Financial and Operational Benefits Available From Investing in Turnkey Comprehensive Interior and Exterior Lighting Upgrade with LED Technology

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What is the typical potential energy (KW) reduction available from a comprehensive LED lighting upgrade?

- 10% - 20%
- 30% - 40%
- 50% - 60%
- 70% - 80%
- Other
Results
Approximately how many times would you have to change an incandescent light bulb before you would have to change an LED light bulb?

- 5 times
- 10 times
- 15 times
- 20 times
- They have the same hours of useful life
Eco Engineering: At a Glance

• Founded in 1993, current ownership since 1998

• Largest independent design-build/ engineering firm in the US specializing in energy efficient turn-key lighting and lighting controls

• Headquartered in Cincinnati, Ohio, with 100 Employees in 15 states

• Manufacturer/ Vendor – Distributor Neutral
Eco Engineering: 2017 Recap

- Projects completed in 46 States, Puerto Rico, & Canada
- Implemented over 50 projects in 700 distinct sites with projected savings of $9.2MM annually
- 10 + projects with Revenue between $750K - $3.2mm
Eco Customers in the Institutional (MUSH) Markets
## Technology – Why Choose LED

<table>
<thead>
<tr>
<th></th>
<th>Energy savings</th>
<th>Lifetime</th>
<th>Starting time</th>
<th>Switching cycles</th>
<th>Heat resistance</th>
<th>Directional Temperature</th>
<th>Mercury Free</th>
<th>Affordability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LED</strong></td>
<td>80%</td>
<td>40,000hrs</td>
<td>&lt;1sec.</td>
<td>≥ 40,000</td>
<td>Warm</td>
<td>25° / 40°</td>
<td>0mg</td>
<td>$$$</td>
</tr>
<tr>
<td><strong>CFL</strong></td>
<td>80%</td>
<td>10,000hrs</td>
<td>&lt;60sec.</td>
<td>≥ 10,000</td>
<td>Hot</td>
<td>≥ 110°</td>
<td>&gt; 5mg</td>
<td>$$</td>
</tr>
<tr>
<td><strong>INC. or HAL.</strong></td>
<td>0%</td>
<td>2,000hrs</td>
<td>&lt;1sec.</td>
<td>≥ 4,000</td>
<td>Very Hot</td>
<td>25° / 40°</td>
<td>0mg</td>
<td>$</td>
</tr>
</tbody>
</table>
LED Technology Certifications and Facts to look for

- ETL Listed
- RoHS compliant
- Lead-free
- Mercury-free
- ENERGY STAR certified
- LM 79, LM 80, TM 21, IES certified
- Classified and UL Listed
- DLC Listed
Interior LED Lamp Option Examples
Interior LED Fixture Option Examples
Exterior LED Fixture Option Examples
Eco Engineering: Operations Process

0.0 Project Pre-Planning
- Project kick off & crew training
- Regular communication to ensure delighted customer
- Sign off each building; final M&V and RMAs

1.0 Contract Received
- Precontract walk thru & M&V plan to ensure 100% energy savings
- Charter meeting &; COI; bond; rebate preapproval
- ESCO/Pre-Con with ESCO/Customer & then with crew

2.0 Order Material
- Purchasing orders materials Schedule work
- Complete M&V and sampling phases & Kick-Off before starting work

3.0 Installing
- PM provides final close out package
- QC Survey process; reconciliation

4.0 Punch list
- PM provides final close out package
- QC Survey process; reconciliation
- Sales to ask for referrals; Signed EPACT letter

