San Diego Zoo
Gift Shop
LED Lighting

ET11SDGE0003

October 28, 2011

Prepared for:

SDGE
A Sempra Energy utility®

Prepared by:

Emerging Technologies Associates, Inc.

Preface

PROJECT TEAM

This project is sponsored by San Diego Gas & Electric's (SDG&E®) Emerging Technologies Program (ETP), with Nate Taylor (NTaylor@semprautilities.com) as the project manager. Kevin Haupt, Facilities Director, was the contact and project manager for San Diego Zoo (SD Zoo). Daryl DeJean (daryldejean@gmail.com) of Emerging Technologies Associates, Inc. (ETA) provided technical consulting, data analysis, coordination of all parties involved and finalized the report.

DISCLAIMER

This report was prepared as an account of work sponsored by SDG&E® ETP. The SDG&E® ETP "is an information-only program that seeks to accelerate the introduction of innovative energy efficient technologies, applications and analytical tools that are not widely adopted in California. The information includes verified energy savings and demand reductions, market potential and market barriers, incremental cost, and the technology's life expectancy."

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ACKNOWLEDGEMENTS

SDG&E® and ETA would like to acknowledge SD Zoo for their cooperation in the project. Without their participation, this demonstration project would not have been possible.

Table of Contents

Abbreviations and Acronyms

CALiPER Commercially Available LED Product Evaluation and Reporting

CEC California Energy Commission

CEUS Commercial End-Use Survey

CT Current Transducer

DOE Department of Energy

ETA Emerging Technologies Associates, Inc.

ETP Emerging Technologies Program

GWh Gigawatt Hours

HVAC Heating Ventilation and Air Conditioning

kW Kilowatt

kWh Kilowatt hours

LCCA Life Cycle Cost Analysis

LED Light Emitting Diode

MW Megawatt

MWh Megawatt hours

PAR Parabolic Aluminized Reflector

SDG&E® San Diego Gas & Electric

SSL Solid State Lighting

W Watts

List of Figures

List of Tables

Executive Summary

San Diego Gas & Electric (SDG&E®) wanted to evaluate the potential of converting a retail store's focal point lighting entirely to LEDs. San Diego Zoo (SD Zoo), one of the most progressive zoos in the world, was searching for the "perfect" lighting solution for their gift shop. In late 2010, SD Zoo agreed to collaborate with SDG&E® to pursue the concept of a complete LED lighting "makeover." The objectives of this project were to evaluate the quality of LED lighting as compared to the base case halogen, determine the energy savings potential provided by the LED solution and ensure that the selected LED lamp met the gift shop's visual merchandising objectives. The SD Zoo gift shop was selected as the perfect test site since it is a relatively small area yet offered the challenge of meeting general illumination and focal point lighting needs.

SDG&E® retained Emerging Technologies Associates, Inc. (ETA) to manage the project, coordinate the participants and stakeholders, and conduct the data collection and analysis for the project. Pre and post installation field visits were conducted. Electrical power data for both the base case and the LED solution was collected and analyzed to determine energy and cost savings. The results of this project proved that LEDs provide an efficient, better quality lighting solution for focal point lighting applications. By switching each halogen MR16 lamp with a LED PAR20 focal point lamp and track head fixture, the electric energy and demand savings of 80% was achieved with a simple payback of 1.1 years. The results are shown in Table 1 and Table 2, respectively.

Table 1: Energy and Demand Savings

Lamp	System Wattage (W)**	Annual Operating Hours	Number of Lamps	Energy (kWh)	Demand (kW)	Energy Savings (%)
Halogen MR16 *	54.5	5,110	254	70,738	13.84	-
LED PAR20	11.0	5,110	254	14,277	2.79	80

** Base Case*
*** Wattage of lamp plus transformer*

Table 2: Simple Payback – Retrofit

Lamp	Cost/lamp ($)	Number of Lamps	Total Product Cost ($)	Energy (kWh)	Energy Cost/kWh ($)	Annual Energy Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (years)
Halogen MR16 *	7	254	1,778	70,738	0.18	12,733	-	-
LED PAR20	50	254	12,700	14,277	0.18	2,570	10,163	1.1

** Base Case*

This demonstration project will assist numerous retail store managers and owners across the country when considering LED technology as an option for retail focal point applications. It will meet their

energy efficiency goals while maintaining the desired product focal point lighting. Individual retail store requirements as well as economic considerations may directly impact the outcome of similar demonstration projects. Therefore, readers are advised that each installation is unique and due diligence is recommended in selecting the appropriate LED technology specific to their needs.

