targeting conditions that typically result in system peak
- Event called the day before curtailment is needed
- Customer incentivized based on the performance of their curtailment

Customer Engagement Approaches

Internal PA staff
- Account/sales representatives, program managers, technical staff
- MOU/MOAs & SEMP

PA Vendors
- Turnkey Vendors
- Upstream/Point of Sale

Implementation contractors/project coordinators
- Segment specific approaches

Marketing campaigns
- Print, electronic, Main Streets, Community outreach

Trade Allies & Market Actors

Direct PA Influence & Control
PA Influence Only
The PAs use various Customer Engagement approaches to drive customers into savings pathways

Distribution of Accounts & Usage

<table>
<thead>
<tr>
<th>Approach</th>
<th>Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Contractors –</td>
<td>Typically Prescriptive, sometime Custom</td>
</tr>
<tr>
<td>working with customers</td>
<td>(NRE + EB)</td>
</tr>
<tr>
<td>Point of Sale – through</td>
<td>Prescriptive (NRE)</td>
</tr>
<tr>
<td>distributors</td>
<td></td>
</tr>
<tr>
<td>Turnkey/CDO</td>
<td>Typically Prescriptive, sometime Custom</td>
</tr>
<tr>
<td>Implementation Vendors –</td>
<td>(NRE + EB + NC)</td>
</tr>
<tr>
<td>Segment Specific Approaches</td>
<td></td>
</tr>
<tr>
<td>Internal Staff</td>
<td>Typically Prescriptive and Custom</td>
</tr>
<tr>
<td></td>
<td>(NRE + EB + NC)</td>
</tr>
</tbody>
</table>

CDO: Customer Directed Option; EB: Existing Building Retrofit; NC: New Construction & Major Renovation; NRE: New & Replacement Equipment
Options for ALL Customer Choices

- **Turnkey/CDO (EB + NRE)**
- **Custom Applications (NC + EB + NRE)**
- **Prescriptive Applications (EB + NRE)**
- **Point of Sale (NRE)**
- **Performance Lighting**

CDO: Customer Directed Option; EB: Existing Building Retrofit; NC: New Construction & Major Renovation; NRE: New & Replacement Equipment
Typical Project Progression – With PA Influence & Education

Marketing/Awareness → Scoping → Project Proposal → Customer Decision → Construction/Implementation → Post-Insp. & Comm. → Incentive Pad & Savings Claimed

- PAs build awareness through multiple pathways
- PAs provide expertise through – staff, TAs, Vendors, & more
- PAs provide influence through estimated financial incentives and assurance/trust in savings estimates
- PAs follow project implementation
- PAs provide assurance & project incentive payment
There is NO one-size fits all offering

- Retrofit existing facilities + New Equipment + Equipment Optimization to customers on the EE continuum
- EE + ADR = EE is seeding technology in customer’s facilities that can then be controlled for ADR if customer is motivated
- Turnkey + Point of Sale = addressing near-term and longer-term customer needs
- New Buildings + Equipment Optimization deliver well built and performing new buildings for years to come
- EE + ADR and beyond – connections to customers developed through EE can support other customer decisions – EV Charging & Other Energy solutions

How do we know?
Because Participation Through Multiple Pathways Has Increased

**Finding 7.1.8:** Small and medium-sized electric accounts have demonstrated improved performance metrics since 2013 through increased depth of savings or increased participation.

**Finding 7.1.9:** Small gas accounts have realized increased depth of savings, while the performance metrics for medium-sized gas accounts have remained steady.

Source: 2017 Customer Profile Study
And Multiple Pathways Has Meant More Efficient Equipment Gets into Customer’s Facilities Quicker

**Finding 7.1.4:** The upstream pathway was effective for providing commodity-style HVAC measures, such as unitary systems.