5.0 Installation Complete
- OM/Sr. PM accept contract T&C with CFO; taxes; billing; exclusions, advise President if budget shortfall
- Order Materials, Confirm communication on protocol; safety rules; invoicing guidelines
- Accept all materials; final schedule; troubleshoot any problems discovered; PW letters published
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Purpose</th>
<th>Accuracy of Measurement</th>
<th>Example Brand Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light level meter</td>
<td>Establish functional performance of baseline and new lighting equipment</td>
<td>± 5%</td>
<td>Extech, Amprobe, Greenlee</td>
</tr>
<tr>
<td>Power meter</td>
<td>Establish true RMS power draw of baseline and new lighting equipment</td>
<td>± 3%</td>
<td>Fluke 39/41/41B, Extech 4KC20, AEMC 3910</td>
</tr>
<tr>
<td>Light on/off and Occupancy data logger</td>
<td>Measure occupancy of space and run time of lighting fixtures and</td>
<td>Time measurements are ±1 minute / week; Light threshold adjustment range 10 – 1,000 lumens / m²</td>
<td>Onset Hobo Loggers, Dent Instruments SmartLogger, Sensorswitch data loggers</td>
</tr>
<tr>
<td>Parameter</td>
<td>Period</td>
<td>Population</td>
<td>Measurement</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td><strong>Lighting Power (kW)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>Baseline</td>
<td>10% precision with 90% confidence or 20% precision with 80% confidence</td>
<td>Spot measurement</td>
</tr>
<tr>
<td>Performance</td>
<td>Post-Installation</td>
<td>10% precision with 90% confidence or 20% precision with 80% confidence</td>
<td>Spot measurement</td>
</tr>
<tr>
<td>Performance</td>
<td>Performance</td>
<td>Verified at post-installation (one time or continuous, depending on savings)</td>
<td>None or periodically depending on savings</td>
</tr>
<tr>
<td><strong>Lighting Levels (foot-candles/lumens)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>Baseline</td>
<td>10% precision with 90% confidence or 20% precision with 80% confidence</td>
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<td>Performance</td>
<td>Verified at post-installation (one time or continuous, depending on savings)</td>
<td>None</td>
</tr>
<tr>
<td><strong>Lighting Run Time (hours per location)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Baseline</td>
<td>10% Precision with 90% confidence or 20% precision with 80% confidence</td>
<td>Short-term metering</td>
</tr>
<tr>
<td>Operation</td>
<td>Post-Installation</td>
<td>Measured during baseline period</td>
<td>Stipulated</td>
</tr>
<tr>
<td>Operation</td>
<td>Performance</td>
<td>Measured during baseline period</td>
<td>Stipulated</td>
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</table>
Federal Energy Mgt. Program (FEMP) M&V Parameters

• **Power Level** - Baseline and post-installation performance parameters for a sample set of fixtures will be spot measured. It is recommended to spot measure the larger groups of fixtures being installed. Ideally, fixtures that represent at least 75% of the lighting energy use will be measured.

• **Hours of Operation** - Baseline operational parameters will be verified via short-term data logging. It is recommended to focus on typical spaces in the facility. Ideally, spaces that represent at least 80% of the lighting energy use will be measured.

• **Lighting Levels** - Baseline and post-installation lighting levels will be verified by spot measurements in about 20% of the spaces or exterior areas. It is required that the lighting levels meet the customer’s lighting design illumination levels.
Why Upgrade to LED Lighting - Benefits

- **Financial Benefit of KW & Kwh savings** – Typically 50% + due to higher lumens per watt for LED vs older technology (lower wattage/ fewer fixtures)
- **Maintenance Savings** – Not having to maintain older technology lamps and ballasts (LED solutions have 5-10yr warranties and 50-100K life expectancy). Thus, virtually eliminating lighting maintenance labor & matl’s replacement
- **Lighting quality** – Light levels and distribution can be significantly improved which can mean better and higher light levels providing safety & security
- **Instant On & Cold Temperature Operation** – Unlike some cfl’s and HID lighting LED will come on immediately, and deliver expected light at low temps
- **Controllability & Intelligence** - Pairing LED lighting with intelligent sensors and controls can help build smarter, more sustainable solutions.
Case Study – Eco Engineering and Siemens Upgrade Lighting for Yolo County (CA) Housing Authority
Case Study – Eco Engineering and Siemens Upgrade Lighting for Yolo County (CA) Housing Authority

• Yolo County Housing is dedicated to working together to provide quality affordable housing and community development services to all within its service area in California. Created in 1950, Yolo County Housing’s primary programs are funded by the United States Department of Housing and Urban Development (HUD) and through the State of California (OMS and HCD). The Housing Authority and its allied organizations provide assistance to approximately 2,076 households.