Based upon the findings of this project, it is recommended that future projects consider the following:

- understand the interactive nature of all kinds of lighting in the retail market for visual merchandising including ambient, focal point, perimeter, display case, etc.
- evaluation of impact of LEDs on heat load and total reduction in cooling requirements

Introduction

The main goal of retail store owners and managers is to increase sales. Hence, they are always looking for the best possible ways to promote their merchandise. One way retail store owners and managers have been able to create attractive looking displays that draw attention is through the use of focal point lighting. By catching the customer's attention, they will more likely shop longer and buy more items. Focal point lighting concentrates the light on a product in hopes of causing the customer to shift their attention (focus) to the product. It allows users to achieve a level of control since the direction or angle of focal point lighting can be changed. By installing a track, users can achieve an even greater level of control by moving lights to different locations throughout the store. Consequently, focal point lighting remains the preferred source of lighting in retail stores.

Retail merchants primarily use halogen light sources to provide focal point lighting. A halogen lamp uses a special gas mixture, higher temperatures, and special glass to improve lamp life. Halogen lamps offer various advantages including a narrow beam to concentrate the light, good lamp life and great color (very clean, bright white light). Drawbacks associated with halogen lamps include extremely high bulb temperatures (halogen lamps do not have a second glass envelope that limits bulb surface temperatures). The resulting increase in heat load adds to the space cooling needs.

SDG&E® was interested in evaluating the potential of converting the focal point lighting in a retail store entirely to LEDs. In response to the excitement surrounding solid-state lighting (SSL), SD Zoo agreed to a LED lighting "makeover" for their gift shop. LEDs offer various advantages over traditional methods in a retail scenario including reduced energy consumption, longer operating life, lower maintenance and life-cycle costs, reduced radiated heat, minimal light loss, controllability, directional illumination, and adjustable color when compared to traditional sources.[1]

Other than improving the quality of their lighting, SD Zoo also wanted to create a cooler "atmosphere" and utilize the visual attributes of LED lighting to enhance the appearance of the gift shop merchandise. According to Kevin Haupt, Facilities Director, "The excessive use of halogen lamps for focal point lighting to display merchandise created extensive heat at the SD Zoo gift shop. This results in our HVAC system operating more than if the lighting did not produce as much heat." Moreover, halogen lamps require frequent replacement. SD Zoo hoped that by switching to LEDs, they could reduce their maintenance costs since LEDs are presumed to have a longer life than traditional light sources.

[1] Navigant Consulting, Inc. (2008). "Savings Estimates of Light Emitting Diodes in Niche Lighting Applications."

Project Objectives

The SDG&E® ETP conducted the San Diego Gift Shop LED Lighting project with the following objectives:

- identify potential LED application in the retail market sector, specifically for focal point lighting applications
- perform a visual comparison of the quality of LED technology against traditional high power halogen technology in focal point lighting applications
- validate manufacturer's claims regarding energy savings
- determine energy savings potential of LEDs
- determine customer acceptance levels of LED technology

Project Background

TECHNOLOGICAL OVERVIEW

LED lighting in the retail merchant applications has been gaining momentum because of the ability to provide greater control of light dispersion and maintenance savings potential. At the time of this assessment, using LEDs looked promising in retail display lighting because of their potential for reduced energy consumption.

This project focused on high brightness, focal point lighting used to provide quality lighting for retailers to display their products. Focal point lighting is the second most common type of lighting in retail display lighting, following linear fluorescent track lighting, which is used to provide accent or display case lighting.[2] Currently, in many applications focal-point lighting is accomplished with halogen MR16 lamps. Halogen MR16s have dominated the retail lighting market for many years due to their excellent performance and low cost compared to ceramic metal halide or LED.