**Finding 7.1.5:** We are seeing increases from smaller gas customers, largely via the upstream delivery pathway.

*Source: 2017 Customer Profile Study*
C&I Portfolio
Background
Electric Savings by End-Use

- Lighting
- CHP
- HVAC
- Motors & drives
- Process
- Refrigeration
- Envelope
- Compressed air
- Custom measures
- Food service
- Hot water
- Behavior
Electric Savings by Current Program/Initiative (retrospective)
Electric Savings by Pathway and End Use

**Custom**
(% of 2016-18 Net LtMWh)

- Lighting
- CHP
- HVAC
- Process
- Refrigeration
- Envelope
- Motors & drives
- Custom measures
- Compressed air
- Hot water
- Behavior

**Prescriptive**
(% of 2016-18 Net LtMWh)

- Lighting
- Motors & drives
- HVAC
- Compressed air
- Refrigeration
- Envelope

**Turnkey**
(% of 2016-18 Net LtMWh)

- Lighting
- Refrigeration
- HVAC
- Process
- Motors & drives
- Custom measures
- Hot water
- Compressed air

**Point of sale**
(% of 2016-18 Net LtMWh)

- Lighting
- HVAC
- Food service
Gas Savings by End Use

Net LtMMBtu

HVAC  Process  Hot Water  Envelope  Custom Measures  Food Service  Behavior

2016  2017  2018  2019

Actual  2019 Estimate from Plan
Gas Savings by Current Program/Initiative (retrospective)

- **Actual**
- **2019 Estimate from Plan**

<table>
<thead>
<tr>
<th>Year</th>
<th>EBR</th>
<th>NRE</th>
<th>NB&amp;MR</th>
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</thead>
<tbody>
<tr>
<td>2016</td>
<td>8,000,000</td>
<td>2,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>2017</td>
<td>8,000,000</td>
<td>2,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>2018</td>
<td>8,000,000</td>
<td>2,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>2019</td>
<td>12,000,000</td>
<td>4,000,000</td>
<td>6,000,000</td>
</tr>
</tbody>
</table>
Gas Savings by Pathway

- 72% Custom
- 13% Prescriptive
- 12% Turnkey
- 3% Point of sale

2016-2018: Using NLTmBTU
Gas Savings by Pathway and End Use

- **Custom** (% of 2016-18 Net LtMMBtu)
  - HVAC
  - Process
  - Envelope
  - Custom Measures
  - Hot Water
  - Food Service
  - Behavior

- **Prescriptive** (% of 2016-18 Net LtMMBtu)
  - HVAC
  - Hot Water
  - Envelope
  - Food Service

- **Turnkey** (% of 2016-18 Net LtMMBtu)
  - Hot Water
  - Envelope
  - HVAC
  - Custom Measures
  - Process

- **Point of sale**
  - Hot Water
  - Food Service
## 3 Year Plan Focus

### Strategic Enhancements and Innovations

#### Pivoting to the Future
- Enhanced Technical Assistance and Design Support for Whole Building New Construction
- New Passive House Offer and Market Development Strategy
- Addition of an Active Demand Reduction Initiative
- Investigating and Testing New Approaches to Whole-Building Projects
- Expanded Support for the Development of Enhanced Energy Codes and Product Standards at the State and National levels.
- Expanded Advanced Systems Training for HVAC and Lighting controls.

#### Serving All Customers
- Small Business Enhancements
- Expanding Upstream Offerings
- Customized Services to Franchise Businesses
- Expanded Resource Offer within the Industrial and Process Segment-targeted approach
- Expedited Paths to HVAC Optimization including Operations & Maintenance (“O&M”) Savings and Retro-Commissioning (“RCx”)
- Testing Strategic Energy Management Cohort Approach

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**Implementation of Mass Save Application Portal (“MAP”)**

Increased leveraging of training and workforce development to transition to an era of integration of energy efficiency strategies, smart technologies and energy using equipment.
Takeaways

- Lighting remains a substantial portion of the C&I portfolio while the measure mix changes overtime
  - Reducing Screw-Ins through Upstream
  - Balancing of incentives towards lighting with controls while still meeting customer needs
- HVAC is much more than just equipment replacement for electric and gas portfolios
- Meet customers where they are and promote the best solutions to support their goals
## Completed CHP Projects YTD and 2019 Pipeline

### Category Definitions

- **Under Construction:** Customer has started work on the project (e.g., equipment has been ordered, contracts with engineers have been executed, etc.) – values weighted by probability of completion

- **Completed/Paid:** The project has been installed and at least some incentives have been paid through Q3 2019

### Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>MW</th>
<th>MWh (annual)</th>
<th>MWh (lifetime)</th>
<th>Incentives</th>
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</thead>
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<tr>
<td>Under Construction for 2019 completion</td>
<td>15</td>
<td>8.6</td>
<td>56,411</td>
<td>1,008,486</td>
<td>$8,670,955</td>
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<tr>
<td>Completed/Paid thru Q3 2019</td>
<td>6</td>
<td>1.2</td>
<td>5,101</td>
<td>106,026</td>
<td>$559,408</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>21</td>
<td>9.8</td>
<td>61,512</td>
<td>1,114,512</td>
<td>$9,230,363</td>
</tr>
<tr>
<td>3 Yr Plan Commitment - Statewide</td>
<td>-</td>
<td>51.7</td>
<td>407,127</td>
<td>8,119,428</td>
<td>$45,838,667</td>
</tr>
<tr>
<td>Completed/Paid thru Q3 2019</td>
<td>n/a</td>
<td>19%</td>
<td>15%</td>
<td>14%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Discussion & Q&A - #1
HVAC & Controls
What is HVAC?