• Through a transparent, competitive selection process, Yolo County Housing awarded a multi-faceted project to Siemens Building Technologies in an effort to make the facilities more efficient. Eco Engineering audited the existing lighting systems, designed replacement solutions, and led the installation of the new technology on behalf of Siemens. The lighting portion of the project entailed LED technology across both interior and exterior areas of the building portfolio.

• The results from the lighting system upgrade included more than $110,000 in annual energy savings and an additional $4,000 in sustained annual maintenance savings.
Case Study – Eco Engineering and Siemens Upgrade Lighting for Yolo County (CA) Housing Authority

Scope of Work Summary

1638 compact fluorescent fixtures will be relamped with LED lamps.
1253 common incandescent lamps will be replaced by new LED lamps.
625 four foot fluorescent fixtures will be retrofit with Direct Wire LED lamps.
221 Existing Dome fixture Retrofit with LED kit.
220 Existing Sign lighting retrofit w LED kit and PC if necessary.
76 fixtures will be replaced by new LED wall pack fixtures.
72 fixtures will be replaced by new LED pole fixtures.
65 Two foot fluorescent fixtures will be retrofit with Direct Wire LED lamps.
62 fixtures will be replaced by new LED pole fixtures with PC.
41 Fixture will be relamped with a direct wire LED "corncob" bypass lamp.
14 fixtures will be replaced by new LED flood fixtures.
7 wall mount occupancy sensors will be installed.
5 fixtures will be replaced by new LED wall pack fixtures with PC.
1 fixtures will be replaced by new LED canopy fixtures.
Case Study – Eco Engineering and Siemens Upgrade Lighting for Yolo County (CA) Housing Authority

<table>
<thead>
<tr>
<th>Variable</th>
<th>Monthly</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Project Cost, including applicable taxes</td>
<td>$535,686</td>
<td></td>
</tr>
<tr>
<td>Total Savings</td>
<td>$9,548</td>
<td>$114,576</td>
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<tr>
<td>Payback Years</td>
<td></td>
<td>4.7</td>
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</table>
Case Study – Eco Engineering and Hitachi “Smart Cities” Upgrade Lighting for Annie Coleman 14 Housing, Miami FL

- Eco Engineering, teamed with Hitachi – ATT “Smart Cities” to design an exterior pilot lighting system for the Miami Area Housing Authority at a property complex named Annie Coleman 14. The Lighting upgrade included the use of New LED fixtures controlled with Cincom wireless lighting control, and equipped with Bullet-Proof light fixture shields to protect the LED fixtures.

- Built in 1967 in unincorporated Miami Dade, the complex is made up of 50 housing units in 16 walkup style, two story buildings, housing approximately 47 families.

- While intended to provide an exterior lighting solution that was more energy efficient, there was also a goal of providing a lighting system that could communicate with the local municipality and utility, while offering other beneficial features available with ALCS (Advanced Lighting Control System).
Case Study – Eco Engineering and Hitachi “Smart Cities” Upgrade Lighting for Annie Coleman 14 Housing, Miami FL
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• CIMCON’s revolutionary platform transforms existing exterior lighting infrastructure into an Internet of Outdoor Things system. This transition aids cities and helps utilities monitor, meter, manage and monetize the lighting and other assets affixed to and located near the light pole, thereby enabling:
  • increased operational efficiency
  • reduced energy costs
  • improved public safety
  • higher resident quality of life
  • The Cincom platform enables solutions such as small cell deployments, IoT communication infrastructure, parking and traffic tracking, environmental monitoring and other public safety solutions to any smart city deployment.
Case Study – Eco Engineering and Hitachi “Smart Cities” Upgrade Lighting for Annie Coleman 14 Housing, Miami FL