New LED lighting technologies have the potential to meet the needs of retailers in many in-store design and visual merchandising applications previously met by incandescent, halogen and fluorescent lighting systems. Manufacturers claim high quality lighting can be achieved by LEDs at a fraction of the energy consumption, while providing longer life and ensuing reduced maintenance. It is believed that such light quality needs as high color rendition and contrast can be coupled with lower operating cost and reduced energy usage can be met by LEDs. Currently, the initial price of LED technology is much higher than conventional light sources, causing a significant barrier of entry into the retail market. This sector has been dominated by traditionally low operating margins and thus retailers have been forced to delay adoption of new technologies until a mass market brings down prices.

Information from the US Department of Energy suggests LED technology is changing at a rapid pace such that, “commercial white LED device efficacies have increased from 100 lumens per watt in 2008 to as high as 124 lumens per watt in 2010.”[3] Due to these rapid advances in this field, it is expected that even more robust LED products will be entering the market which may permit not only direct one-for-one replacement scenarios, but retail lighting designs requiring reduced luminaires.

MARKET OVERVIEW

The advancement of LED technology since the advent of white LEDs presents some significant opportunities in retail lighting. According to an article published in the Architectural Lighting Magazine in March 2003, “A high quality, energy-efficient lighting system can help add to a retailer’s competitive

[2] Navigant Consulting, Inc. (2008). “Savings Estimates of Light Emitting Diodes in Niche Lighting Applications.”
[3] Navigant Consulting, Inc. (2011). “Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications.”

advantage by attracting more customers and reducing operating costs, while directly helping the company's bottom line." The U.S. EPA ENERGY STAR program's retail experts claim that "grocery stores saving $1 in energy costs can improve profits as much as increasing sales by $80."[4]

The California Energy Commission (CEC) conducted the California Commercial End-Use Survey (CEUS), a comprehensive study of the state's commercial sector energy use. Based on this study, California's total commercial electric consumption can be estimated to be 67,077 GWh annually (Table 3). The retail sector, one of the biggest consumers of the states total electricity, consumes 14.7% (Figure 1) or 9,871 GWh annually.

Table 3: Overview of Energy Usage in the Statewide Service Area

Building Type	Floor Stock (kft^2)	Annual Energy Intensities			Total Annual Usage	
		Electricity (kWh/ft^2)	Natural Gas ($therms/ft^2$)	Natural Gas ($kBtu/ft^2$)	Electricity (GWh)	Natural Gas (Mtherms)
All Commercial	4,920,114	13.63	0.26	25.99	67077	1278.60
Small Office (<30k ft^2)	361,584	13.10	0.11	10.54	4738	38.10
Large Office (>=30k ft^2)	660,429	17.70	0.22	21.93	11691	144.80
Restaurant	148,892	40.20	2.10	209.98	5986	312.60
Retail	702,053	14.06	0.05	4.62	9871	32.50
Food Store	144,209	40.99	0.28	27.60	5911	39.80
Refrigerated Warehouse	95,540	20.02	0.06	5.60	1913	5.30
Unrefrigerated Warehouse	554,166	4.45	0.03	3.07	2467	17.00
School	445,106	7.46	0.16	15.97	3322	71.10
College	205,942	12.26	0.34	34.24	2524	70.50
Health	232,606	19.61	0.76	75.53	4561	175.70
Lodging	270,044	12.13	0.42	42.40	3275	114.50
Miscellaneous	1,099,544	9.84	0.23	23.34	10817	256.60
All Offices	1,022,012	16.08	0.18	17.90	16430	182.90
All Warehouses	649,706	6.74	0.03	3.44	4380	22.40