HVAC = Heating, Ventilation and Air Conditioning
Anatomy of HVAC

- Small Business
  - Wifi Thermostat, Timer, Occupancy Sensors
- Large C&I
  - Building Management System

- HVAC
  - Heat Pumps, Boilers, RTUs
  - RTU, AHU, CRAC, Chiller/Cooling Towers
It can get complicated...
Just about any business type where workers are present will have a form of an HVAC system of varying size and sophistication.

Segment and size characteristics of comprehensive opportunities – larger, single site locations with central controls (Property Management, University, Hospital, etc.)

One-off equipment, commodity style – prescriptive or upstream approaches (all segments)

Example familiar equipment & measures include Chillers, Boilers, and associated distribution systems.
EE Opportunities for HVAC

- Asset Improvement
  - Equipment Retrofit
  - Equipment Replacement

- System Optimization
  - New Controls
  - Tuning Controls
  - Smart Modulation
Pathways - Comprehensive Custom HVAC

- **Characteristics/Often**
  - High touch customer engagement
  - Leverages technical resources
  - Involves multi-measure or system-wide approach to end uses
  - Can have high savings relative to touch-point
  - **Takes a long time!** Which can lead to potential for unrelated derailment issues to arise…
Pathways – ESPO for HVAC

**SIMPLE, SINGLE MEASURES**

- Low Cost Tuning Measures
  - Cond. Water Reset
  - Chilled Water Reset
  - Clean Cond. Coils
  - Reduce Defrost

**EXPEDITED PATH**

**RESOURCES TAILORED TO SITE OPPORTUNITY AND NEED**

**TARGETED INCENTIVES**

- Prescriptive Incentives

**CUSTOM INVESTIGATION AND IMPLEMENTATION INCENTIVES**

- Custom Invention and Implementation

**COMPREHENSIVE TUNING – SINGLE SYSTEMS or HOLISTIC**

- Targeted Systems Tuning
  - Chiller Plants
  - Refrigeration

- Whole Building & Process Tuning
  - All Building Systems
  - All Plant Processes
## Pathways - Prescriptive Downstream

### Pathways Snapshot

### Variable Speed Drives - Retrofit

<table>
<thead>
<tr>
<th>Eligible Types</th>
<th>Per Unit Incentives by Horsepower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HP Size</td>
</tr>
<tr>
<td>Boiler Draft Fan</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Boiler Feed Water Pump</td>
<td>5 to 7.5</td>
</tr>
<tr>
<td>Building Exhaust Fan</td>
<td>10</td>
</tr>
</tbody>
</table>

### Cooling

- **Chiller, Air Cooled with Condenser**
  - Less than 150 Tons: $23 per Ton plus $1.40 per 0.1 EER above Base
  - 150 Tons or Greater: $20 per Ton plus $1.40 per 0.1 EER above Base

### Heating

- **Gas Condensing Boiler**
  - Up to 300 MBH, 90% AFUE or greater: $1,000
  - Up to 300 MBH, 95% AFUE or greater: $1,500
  - 301 to 499 MBH, 90% Thermal Efficiency or greater: $2,000
  - 500 to 999 MBH, 90% Thermal Efficiency or greater: $4,000
### Pathways - Upstream for HVAC

#### Air-Cooled Air Conditioning and Heat Pump Systems

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Unit Type</th>
<th>Tier</th>
<th>Size Category¹</th>
<th>Sub Category</th>
<th>Full Load Cooling Efficiency</th>
<th>Seasonal/Part Load Cooling Efficiency</th>
<th>Heating Efficiency²</th>
</tr>
</thead>
</table>
| Water-Cooled Air Conditioning and Heat Pump Systems
| Equipment Type | Unit Type | Tier | Size Category¹ | Sub Category | Full Load Cooling | Seasonal/Part Load Cooling | Heating Efficiency² |
| Ductless Mini and Multi Split Systems
| VRF Systems
| Equipment Type | Unit Type | Tier | Size Category¹ | Sub Category | Full Load Cooling Efficiency | Seasonal/Part Load Cooling Efficiency | Heating Efficiency² |
| Dual Enthalpy Economizer Controls (when installed with new qualifying equipment)
| Equipment | Outside Air Economizer utilizing 2 enthalpy sensors

