SOUTHERN CALIFORNIA EDISON®
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LED Streetlights Education Campaign

March 15, 2011

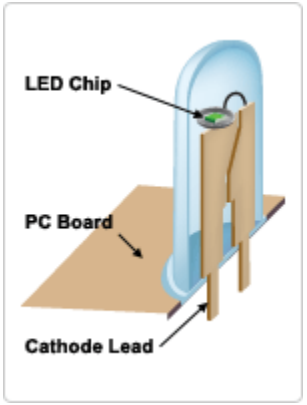
Southern California Edison

Agenda

- LED Overview
- Current Status of LED Technology
- Regulatory Status
- Current Installations
- SCE's LED Streetlight Assessment
- Streetlight Cost Comparison
- Customer Options in Lowering Streetlight Bills
- Draft Outline of LS-1 Early Adopter Rate
- LED and HPSV Comparison

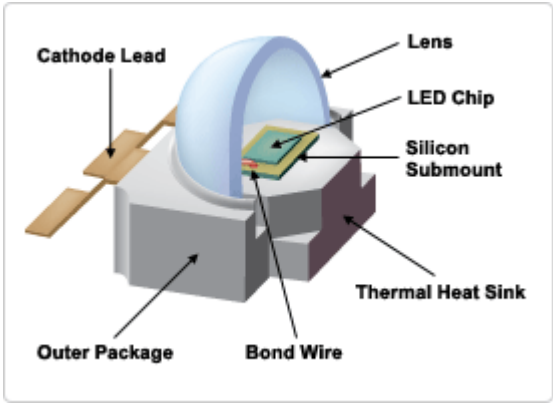
Brief Overview

What are LEDs?



- Light-Emitting Diode (LED)
  - An electronic device that directly produces light when electricity is applied to it.

- There are two basic types of LEDs
  - Low-Power
    - Uses a fraction of a watt and is typically used as indicators lights (i.e., exit signs, small consumer electronics).
  - High-Power
    - Uses 1W or more and produces much more light, however as a result of the increased power, must be thermally managed. Used for general lighting including outdoor area Lighting.



Overview -- continued

History of LEDs

- LED is solid-state lighting device born out of the semi-conductor industry.
- The core technology has been around for over 40 years; early technology had limited performance and has been mainly relegated to indicator light applications.
- Advancements with this technology began with the introduction of the blue LED in the 90's, which immediately led to the innovation of an LED that produces white light.
- Through the late 90's into the early 2000's, light output of the white LEDs per watt of power has significantly increased.

20 lumens/watt in 2005 → 150 lumens/watt in 2010

Overview -- continued

LED Roadway Lighting Fixtures

- LED Streetlight fixtures began appearing in the marketplace in 2005.
- Early products had…
  - Reduced light output
  - Poor color quality and consistency
  - Very high costs--over $1,000 per fixture
  - Overstated life claims
- Little to no standardization from one manufacturer to another.

Current Status of LED Technology

- **The Pros**
  - Increased chip efficacy now at 150 lumens/watt
  - Performance test standards for light output performance (IESNA LM-79) is under IES Committee review
  - Tighter specification of color consistency, “Binning” (ANSI C78.377-2008)
  - Costs of fixtures have declined with a continued downward trend – however, presently, LED Street Light fixtures are at least 5 times costlier than High Pressure Sodium Vapor (HPSV)
  - Increased consideration to thermal management in fixture design

- **The Cons**
  - Lack of industry standards for Roadway Lighting applications
  - Little documentation of power quality assurance (i.e., Harmonic Distortion, Power Factor)
  - Product warranties still short of lifespan claims
    - 5 years warranty, but claimed life over 10 years
  - No reliable standard for rating of life
    - Uncertainty of individual components of a fixture (i.e., driver life)
  - High cost

Regulatory Status

- SCE LS Tariffs (80% SCE, 20% Customer)
  - LS-1: LED is <u>currently not an option</u> (SCE-owned, flat billed).
  - *LS-2: LED is an option effective 08/17/09 (customer-owned, flat billed).*
  - LS-3: LED is an option (customer-owned, metered tariff).
- PG&E (20% PG&E, 80% Customer)
  - LS-1: Not an option.
  - LS-2: An option effective 5/01/09.
- SDG&E (20% SDG&E, 80% Customer)
  - Not currently an option on either LS-1 or LS-2.

