Department of Veterans Affairs

LED Task Light

ET10SDGE0007

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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. Jon Coger, Energy Manager, was the contact and project manager for the Veterans Administration Medical Center San Diego (VA). 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 (all actual measurements unless stated otherwise), 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 VA for their cooperation in the project. Without their participation, this demonstration project would not have been possible.

Table of Contents

Abbreviations and Acronyms

ALCS Advanced Lighting Controls System

ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers

BMS Building Management Systems

CALiPER Commercially Available LED Product Evaluation and Reporting

DOE Department of Energy

DR Demand Response

EEBI Energy Efficiency Business Incentives

ESB Energy Savings Bid

ETA Emerging Technologies Associates, Inc.

ETP Emerging Technologies Program

GHG Greenhouse Gas

GWh Gigawatt hour

kW Kilowatt

kWh Kilowatt hours

LCCA Life Cycle Cost Analysis

LED Light Emitting Diode

MW Megawatt

MWh Megawatt hours

OTF Office of the Future

OTFC Office of the Future Consortium

SDG&E San Diego Gas & Electric

SQFT Square Feet

SSL Solid State Lighting

VA Veteran's Administration

W Watts

List of Tables

Executive Summary

In December 2010, San Diego Gas & Electric (SDG&E®) completed stage one, phase one (overhead lighting) of the four-stage assessment at the Veteran's Administration Medical Center San Diego (VA) as part of the Office of the Future Consortium's 25% Solution. This project is stage one, phase two (task lighting) of the four-stage project. The purpose of this technology assessment project was to determine the impact of LED task lights, one of the categorical measures recommended by the Office of the Future Consortium's (OTF Consortium) 25% Solution as provided by the New Buildings Institute.

The 25% Solution was developed by the OTF Consortium to assist tenants, building owners and managers in reducing site electrical energy use in office spaces by 25% or more. In developing the categorical measures, Title 24-2005 served as a baseline for minimum performance in California and ASHRAE 90.1-2004 as the minimum baseline for the rest of the country. The 25% Solution addresses energy reduction potential in the following categories: lighting, plug loads, and HVAC systems. It promotes a comprehensive "systems" approach to achieve persistent energy reductions while improving lighting quality and HVAC performance. The recommended 25% Solution applies to new construction and retrofit projects and does not address categories such as central systems, exterior lighting, elevators and central corridors.

The VA is a six-story building located in San Diego, CA. It has various offices building-wide utilizing task lights. The project consisted of replacing thirty 40-watt fluorescent task lights with 21-watt LED task lights with occupancy sensors. 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.

This project proved in favor of LED task lights as a more efficient lighting solution for task lighting applications than fluorescents. An estimated electrical energy and demand savings of 48% was achieved. The simple payback was calculated for both new construction and retrofit scenarios. The results of these are shown in Tables 1, 2, and 3, respectively.

Table 1: Energy and Demand Savings

Lamp	System Wattage (W)	Annual Operating Hours	Number of Lamps	Energy (kWh)	Demand (kW)	Energy Savings (%)
Fluorescent *	40	1,757	30	2,108	1.20	-
LED	21	1,757	30	1,107	0.63	48

* *Base Case*

Table 2: 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)
Fluorescent *	135	-	30	-	2,108	0.43	907	-	-
LED	270	135	30	4,050	1,107	0.43	476	431	9.4

* *Base Case*

Table 3: 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)
Fluorescent *	7	30	210	2,108	0.43	907	-	-
LED	270	30	8,100	1,107	0.43	476	431	18.3

* *Base Case*

The results of this project will assist numerous facility managers and building owners across the country when considering LED technology as an option for task lighting applications. It will enable them to meet their energy efficiency goals while maintaining employee comfort and productivity. Local site requirements, lighting design, as well as economic considerations may directly impact the outcome of similar assessment projects. Readers are advised that each installation is unique and recommended to exercise due diligence in selecting the lighting technology appropriate to their needs.

SDG&E's Emerging Technologies Program's intention was to continue the staged approach to projects allowing each categorical measure to be isolated and its effectiveness determined. Future planned projects include the following:

- efficient plug load measures
- performance review and integration of HVAC and building management system (BMS) with ALCS
- demand response measures

Introduction

San Diego Gas & Electric (SDG&E®) was interested in evaluating LED technology for task lighting. Veteran's Administration Medical Center San Diego (VA) agreed to participate in an assessment to determine the viability of LED task lighting for their offices. The goal of this project was to demonstrate the potential of LED task lights as a viable replacement lighting solution and determine the energy savings potential provided by LED task lights as compared to fluorescent base case.