### Electronically Commutated Motor (ECM) Circulator Pumps for hydronic heating or service hot water installations

<table>
<thead>
<tr>
<th>Commercial Pump Size</th>
<th>Customer Discount ($/Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1/6 HP</td>
<td>$100.00</td>
</tr>
<tr>
<td>&gt; 1/6 HP and ≤ 3/4 HP</td>
<td>$100.00</td>
</tr>
</tbody>
</table>
New, Cross-cutting Trends in HVAC-Energy Optimization (EO), Heat Pumps

- 2018 amendment to GCA allowed for electric programs to look beyond electric measures - delivered fuels & strategic electrification
- Optimize energy use without focus fuel type
Energy Optimization – Using Heat Pumps to Displace Fossil-Heating Update

- Actively working with MassCEC leveraging longstanding program development and market knowledge
- Customer targeting - PAs worked to ID delivered fuel customers, trend -> Small Buildings without gas availability
- Pathway development underway – Upstream and Custom Express/Prescriptive Tools & Incentives
  - Existing Non-Displacement Approach – Upstream HVAC – Central Air, Mini Splits, & VRF
  - Existing Displacement Approach – Project-specific custom analysis
  - In development – Simple System & Complex System calculator tools, incentive schema, prescriptive rebates and potentially other pathways
- Deepening relationships and knowledge of niche market including manufacturers & installer community
- Increasing targeted marketing & outreach presence w/ videos geared at delivered fuel customers
- Aligning Residential & C&I incentives, and creating better pathway for contractors, could yield more positive results
Future Potential Exists

- HVAC has continued potential to drive EE savings for customers well into the future for existing buildings and true new construction

- PAs are focused on
  - Pathway improvement accounting for market dynamics of niche areas seeking areas of greatest potential impact, prioritizing controls, comprehensiveness and driving scale/participation
  - Reducing customer barriers including overcoming first cost, facilitating ease of engagement, access to supporting resources
  - Building NEW pathways for long-lived equipment such as RTUs and EMS/BMS. Understanding and finding ways for programs to influence customers with extremely long-lived equipment and controls, particularly when evaluation implications (ISP/Shifting baselines) can affect the PAs ability to work with customers
  - Workforce Development!!
Future of New Construction Support

- Focus on EUI Reductions
- New Measures
- New ZNE Pathway
- Market Transformation
- Education and Training
Discussion & Q&A - #2
## What is C&I Lighting?

- **C&I Lighting is not homogenous**
  - Interior / Exterior
  - Lamps / Retrofit Kits / Luminaires
  - Wide Variety of Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-type</td>
<td>A-type lamp shapes</td>
<td></td>
</tr>
<tr>
<td>Decorative</td>
<td>Bullet, candle, flare, globe, etc.</td>
<td></td>
</tr>
<tr>
<td>Directional</td>
<td>Reflector (R, BR, PAR, MR), track heads and integrated track luminaires</td>
<td></td>
</tr>
<tr>
<td>Downlighting</td>
<td>Reflector lamps, retrofit kits and integrated downlight luminaires</td>
<td></td>
</tr>
<tr>
<td>Linear Fixture</td>
<td>Lamp replacements for T12, T8, and T5 fluorescent lamps, retrofit kits and luminaires (troffers, strip, etc.)</td>
<td></td>
</tr>
<tr>
<td>Low / High Bay</td>
<td>High wattage lamp replacements and low and high bay integrated fixtures</td>
<td></td>
</tr>
<tr>
<td>Other Indoor</td>
<td>Specialty, emergency, etc.</td>
<td></td>
</tr>
<tr>
<td>Parking Lot</td>
<td>High wattage lamp replacements and luminaires in parking lots and top deck parking garage</td>
<td></td>
</tr>
<tr>
<td>Parking Garage</td>
<td>Replacement lamps and luminaires for parking garages</td>
<td></td>
</tr>
<tr>
<td>Streetlights / Roadway</td>
<td>Replacement lamps and luminaires for street and roadway applications</td>
<td></td>
</tr>
<tr>
<td>Building Exterior</td>
<td>Lamps and luminaires for spot, architectural, flood, wall pack, bollard, etc. applications</td>
<td></td>
</tr>
<tr>
<td>Other Exterior</td>
<td>Signage, stadium, billboard, etc.</td>
<td></td>
</tr>
</tbody>
</table>
What are Lighting Controls?