Current Installations of Street Lights

- SCE Owns and Maintains over 700,000 Street and Area lights in its territory.
- There are over 200,000 customer-owned streetlights in SCE's territory.
- The current light source for over 97% of SCE-owned streetlights is HPSV. The balance is made up of the Metal Halide or Low-Pressure Sodium Vapor light sources.

SCE's LED Street Light Assessment

- Project Description
  - Business Customer Division's Design & Engineering Services led an inter-departmental team that conducted a six-month assessment of LED street lights.
    - Launched May 2009 and completed December 2009
  - Project consisted of three stages:
    - Simulations – Lighting simulation software based on computer models
    - Laboratory Testing – Verification of photometric performance and Temperature dependency of light output
    - Field Tests – Real-world testing at 4 test sites spread across 4 climate types in SCE's service territory
  - Main objective of the test project was to assess and quantify the energy efficiency and cost saving potential of LED street light fixtures over the current HPSV standard while meeting or exceeding HPSV's photometric performance.
  - This assessment aimed to provide key data associated with this emerging technology.
    - Definition of "comparable" fixture to the existing technology
    - Claimed light output versus actual output
    - Claimed energy consumption vs. actual consumption
    - Temperature Impacts and Thermal Qualities (heat dissipation)
    - Economics and Availability of quality fixtures
    - Quality of light (color quality)
    - Power quality (harmonics and power factor)
    - Tariff (LS-1 SCE-owned) and Rate Structure development information

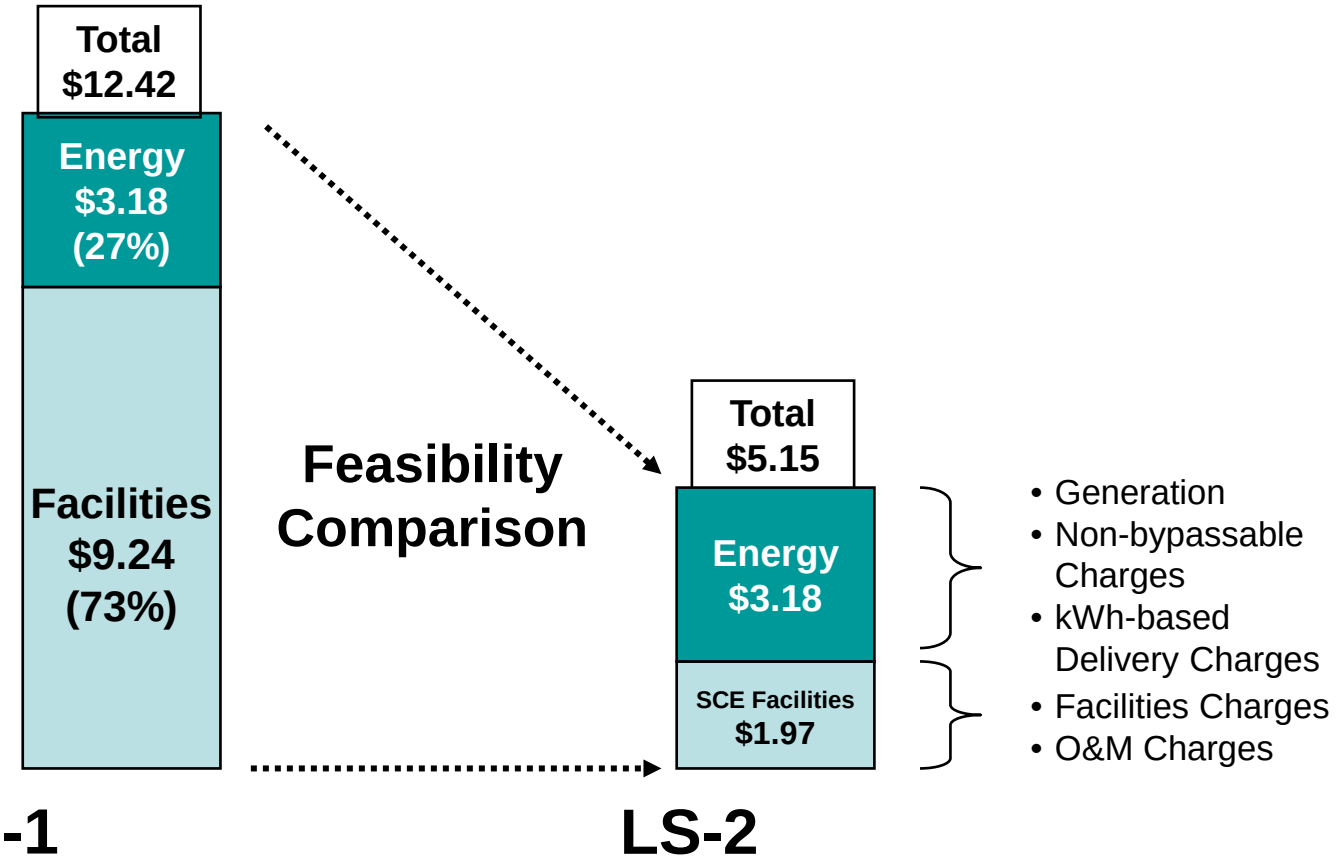
SCE's LED Street Light Assessment (cont'd)