[4] http://www.archlighting.com/industry-news.asp?sectionID=0&articleID=453132

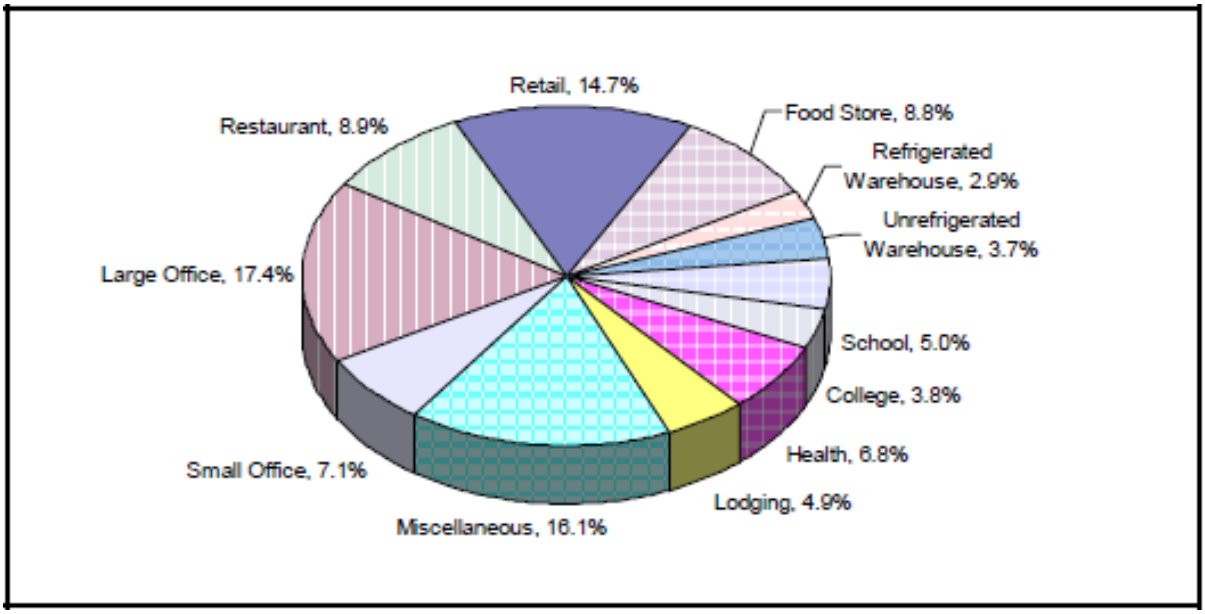

Figure 1: Commercial Electricity Use by Building Type

Within the retail sector, interior lighting consumes the most electricity accounting for 4,246 GWh annually (Table 4)[5]. Assuming SDG&E® service territory equates to approximately 7.3% of California's total electricity consumption[6], it is estimated that SDG&E's retail sector consumes approximately 310 GWh for interior lighting purposes.

Table 4: Electric Usage (GWh) by Building Type and End Use

Building Type	Heat	Cool	Vent.	Refrig.	WH	Cook	Int. Ltg.	Ext. Ltg.	Office Equip.	Misc.	Air Comp.	Motors	Proc.	Total
All Commercial	1,087	10,017	8,000	9,014	611	2,805	19,265	3,916	4782	3924	204	2811	642	67,077
Small Office	72	943	467	208	90	38	1,386	343	793	283	1	79	36	4,739
Large Office	322	2358	2,019	268	80	77	2,445	324	2365	383	18	474	60	11,691
Restaurant	7	858	482	1,469	56	1,546	961	300	94	168	1	41	3	5,986
Retail	38	1503	1,207	720	96	197	4,246	644	343	483	37	201	64	9,871
Food Store	12	415	372	3,233	20	266	1,233	137	54	138	1	26	6	5,911
Refrigerated Warehouse	2	31	23	1284	3	3	262	33	17	55	4	174	22	1,913
Unrefrigerated Warehouse	20	183	156	154	26	12	1,223	145	131	215	9	162	32	2,467
School	56	520	429	225	43	78	1,281	330	206	110	1	37	7	3,322
College	159	393	423	95	25	55	790	188	148	100	2	119	28	2,524
Health	166	901	940	166	18	101	1,119	132	200	586	1	181	50	4,561
Lodging	114	650	483	244	9	185	945	165	46	301	0	128	6	3,275
Miscellaneous	104	1,212	941	942	145	287	2,874	1,175	386	1103	129	1190	330	10,817
All Offices	393	3,301	2,485	476	171	115	4,331	666	3157	666	19	553	95	16,430
All Warehouses	22	214	179	1,438	28	15	1,485	178	148	270	13	336	54	4,380

[5] http://www.energy.ca.gov/2006publications/CEC-400-2006-005/CEC-400-2006-005.PDF
[6] Based upon statistics located at http://www.ecdms.energy.ca.gov/elecbyplan.aspx data found in Appendix A