- **Control Functionality**
  - Switching (on / off)
  - Dimming (light level)
  - Color control (warm / cool)

- **Control Strategies**
  - Manual control
  - Time scheduling
  - Occupancy sensing
  - Daylight response (aka daylight harvesting)
  - Task tuning (space appropriate light levels)
  - Color tuning

- **Advanced Lighting Controls (ALCs)**
  - Fixture integrated sensors – allows for lighting to be controlled at each fixture vs. for a whole lighting circuit
  - Room based controls: often making it possible for out of the box plug and play lighting set-up; addressable or programmable zones — each fixture can be programmed to independently dim and illuminate
  - Networked systems – lighting can be networked to meet various lighting scenes and schemes
  - Wireless technology – makes installation and future reconfigurations potentially easier
Opportunity and Adoption

Savings Potential: Considerable opportunity for controls

- LEDs (w/out controls) provide energy savings ranging from 50% to 90% compared to alternative fluorescent, HPS, etc.

- According to a Lawrence Berkeley National Laboratory (LBNL) analysis, lighting control strategies produce additional energy savings ranging from 24% for occupancy sensing to 28% for daylighting to 36% for tuning and 38% for multi-layered strategies.

- Networked Lighting Controls provide roughly 47% energy savings according to the DesignLights Consortium® (DLC)

LED penetration has been increasing significantly according to evaluation findings

- Linear LED lamps (i.e., TLEDs) and LED fixtures (i.e., Troffers) accounted for 26% of total linear sockets in 2018 compared to 3% in 2015

- LED lamps (i.e., Screw-ins) and integrated fixtures account for 73% of sockets in 2018, which is significantly larger than the 2015 saturation estimate of 26%
The Evolving LED Lighting Market

U.S. Adoption Curve for LED Lighting Applications

- 26% MA Linear LED
- 73% MA LED Screw-in
## Program Pathways: Lighting

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Upstream</th>
<th>Downstream</th>
<th>Custom (Incl. Performance Lighting)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approach</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Project Type(s)</strong></td>
<td>Point of Sale</td>
<td>Direct Install</td>
<td>Prescriptive</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Transaction Costs</strong></td>
<td>Very Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Target Market</strong></td>
<td>Small CI Customers</td>
<td>Small C&amp;I Customers</td>
<td>Medium / Large C&amp;I Customers</td>
</tr>
<tr>
<td></td>
<td>Large DIY Customers with Small Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Target Lighting Types</strong></td>
<td>Most lighting types from screw-based and TLEDs (smaller incentives) to fixtures with controls (higher incentives)</td>
<td>Focus on fixture replacements and controls (where appropriate). TLEDs are not generally included.</td>
<td>Most lighting types from screw-based and TLEDs (smaller incentives) to fixtures with controls (highest incentives).</td>
</tr>
</tbody>
</table>
Market Evolution: Progress being made, still in the early stages

- In May 2016, DLC released V.1.0 of its Networked Lighting Control Systems Specification.
- Some tailwinds are helping advance controls adoption
  - “Controls have traditionally been difficult for contractors and distributors, but they are increasingly standard on projects due to energy codes, which are becoming detailed in control requirements. This, in turn, makes networked control more attractive.” Electrical Contractor Magazine
- Recent evaluation studies have identified some important challenges
  - “…despite high market interest, ALCS is still a very expensive and complex technology.”
  - “ALCS projects routinely do not meet simple payback requirements for Customers.”
  - “…customers most likely to pursue ALCS projects are those who are interested in staying on the front end of the latest technological developments, even if there is some uncertainty regarding performance or cost.”