**Scope of Work Summary**

- 27 HID fixtures will be replaced by new LED flood fixtures.
- 12 HID fixtures will be replaced by new LED pole fixtures.
- 6 new LED flood fixtures will be installed.
- 3 new LED pole fixtures will be installed.
- 1 gateway will be installed
- 1 modem will be installed
Laying the Foundation for a Better Future

Case Study – Eco Engineering and Hitachi “Smart Cities”
Upgrade Lighting for Annie Coleman 14 Housing, Miami FL

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<th>Annual</th>
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<tbody>
<tr>
<td>Total Project Cost, including applicable taxes</td>
<td>$103,726</td>
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<tr>
<td>Total Savings</td>
<td>$479</td>
<td>$5,748</td>
</tr>
<tr>
<td>Payback Years</td>
<td></td>
<td>18.0</td>
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</table>
Questions?

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Introductions

Michael Chow, PE, CxA, CEM, LEED AP BD+C
President of Metro CD Engineering, LLC
Columbus, Ohio
– CxA: Certified Commissioning Authority
Introductions

Ryan Hoffman
Principal, Heapy Engineering
Dayton, Cleveland, Columbus, Findlay
Who ideally contracts directly with the Commissioning Agent/Authority?

- The Architecture Firm
- The General Contractor or Construction Manager
- The HVAC Sub-Contractor
- The Building Owner
- The MEP (Mechanical, Electrical, Plumbing) Engineering Consultant/Firm
Results
Which of the following are roles and responsibilities of a Commissioning Agent/Authority?

- Provide start-up checklists of key equipment such as HVAC units
- Provide an independent review of Construction Documents to meet the Owner’s Project Requirements
- Witness functional testing of key equipment such as HVAC units
- Maintain a Commissioning Issues Log
- All of the above
Results
What is Building Commissioning?

- Wikipedia: **Building commissioning** (Cx) is the process of verifying, in new construction, all (or some, depending on scope) of the subsystems for mechanical (HVAC), plumbing, electrical, fire/life safety, building envelopes, interior systems (example laboratory units), co-generation, utility plants, sustainable systems, lighting, wastewater, controls, and building security to achieve the owner’s project requirements as intended by the building owner and as designed by the building architects and engineers.
What is Building Commissioning?

ASHRAE:
A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.
Why Building Commissioning?

- Commissioning Authority (CxA) or Commissioning Agent works for the Owner
- CxA helps ensure Owner’s Project Requirements are met
- Building construction involves many stakeholders such as architects, engineers, General Contractor, sub-contractors that may work independently of each other. Ineffective communication and coordination can lead to issues on projects. CxA can provide a third party review of design documents, specs and shop drawings.
- Witness functional testing of key equipment such as HVAC units
- Maintain a Commissioning Issues Log to ensure items are resolved
WHAT IS RETRO-COMMISSIONING (RCx)?

• A process by which existing building systems are optimized using engineering expertise:
  – Controls
  – HVAC
  – Lighting

• Can be referred to as a “building tune-up” focused on measures that can be quickly implemented, are that are not capital intensive
RETRO-COMMISSIONING APPROACH

1. Existing Conditions Review (utility bills, drawings, sequences, O&M logs)
2. Regression modeling / Energy cost goal development
3. Analysis of controls system operations
4. Identification of recommended measures and associated financial impact
5. Implementation of measures by preferred vendor
LAWRENCE BERKLEY NATIONAL LABS STUDY: THE COST-EFFECTIVENESS OF COMMISSIONING

- 15% average energy cost savings
- 8 MONTH average payback
- $45,000 average annual savings
- $0.27/SF average Retro-Cx cost
KNOWN RCX INCENTIVES IN OHIO:

• Dayton Power & Light
• AEP Ohio
• First Energy
Green Commissioning: Residential LEED

LEED = Leadership for Energy and Environmental Design

- LEED for Homes: Single-family and multifamily buildings three stories or fewer
- LEED BD+C: Multifamily Midrise is for multifamily construction.
- LEED O+M: Multifamily: Existing multifamily buildings
Green Commissioning: Other Residential Rating Systems

- Enterprise Green Communities
- ENERGY STAR Multi-Family Highrise
Q&A

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