With the continued advancement of LED light sources and published claims that LEDs have a longer lamp life than traditional sources, there is an interest in determining the validity of LEDs as a solution in numerous office lighting applications, including task lights. In collaboration with SDG&E, VA desired to continue the four-staged assessment as part of the Office of the Future Consortium's 25% Solution. This project is stage one, phase two of the four-stage project that will ultimately provide up to a 75% reduction in energy consumption in offices. It consisted of replacing thirty 40-watt fluorescent task lights with 21-watt LED task lights with occupancy sensors. 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.

The results of this project will help tenants, building owners and managers understand the value of implementing the 25% Solution. By doing so, the hope is to achieve rapid adoption of the recommendations provided by the 25% Solution.

Project Objectives

The SDG&E® ETP conducted the VA LED Task Light project with the following objective:

- continue the staged approach of the 25% Solution by identifying potential LED solution for task lighting applications

Project Background

TECHNOLOGICAL OVERVIEW

The 25% Solution contains categorical measures and design providing an integrated solution to reduce energy in office spaces. The general areas of the 25% solution are:

- High Quality Lighting Design
- Efficient Plug Load Measures
- HVAC Performance Review
- Advanced Metering
- Demand Response Thermostats (where applicable)

The 25% Solution is designed to be a low-impact, high efficiency, easily implemented integrated solution coupled with tenant and owner education to ensure savings persistence.[1] Historically, energy savings from lighting have resulted primarily from component retrofits in existing fixtures. Due to such retrofits having achieved significant market penetration, a new fresh approach to achieve deeper savings must be considered.

Energy and demand can be reduced through a combination of lighting technologies, luminaire selection, lighting layout and controls. No longer can we solely focus on one element of technology, i.e., integration of all elements of the system considering the interactions and relationships of lamps, ballasts, fixtures, lighting design, daylighting, and lighting controls. Instead a synergistic combination of strategies offers not only higher quality lighting, but optimum energy savings as well. The 25% Solution's recommended designs and measures enhance lighting quality and provide options for personal control, which have been linked to increased visual comfort, satisfaction, health and productivity.

MARKET OVERVIEW

The largest areas of energy use in office buildings are interior lighting, plug loads (computers, office equipment, etc.), ventilation to ensure adequate fresh air, and heating and cooling. Implementation of the 25% Solution recommended lighting designs, measures and practices represents a significant energy efficiency, demand reduction and demand response opportunity in the commercial sector for retrofit as well as new construction applications. Statewide interior lighting energy use for the large

[1] SCE Engineering & Design Services, "Office of the Future Phase II Report – The 25% Solution," ET 08.01 Final Report

and small office sectors is 4,331 GWh/year (Table 4). Commercial lighting energy use in general is responsible for roughly 29% of total statewide energy use.[2]

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	19,165	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	2,945	324	2365	383	18	474	60	11,691
Restaurant	7	858	482	1,469	56	1,546	981	300	94	168	1	41	3	5,986
Retail	55	1553	1,267	726	96	157	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

The measure of the 25% Solution evaluated in this report better enable customers to understand the importance of selecting the proper lighting technology and how it enhances their energy efficiency and demand reduction capabilities. These benefits may contribute to an increased market penetration of high efficient task lighting.

PROGRAMS

SDG&E® offers various programs and services for businesses to promote market adoption help lower their energy usage and manage costs. Some of their energy-savings programs include rebates, incentives, on-bill financing, and Demand Response (DR).

Rebates are the easiest way for businesses to offset costs of energy-efficient purchases. With SDG&E's Energy Efficiency Business Rebates program, businesses can earn cash rebates with the purchase of new energy-efficient equipment such as lighting, refrigeration, ventilation, food service and more. Through its Energy Efficiency Business Incentives (EEBI) and Energy Savings Bid (ESB) programs, SDG&E® offers cash incentives for customers who replace existing equipment or install new high efficiency equipment. On-Bill Financing offers eligible businesses zero-percent financing for qualifying energy-efficient business improvements and works in conjunction with SDG&E's incentive and rebates

[2] PG&E Report , Advanced Lighting Controls for Demand Side Management (reports 0806, 0813, 0814), Energy Solutions, 2009

programs. Moreover, with the DR programs, businesses that can lower their energy use during peak demand or shift their electricity use to off-peak hours are eligible to receive bill credits, payments or other incentives.

SDG&E® also offers online tools to help businesses manage energy use. Some of its online tools include kWickview, Benchmarking, Energy Waves, and Energy Challenger. There are also seminars, training workshops, and on-site energy consultations available as well. For more information on SDG&E® energy efficiency programs, it is recommended visiting the SDG&E® energy efficiency website: http://www.sdge.com/business/rebatesincentives/programs/allPrograms.shtml.

Methodology

HOST SITE INFORMATION

The Office of the Future 25% Solution assessment stage one, phase two (task lighting) was hosted by the Veterans Administration Medical Center San Diego (VA). The office area chosen to evaluate the potential of LED task lights is approximately 3040 sqft in the Engineering Department. This area is located in a six-story building dominated by an open floor plan with cubicles. There were thirty task lights evaluated in this study.