The US DOE conducted a study to analyze niche markets and applications for LEDs. The findings of this study can be found in the report titled, "Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications."[7] The total installed base for MR16 lamps is estimated at 78.4 million for the US commercial sector (Figure 2). Since California consumes roughly 6.9% of US electrical energy consumption[8], California has an estimated 5.4 million MR16 lamps installed. Based upon SDG&E® service territory accounting for approximately 7.3% of California's electricity consumption[9], SDG&E® has an estimated installed base of 394,200 MR16 lamps in its service territory operating 5,110 hours annually. Total market adoption for all MR16 lamps would result in a reduction of 22,257 GWh and a demand of 4.4 GW. Assuming 5% market penetration each year would result in an electricity savings of approximately 1,112 GWh annually. In SDG&E® service territory, this translates into 218 MW of reduced demand. Although these figures are not exclusively for display case and focal point retail display lighting using MR16 lamps, including accent lighting, the figures give an idea of the significant potential that exists for savings.

Lamp Type	Percentage	Number of Lamps (000's)		
		Residential	Commercial	Total Lamps
MR16	98.3%	41,800	78,400	120,000
MR16 LED	1.7%	-	2,000	2,000
Total	**100%**	**41,800**	**81,400**	**122,000**

Figure 2: MR16 Replacement Lamp Installed Base

The penetration of LEDs into the retail lighting display niche is of importance for energy efficiency measures because this application normally involves high-power, high-brightness fixtures or lamps. Currently, the market penetration of LEDs in the retail display sector is estimated to be at a minimum since LED lamps with performance characteristics comparable to halogen MR16 lamps have only recently become available. Additionally, retailers are typically looking for a direct replacement solution to eliminate the cost of changing the fixture. Further market penetration is expected to increase, as efficacy increases. [10]

[7] http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_january2011.pdf
[8] http://apps1.eere.energy.gov/states/electricity.cfm/state=CA#total
[9] Based upon statistics located at http://www.ecdms.energy.ca.gov/elecbyplan.aspx data found in Appendix A
[10] Navigant Consulting, Inc. (2008). "Savings Estimates of Light Emitting Diodes in Niche Lighting Applications."

Methodology

HOST SITE INFORMATION

The world famous San Diego Zoo (SD Zoo) is located in Balboa Park, San Diego, California. It hosts over 4,000 animals and 800 species and sits on 100 acres of parkland leased from the City of San Diego. The general illumination and focal point lighting was provided by 254 fixtures of 54.5-watt (system) halogen MR16 lamps in the SD Zoo gift shop. The fixtures were mounted at a height of twelve feet with spacing of six feet between the halogen MR16 fixtures. Even though daylight is available, the gift shop lights remain on for 14 hours each day (5,110 hours annually) since the gift shop is a common area for customers to shop and purchase items. SD Zoo's blended electric cost is $0.18 per kWh.