PAs addressing barriers to accelerate adoption

- Training – influencing and supporting a capable workforce
  - Jan 19, 2017 – “MA Lighting Programs and Incentives”, IES NE Meeting, Boston MA
  - Jun 27, 2017 – “Advanced Lighting and Controls”, Webinar
  - Apr 20, 2018 – “Advanced Lighting Program Updates: Integrating Incentives into Design”, Webinar
  - Jun 20-21, 2018 – “Networked Lighting Controls for Installers”, MAEEP, Norwood, MA
  - Apr 27, 2019 – “Advanced Lighting Controls”, IBEW Local 103, Joint Apprentice Training Center, Dorchester, MA
  - May 7, 2019 – “Networked Lighting Controls for Installers”, MAEEP, Norwood, MA
  - May 8, 2019 – “Networked Lighting Controls for Installers”, MAEEP, Norwood, MA
  - May 18, 2019 – “Advanced Lighting Controls”, IBEW Local 103, Joint Apprentice Training Center, Dorchester, MA
- Financial – offering significantly greater incentives for fixtures and fixtures with controls

<table>
<thead>
<tr>
<th>Upstream Product</th>
<th>Incentive</th>
<th>Market Price</th>
<th>% of Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLED</td>
<td>$3</td>
<td>$6.50</td>
<td>46%</td>
</tr>
<tr>
<td>Troffer</td>
<td>$32</td>
<td>$55</td>
<td>58%</td>
</tr>
<tr>
<td>Troffer w/controls</td>
<td>$80</td>
<td>$125</td>
<td>64%</td>
</tr>
</tbody>
</table>

Source: 2019 Upstream Lighting Incentives; Navigant LED Lighting Price Survey
Upstream Lighting Sales & Savings by Product Category

- **4 major “waves” of lighting**

  - **2011 to 2016 –** High efficiency Linear Fluorescent (e.g., T8, T5HO) lighting replacing standard efficiency. Peaked in 2012-14. Extremely high volume, low savings. No longer claimable.

  - **2012 to 2019 (and a bit beyond) –** LED Screw-in (e.g., A Lamps, PAR/MR) replacing fluorescent and/or CFL lamps. Peaked in 2015. High volume and savings. Little left to claim.

  - **2014 to ? –** Linear LED (i.e., TLEDs, Troffers) replacing standard and/or high efficiency fluorescent lamps. Very high volume and savings. Differences in cost/complexity and therefore adoption within category. Large remaining opportunity.

  - **2016 to ? –** Other LED Fixtures (e.g., high/low-bay, wall packs, stairwell, etc.) replacing fluorescent, halogen, etc. in a wide variety of applications. Given higher unit costs and complexity of installation, likely to take longer to reach peak market penetration. Moderate volumes but high savings per unit.
Upstream Lighting Sales & Savings by Product Category – Linear Only

- **3 “waves” of linear lighting**
  - 2011 to 2016 – High Efficiency Linear Fluorescent (e.g., T8, T5HO) lighting replacing standard efficiency. Peaked in 2012-14. Extremely high volume, low savings. No longer claimable.
  - 2014 to ? – Linear LED Lamps (i.e., TLEDs) replacing standard and/or high efficiency fluorescent lamps. Very high volume and moderate savings. Large remaining opportunity,
  - 2015 to ? – Linear LED Fixtures (i.e., Troffers w/ and w/out controls) replacing fluorescent lamps/fixtures. High volume and high savings per unit. Large remaining opportunity, but will take time given cost/complexity, especially with controls.
- Industry groups
- Trade allies
- Local installers/designers
- Program data
Customer Scene 1

- Customer not named
- Lighting control system that was too complex
- Compatibility issues
- Ultimately, this was disabled and other customers took note of this project.
Customer Scene 2

Space Needs
- Little to no daylight
- Mechanics and painters
- Space lighting

Existing lighting
- Fluorescents
- Manual switches

New Lighting
- LED High Bay Fixtures
- Wall Dimmers
Customer Scene 3

Gallo Ice Arena

About Gallo Ice Arena
In 2017, the Gallo Ice Arena underwent an energy makeover. The rink is owned by the Bourne Recreation Authority (BRA) who were interested in replacing old equipment with new, efficient equipment as well as improving the skating experience for all who use the rink. They engaged Rethinking Power Management (RPM), an energy and sustainability consulting company, to help design and oversee the projects. BRA also worked closely with Sia Karplus, Science Wares Inc. on project development and Cape Light Compact to take full advantage of its energy efficiency incentive programs.

Project Summary
Beginning with upgrades to the boilers and lighting, the final project provided a variety of benefits and changed the arena dramatically. In addition to energy savings, it improved the ice surface, expanded skating opportunities, improved rink aesthetics, and enhanced use by the community.