- LED Project Summary Results
  - Simulations
    - Established typical street lighting scenario (i.e., ideal geometries)
    - Post-field assessment simulation of actual test sites using real-world fixture placement
  - Laboratory Testing
    - Light output has a linear relationship with ambient temperature
      - An increase from 40 C to 100 C resulted in an average of 8% light loss
  - Field Tests
    - The LED fixtures resulted in lower energy use, however lower average light levels were observed.
    - Minimum light levels were close to that of HPSV
    - Uniformity was greatly improved with the LED fixtures.
  - Analysis
    - Lifecycle cost comparisons of LED fixtures versus HPSV still favor HPSV .

Streetlight Cost Comparison

LS-1 vs. LS-2 Monthly Cost Comparison - 100W HPSV

Critical Factors



Streetlight Cost Comparison (cont'd)

For Illustrative Purposes Only – Potential LED Cost/Saving Estimates

	Facility Charge ($/Month)	Energy Charge ($/Month)	Monthly Total ($)	% Difference
Existing LS-1 Rate	9.2	3.0	**12.2**	
LED with 20% energy savings	9.2	2.4	**11.6**	**-5%**
LED with 40% energy savings	9.2	1.8	**11.0**	**-10%**
LED with 20% energy savings plus $400 increased capital costs **	12.1	2.4	**14.5**	**19%**
LED with 40% energy savings plus $400 increased capital costs **	12.1	1.8	**13.9**	**14%**

Breakeven Point (Target incremental capital cost)

LED with 20% energy savings @ **$77** increased capital costs	9.8	2.4	**12.2**	**0%**
LED with 40% energy savings @ **$165** increased capital costs	10.4	1.8	**12.2**	**0%**

* Estimates of facility costs do not include O&M expense

** Based on **$400** incremental capital costs

Customer Options in Lowering Streetlight Bills

- De-energizing or removing existing LS-1streetlights
  - Temporary
    - SCE would remove the photocell, cover the socket with a sealing tape and place a 'de-energized sticker' on the refractor (lens), at a customer charge of $44/light, per tariff.
    - After 6 months, SCE would revisit the situation with the customer to determine if the light would be turned back on or, as required by tariff, permanently removed. If turned back on at later date, there would be a customer charge of $49/light, which includes new photocell, per tariff.
    - Customer still responsible for paying the Service Charge portion of the billing for each light, even though de-energized.
  - Permanent
    - For permanent removal, SCE will remove the lights/poles. Based on when the poles were installed, either SCE or the customer would pay the removal cost.
    - On wood poles, SCE would remove the arm and light and for concrete poles, SCE would do a partial removal of the foundation and cover the hole with either dirt or cold patch asphalt.
    - Based on the configuration of the supporting distribution and streetlight facilities, there may be additional costs to the customer to restore the operation of the system if the removal of the streetlights has a negative impact to system integrity.
  - Costs
    - Poles installed < 10 years: Customer pays the removal costs.
    - Poles installed > 10 years: SCE pays the removal costs.
    - SCE’s average removal (loaded) cost for a concrete pole is estimated to be at $900 to $1000 per pole.