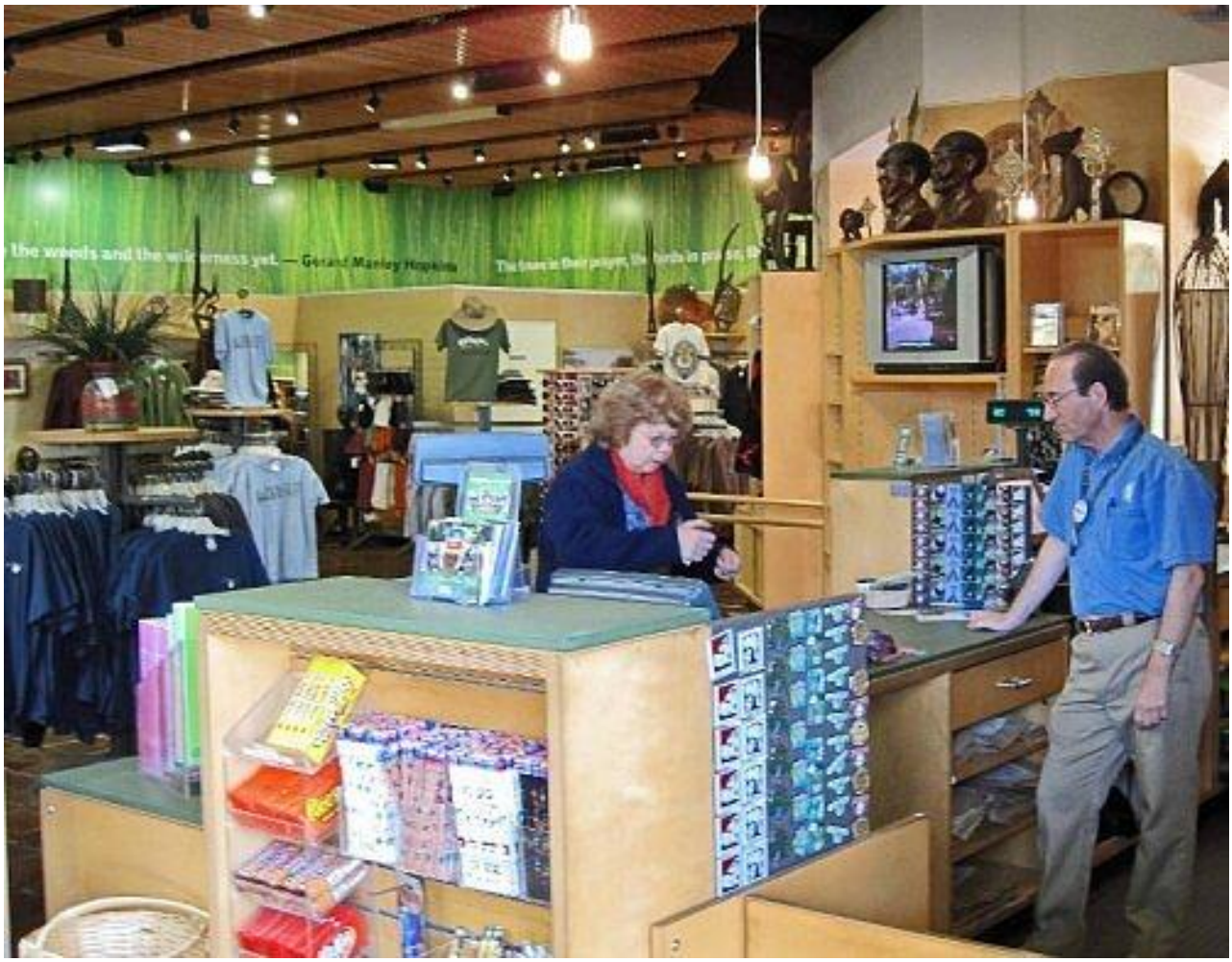

Figure 3: The SD Zoo gift shop used halogen MR16 lamps before which produced excessive heat.

Figure 4: The new LED PAR20 lamps provided better light, reduced heat, and provided substantial savings for the SD Zoo gift shop.

MEASUREMENT PLAN

SDG&E® retained Emerging Technologies Associates, Inc. to manage the San Diego Zoo Gift Shop LED Lighting project, coordinate the participants and stakeholders, and conduct the data collection and analysis for the project. SDG&E® selected and arranged for the installation of LED lighting in the gift shop to do a one-to-one replacement of the existing halogen MR16 lamps used for general illumination and focal point lighting with LED PAR20 lamps. With a total of 254 halogen MR16 lamps installed in the gift shop, this demonstration project allowed for an ideal comparison of the base case with the LED solution. Pre and post installation field visits were conducted. Electric power data for both the base case and the LED solution was collected utilizing a Hobo data logger and current transformer (CT). To ensure visual acceptance, the SD Zoo retail team was asked for their opinion. The team reviewed the "new" lighting to determine acceptance ensuring the design and ambiance of the gift shop were maintained. A detailed measurement plan can be found in Appendix B.

EQUIPMENT

The following equipment was used to collect the power characteristic data. The logger and CT were calibrated as per manufacturer specifications.

Power reading:

HOBO U12 DATA LOGGER
ACCURACY: ± 2 mV ± 2.5% of absolute reading;
± 2 mV ± 1% of reading for logger-powered sensors

HOBO CURRENT TRANSFORMER
ACCURACY: ± 1%

Project Results

ELECTRICAL ENERGY AND DEMAND SAVINGS

The gift shop lighting consisted of 254 halogen MR16 lamps. Even though daylight is available, the lights remain on 14 hours per day. Each halogen MR16 lamp and fixture consumed 54.5 watts and was retrofitted by LED PAR20 focal point lamp and track head. The new lighting consumed 11.0 watts which resulted in 80% reduction in power. The results are shown in Table 3.