- Installed measures are expected to save about 25% on energy costs annually.
- The rink has a new look, thanks to LED lights, a new energy efficient ceiling, and some newly replaced wall panels.
- The rink is now easier to operate. Internet-enabled gateways positioned throughout the facility allow management to control the new heating and lighting systems from a local computer. A cell phone app allows control of these systems anywhere on-site or remotely.
- Management can now adjust light levels throughout the arena. The new system even takes advantage of natural light in the bleacher areas to reduce energy costs during daylight hours.
- The new lighting can be made bright enough for TV filming, allowing use by regional high school and college hockey tournaments that want to telecast their games. It can be turned low enough so community skates are comfortable and fun.
- The tighter building envelope translates to a harder ice surface and opens more opportunities for additional figure skating clubs and events. It also means lighter refrigeration load and lower costs.

| Total Project Cost | $353,196 |
| Mass Save Sponsor Incentives | $102,073 |
| Estimated Annual Energy Savings | 7,832 therms |
| Estimated Annual Cost Savings | $34,694 |

Project Partners
- Rethinking Power Management
- Science Wares Inc.
- Cape Light Compact

Space Needs
- Quality lighting
- Needs change by day and event

Existing Lighting
- Fluorescent tubes and metal halide
- Manual switches

New Lighting
- LED Tubes and Drivers
- LED High Bay Fixtures
- Integrated Lighting Controls

Part of comprehensive project and ideal customer and situation!
Examples of Solutions Currently Included in Portfolio

- **Custom**
  - Truly custom, it looks at the claimable energy savings
  - Customer can assign payment

- **Performance Lighting**
  - In field for almost 3 years
  - Highly incentivizes customers to push the envelope

- **Upstream**
  - TLED incentives are low ($3) versus fixtures with controls

**PAs are giving all signals to the market to advance lighting controls**
Dedication to Controls and Industry Recognition

Massachusetts sponsors highlighted as “first dozen” to provide incentives

First Rebates
As of August 2017, more than 20 utilities and energy efficiency programs required networked control systems be listed in the GPL. About a dozen of these—Baltimore Gas & Electric (BGE), EVERSOURCE, Mass Save, National Grid, Pacific Gas & Electric (PG&E) and Wisconsin Focus on Energy—have rolled out new rebates promoting these systems. The DLC aims to develop a unified incentive strategy to streamline the rebate process across multiple program territories. For now, however, utilities are experimenting with different approaches.

Massachusetts Mass Save Performance Lighting Program takes a prescriptive and performance-based approach. Through its Lighting Systems and Sensors program, Mass Save offers a prescriptive rebate up to $65/DC qualiﬁed LED Luminaires when combined with a DLC qualiﬁed networked control system. Alternatively, it awards a performance-based rebate of $20/W saved for projects that use DLC qualiﬁed luminaires and exceed energy code, which doubles if at least 90 percent of the lighting is controlled by a DLC qualiﬁed networked control system.

PGBD’s LED Accelerator program also uses a performance-based approach, offering $0.17/W/kWh and $150/kW if DLC Premium luminaires are installed, which increases to $0.24/W/kWh and $150/kW if DLC qualiﬁed networked controls are also installed.

Wisconsin Focus on Energy uses a new approach. Customers are awarded either a $0.125 or $0.25 per sq ft rebate if a DLC qualiﬁed networked control system is installed. The rebate varies based on application. Another $0.05/sq ft is awarded if the system features energy monitoring capability and the customer agrees to share energy data with the utility or energy efﬁciency program.

Networked Controls
The DLC also is working on case studies, an energy savings database, and training. The ﬁrst energy savings report was published in September 2017 and will be covered in the next issue of LCM. The organization is developing contractor training that will be available in the spring of 2018.

For lighting management companies, the DLC’s program offers the opportunity to knowledgeably identify, compare and select networked lighting control systems backed by rebates.