Draft Outline of LS-1 Early Adopter Rate

- An Advice Letter has been proposed to the CPUC for an LED rate for LS-1 However, this presentation is for discussion purposes only
- Rate is based on the existing LS-1 and uses a Differential Facilities Charge (DFC) structure to account for the higher initial costs of LEDs
  - Considering a time value O&M/replacement component to the DFC to account for unknown reliability and maintenance needs
  - The O&M component may be a one-time payment as part of the DFC or a variable charge adjusted in each GRC-O&M is an ongoing charge and cannot be prepaid.
    - Replacement coverage options consistent with Added Facilities
- Specific LED fixture for this option yet to be determined
  - Customers will select fixture styles from SCE-approved materials catalog
  - kWh/mo usage will be derived from the limited offerings of fixtures
  - A range of kWh/mo will be used similar to LS-2 LED
  - Rapid evolution of LEDs may result in rendering early generations obsolete

LED “Cobra Head” Styled Street Light fixtures

Retrofitted Products

Specifically Built Products

LED “Cobra Head” Styled Street Light fixtures

- Highlights of issues related to Cobra Head fixtures retrofitted from HPSV to LED
  - Thermal Management Challenges Subject to increased premature LED or Driver failures
  - Limited Light Distribution – poor coverage of areas

- Fixtures built specific for LED applications.
  - Significantly Improved Thermal Management
  - Better Light Distribution – still not ‘like for like’
  - Higher Initial Cost – Can be up to 5 times greater than HPSV
  - Possible higher replacement parts costs due to non standardization by manufacturers

Comparison of HPSV vs. LED features

- HPSV
  - Low initial cost per fixture
  - Proven Rated Fixture Lifecycle of 15 years+
  - Established Commodity
  - Standardized Fixture design (i.e., lamps, sockets, ballasts)
  - Lamps are widely available from multiple sources
  - No temperature dependency
  - Proven lamp lifespan of up to 24,000 hours
  - Contains Mercury in lamps
  - Poor Color Rendition (~20 CRI)
- LED
  - High initial cost per fixture
  - Unproven Rated Lifecycle
  - Limited Adoption No fixture or replacement parts standardization
  - Performance dependent on temperature
  - Unproven lifespan claims of over 50,000 hours
  - Increased glare
  - Improved light distribution
  - Contains no Mercury
  - High fixture efficacy (over 80 lm/W)
  - High Color Rendition (over 70 CRI)

Feedback from other Utilities, Municipalities, etc.

- PG&E
  - Conducting Multiple Projects, no LED fixtures list of Material Standards*
  - LED Fixture incentive program for customer-owned fixtures only
  - LED Fixtures added to tariff for customer-owned fixtures only
- SDG&E
  - Conducting Multiple Projects, no LED fixtures on list of Material Standards*
  - Also due to costs, is recommending Induction Fluorescent technology over LED for customer-owned lighting
- City of Los Angeles/Bureau of Street Lighting
  - Reported to have approved three or four manufacturers for LED Installation project.
  - Has installed a number of fixtures in various locations.
  - Some negative feedback from customers due to 'glare' of LED lights
- Arizona Public Service
  - Conducting multiple Pilot Projects, none on list of Material Standards*
- Grand Rapids, Michigan
  - Pilot Project fixtures removed, due to low light levels, energy savings not as advertised.
- Intolight/Puget Sound Energy (Seattle)
  - Has added some fixtures to Material Standards*. Has been a 'painful process'.
  - Added to Tariff – Requires a Customer Contract for 15-year minimum in service commitment.
- Georgia Power
  - Conducting Pilot Project, none on Material Standards*

In Summary – SCE and LED Streetlights Today

- Though LED costs are coming down and efficiencies are increasing, the costs are still too high and the life spans too uncertain for SCE to be able to recommend to the CPUC today that we be authorized to begin replacing existing HPSV lights with LEDs in LS-1 installations
- The high up-front cost of such a replacement would be reflected in streetlight customers' rates
- For LS-1 customers, proposing the early-adopter rate is the most SCE feels it can do today, consistent with its obligations to our cities and our customers
- SCE will continue to study and monitor the development of this technology and others that may emerge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