Table 3: Energy and Demand Savings

Lamp	System Wattage (W)**	Annual Operating Hours	Number of Lamps	Energy (kWh)	Demand (kW)	Energy Savings (%)
Halogen MR16 *	54.5	5,110	254	70,738	13.84	-
LED PAR20	11.0	5,110	254	14,277	2.79	80

** Base Case*
*** Wattage of lamp plus transformer*

ECONOMIC PERFORMANCE

It is important to note that the cost and fixture assumptions made in this section apply only to SD Zoo. SD Zoo was demonstrating the substitution of halogen light source. Readers should consider their specific variables such as maintenance, energy, luminaire/lamp costs and requirements for dimming before drawing any conclusions about the cost effectiveness of LED lamps or luminaires. For LED lamps and luminaires, luminaire/lamp lifetime is a function of all components of the luminaire (LEDs, driver, housing, coatings, etc.), electrical and thermal properties. Therefore, manufacturer claims, with regard to the aforementioned factors, are highly variable.

1. Energy Cost Estimates

The energy cost is based upon the SD Zoo's blended rate of $0.18 per kWh and the gift shop lighting operates 5,110 hours annually. This project focused on the replacement of halogen focal point lighting in the gift shop with LED lighting technology. Table 4 provides the energy cost and savings for the base case halogen MR16 and the new LED PAR20 lamps with track head.

Table 4: Energy Cost Savings Achieved

Lamp	Number of Lamps	Energy (kWh)	Energy Cost/kWh ($)	Annual Energy Cost ($)	Annual Energy Cost Savings ($)	Annual Energy Savings (%)
Halogen MR16 *	254	70,738	0.18	12,733	-	-
LED PAR20	254	14,277	0.18	2,570	10,163	80

** Base Case*

The simple payback calculation considered the product cost and energy savings for the LED solution. The results are shown in Table 5 and 6, respectively.

Table 5: Simple Payback – Retrofit

Lamp	Cost/lamp ($)	Number of Lamps	Total Product Cost ($)	Energy (kWh)	Energy Cost/kWh ($)	Annual Energy Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (years)
Halogen MR16*	7	254	1,778	70,738	0.18	12,733	-	-
LED PAR20	50	254	12,700	14,277	0.18	2,570	10,163	1.1

** Base Case*

Table 6: Simple Payback – New Construction

Lamp	Cost ($)	Total Incremental Cost ($)	Number of Lamps	Total Incremental Product Cost ($)	Energy (kWh)	Energy Cost/kWh ($)	Annual Energy Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (years)
Halogen MR16 *	30	-	254	-	70,738	0.18	12,733	-	-
LED PAR20	50	20	254	5,080	14,277	0.18	2,570	10,163	0.5

** Base Case*

2. Luminaires and Lamp Life

For LED technology, a properly designed fixture is required, meaning electrically and thermally, to achieve the life expectancy. If the fixture has poor electrical or thermal design, the light source life is adversely affected resulting in a much shorter life.

James Brodrick, Lighting Program Manager, U.S. Department of Energy, Building Technologies Program, in a recent article entitled "Lifetime Concerns", when discussing how best to define the longevity of LED luminaires stated: "That's not a simple matter, because it doesn't just involve the LED themselves, but rather encompasses the entire system-including the power supply or driver, the electrical components, various optical components and the fixture housing."

The manufacturers of the LED luminaires assessed in this project claim life expectancies of 50,000 hours (approximately 10 years at 5,110 operating hours per year).

3. Life Cycle Cost Analysis

Even though life cycle cost analysis (LCCA) was not part of the scope of this project, a full LCCA is recommended. There are many variables and considerations that are specific to each reader's situation. It is recommended that variables such as labor, cost of materials, maintenance practices, cost of financing, inflation, energy rates, material cost, product life, etc. be determined for the specific project under evaluation.

Due to the uncertainty as to future labor, product and other costs, especially for LED technology, readers are recommended to use their judgment and do their own due diligence regarding the future costs. Due to the rapid advancements in LED technology, the pricing of the products may be reduced. Readers are encouraged to obtain current price quotes for halogen and LED lamps. Furthermore, each project's economic analysis will yield its unique set of results depending upon the project sponsors and site requirements.