Massachusetts case study used for DLC/PNNL Controls Study – May 2018

<table>
<thead>
<tr>
<th>Site</th>
<th>FL to LED Only</th>
<th>High-End Trim / Task Tuning</th>
<th>Occupancy Control</th>
<th>Daylighting Control</th>
<th>Total: LED with All Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Brewery</td>
<td>50%</td>
<td>negligible</td>
<td>10%</td>
<td>6%</td>
<td>66%</td>
</tr>
<tr>
<td>2 – Office</td>
<td>64%</td>
<td>included in FL to LED</td>
<td>-2%</td>
<td>5%</td>
<td>67%</td>
</tr>
<tr>
<td>3 – Medical Office</td>
<td>29%</td>
<td>included in FL to LED</td>
<td>24%</td>
<td>9%</td>
<td>62%</td>
</tr>
<tr>
<td>4 – Retail/Grocery</td>
<td>30%</td>
<td>33%</td>
<td>3%</td>
<td>~</td>
<td>66%</td>
</tr>
<tr>
<td>5 – Office</td>
<td>43%</td>
<td>24%</td>
<td>-1%</td>
<td>4%</td>
<td>70%</td>
</tr>
<tr>
<td>Average – By Control</td>
<td>43%</td>
<td>29%</td>
<td>7%</td>
<td>6%</td>
<td>66%</td>
</tr>
<tr>
<td>Average – Site</td>
<td>43%</td>
<td>29%</td>
<td>7%</td>
<td>6%</td>
<td>66%</td>
</tr>
</tbody>
</table>

Note: Not all control savings could be separated at each site. Average savings provided at the controls level and the site level.

https://www.designlights.org/default/assets/File/Lighting%20Controls/DLC_Advanced-Lighting-Controls_Final-Report_PNNL.pdf

Meeting Objectives

1. Collect and discuss lighting industry input on DLC’s Networked Lighting Controls Technical Requirements and QPL
2. Identify possible solutions and next steps to address key industry challenges and opportunities
3. Identify ways we can work together to accelerate adoption

Massachusetts sponsors actively working on addressing barriers – DLC Lighting Controls Summit 2017

https://nalmco.org/NALMCO/LM_M/Articles/Utilities_Unveil_First_Rebates_for_Networked_Controls.aspx
Code requirements for lighting

Summary of Requirements for Lighting and Receptacle Controls
IECC 2018

<table>
<thead>
<tr>
<th>Code requirement summary</th>
<th>Code provision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switch</strong></td>
<td>C405.2.5</td>
</tr>
<tr>
<td><strong>Dimmer or scene control</strong></td>
<td>C405.2.2.2</td>
</tr>
<tr>
<td><strong>Timeclock</strong></td>
<td>C405.2.6.2, C405.2.6.4</td>
</tr>
<tr>
<td><strong>Occupancy sensor</strong></td>
<td>C405.2.1</td>
</tr>
<tr>
<td><strong>Full ON</strong></td>
<td>C405.2.1</td>
</tr>
<tr>
<td><strong>Partial ON</strong></td>
<td>C405.2.1</td>
</tr>
<tr>
<td><strong>Manual ON</strong></td>
<td>C405.2.1.1</td>
</tr>
<tr>
<td><strong>Full OFF</strong></td>
<td>C405.2.1</td>
</tr>
<tr>
<td><strong>Partial OFF</strong></td>
<td>C405.2.2, Exception</td>
</tr>
</tbody>
</table>

Daylight Zone Requirements
IECC 2018

Daylight Zone Requirements:
- Sidelighting (Window)
- Toplighting (Skylight)

Daylight Exceptions:
- Daylight control is not required when the total lighting power of a daylight zone is 150 W or less, or when the total glazing area is 24 sq. ft. or less. Other exceptions exist, based on space type, window area, neighboring obstructions, and glass transmittance.

ISP/Baseline & Moving Targets

- Past studies lead to TRM
- Measure life decreases over time
- Realization rate impacts (must be sure of savings!)
- ISP for code has increased baseline
Sample Strategies & Tactics

<table>
<thead>
<tr>
<th>Harvest Remaining LED Screw-ins</th>
<th>Optimize Penetration of Fixture / Troffer Market</th>
<th>Promote More Control Products and Options</th>
<th>Prioritized Target Marketing</th>
<th>Layer in Additional “Niche” Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>With LED Screw-ins fast becoming standard practice, harvest remaining opportunities.</td>
<td>With products costly and installation more complex, make concerted effort to drive continued market penetration.</td>
<td>Controls technologies are maturing and standardizing thus creating an opportunity to more easily increase adoption.</td>
<td>Given variance in building operating characteristics and past penetration, prioritize segments with high savings potential.</td>
<td>“Niche” products should be continuously added to provide additional modest, but non-trivial savings opportunities.</td>
</tr>
</tbody>
</table>
Discussion & Q&A - #3
Thank You