A visual inspection of the LED lighting was conducted by the Facilities Director and Retail Team of SD Zoo and the SDG&E® Project Team. The purpose was to determine if the LED solutions met the gift shops expected light levels and focus on the products. The LED illumination was aesthetically pleasing and SD Zoo Retail Team expressed an overwhelming endorsement and acceptance of LED technology as a desirable lighting solution.

Conclusion

This demonstration project proved that LED lighting can be a good solution for lighting requirements in the retail sector, especially for focal point applications. For the SD Zoo gift shop, the LED solution proved to be a viable option. In addition, this LED solution of a lamp and a track head replacement is applicable to many other retail lighting applications. However, due to the unproven long life of LEDs, economic and reliability claims are based on the best available information from the manufacturer and DOE reports.

This demonstration project validated that properly designed LED lamps can provide energy savings of 80% without compromising the lighting performance required for gift shop focal point applications. A lesson learned during this demonstration project is that there are many factors that may be unique and require careful consideration. Each reader should consider their capital budgeting needs, maintenance and installation, as well as any internal lighting standards. While the results of this demonstration indicate significant energy savings potential when LED lighting is used instead of halogen lighting, readers are encouraged to complete a life cycle cost analysis to gain the complete economic picture of a technological change out. Therefore, it is important to note that each situation is different. Prior to committing to a technology, readers should conduct their own pilot or mini demonstration of the available options to determine the economic feasibility of their particular project.

For general information and programs on LED technology, it is recommended visiting the DOE SSL website: www1.eere.energy.gov/buildings/ssl. A recommended resource to assist in selecting LED solutions that have been mystery shopped to validate manufacturer claims is the DOE SSL Commercial Available LED Product Evaluation and Reporting (CALiPER) website: www1.eere.energy.gov/buildings/ssl/caliper.html. Other resources include the ENRGY STAR website: www.energystar.gov and the Lighting Facts website: www.lightingfacts.com.

Appendix A

SDG&E® Market Potential Calculations Reference

California Electricity Statistics & Data

ECDMS The California Energy Commission
Energy Consumption Data Management System

http://www.ecdms.energy.ca.gov/elecbyplan.aspx

Electricity Consumption by Planning Area

Planning Area Description	Year	Total Usage *
Burbank, Glendale, and Pasadena	2005	3,394
Dept. of Water Resources	2005	8,283
Imperial Irrigation District	2005	3,232
Los Angeles Department of Water	2005	24,638
Other	2005	1,748
Pacific Gas and Electric	2005	101,460
Sacramento Municipal Utility District	2005	10,523
San Diego Gas & Electric	**2005**	**19,910**
Southern California Edison	2005	99,261
TOTAL		272,449

*All Usage Expressed in Millions of kWh

SDG&E® **7.3 %**

Appendix B

SDG&E® Emerging Technology Demonstration
LED PAR Monitoring Procedure

Pre-Installation Procedure:

1. Verify and record the wattage of existing lamps.
2. Coordinate with staff to remove and replace the existing halogen MR16 lamps with LED PAR20 lamps.

Energy Usage - Procedure:

3. After new lamps have been placed, complete the standard test recordings as outlined below:
    a) Coordinate with staff and isolate the electric circuit(s) that serves the halogen MR16 lamps that will be retrofitted with the LED PAR20 lamps.
    b) Install the power data logger (with help from staff) to monitor the circuit and record an instantaneous power reading, including kW, volts, amps, and power factor. Leave data logger on for a period of 7 days.
    c) With a handheld illuminance meter, measure the amount of light striking the standard surface height (i.e. 42" AFF, at waist height) in the area served by the incandescent and halogen lamps to be retrofitted. Illuminance shall be recorded in a grid pattern to account for light under and between fixtures.
    d) With handheld illuminance meter, measure the amount of light striking below the lamps. Foot-candle readings shall be taken directly underneath the lamp.

Post Installation – Procedure:

4. Remove data logger and return to normal operation.
5. At this point, verify with client proper lighting levels to be left at end of assessment testing.
6. Finally, LED PAR20 lamps shall remain in place or be removed, at client's discretion.