The base case lighting for task light application was fluorescent, T8 magnetic ballasts, consuming 32 watts with system wattage of 40 watts. The task lights operate 1,757 hours annually (11.5 hours/day 251 days/year). VA's blended electric cost is $0.43 per kWh.

MEASUREMENT PLAN

SDG&E® retained Emerging Technologies Associates, Inc. to manage the VA LED Task Light project, coordinate the participants and stakeholders, and conduct the data collection and analysis for the project. In collaboration with VA, SDG&E® selected and arranged for the installation of LED task lights as replacement for the fluorescent base case. The 40-watt fluorescent task lights were substituted with 21-watt LED task lights.

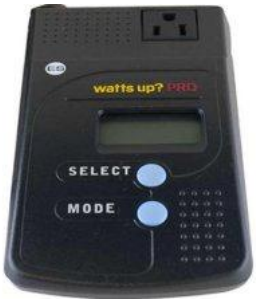
Pre and post installation field visits were conducted. Electrical power data for the fluorescent and the LED case was collected utilizing a WattsUp Pro meter. Meetings with VA were conducted to determine acceptability of the lighting quality. Spot foot candle readings were taken to confirm that lighting levels met the required minimum as set forth in state code.

The acceptability of the technology was determined by VA's acceptance of the light levels, power usage and economic factors. The LED task lights exceeded visual expectations resulting in Jon Coger expressing an overwhelming endorsement and acceptance of LED technology as a desirable lighting solution.

EQUIPMENT

The following equipment was used to collect the power characteristic data. The meter was calibrated as per manufacturer specifications.

Power reading:



WATTSUP PRO
ACCURACY: ± 1.5%

Project Results

ELECTRICAL ENERGY AND DEMAND SAVINGS

The base case consisted of thirty fluorescent task lights with a measured demand of 40 watts. The retrofit LED task light's measured demand is 21 watts, resulting in a reduction in power of 48%. The results are shown in Table 5. Since the LED task lights have occupancy sensors, a further reduction of two hours per day is expected, which will further add to the energy savings and lower the payback.

Table 5: Energy and Demand Savings

Lamp	System Wattage (W)	Annual Operating Hours	Number of Lamps	Energy (kWh)	Demand (kW)	Energy Savings (%)
Fluorescent *	40	1,757	30	2,108	1.20	-
LED	21	1,757	30	1,107	0.63	48

* *Base Case*

ECONOMIC PERFORMANCE

It is important to note that the cost and fixture assumptions made in this section apply only to VA. VA demonstrated the substitution of fluorescent task lights with LED task lights. 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 VA's blended rate of $0.43 per kWh. VA office task lighting operates 1,757 hours annually. Table 6 provides the energy cost and savings estimate assuming all task light lighting was converted from the base case fluorescent to LED lamps/luminaires.

Table 6: Energy Cost Savings Achieved

Lamp	Number of Lamps	Energy (kWh)	Energy Cost/kWh ($)	Annual Energy Cost ($)	Annual Energy Cost Savings ($)	Energy Savings (%)
Fluorescent *	30	2,108	0.43	907	-	-
LED	30	1,107	0.43	476	431	48

* *Base Case*

The simple payback calculations considered the total investment cost and energy savings for the LED solution. The results are shown in Tables 7 and 8, respectively.

Table 7: 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)
Fluorescent *	7	30	210	2,108	0.43	907	-	-
LED	270	30	8,100	1,107	0.43	476	431	18.3

* *Base Case*

Table 8: 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)
Fluorescent *	135	-	30	-	2,108	0.43	907	-	-
LED	270	135	30	4,050	1,107	0.43	476	431	9.4

* *Base Case*

2. Luminaires and Lamp Life

This report uses 50,000 hours as the LED life expectancy, per the DOE website.[3] 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."

Actual performance data documenting the life of LED luminaires/lamps is evolving due to the relative infancy of LED technology for task lighting application. In this project, the LED life is approximately 29 years. The payback period for retrofit and new construction, 18.3 and 9.4 years respectively, does not include maintenance in the economic analysis

While LED technology appears to be a viable option for task lighting, LED product quality can vary significantly among manufacturers. It is recommended that readers exercise due diligence when selecting LED technology for any application. Readers should also be aware that LED life and lighting performance are dependent upon proper thermal and electrical design. Without the latter, premature failure may occur. Readers must properly assess the potential risk associated with LED technology that has not undergone proper testing.

[3] http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/lifetime_white_leds.pdf

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. With the rapid advancement of LED technology, the pricing of the products may be reduced. Readers are encouraged to obtain current price quotes for fluorescent, CFL and LED lamps. Furthermore, each project's economic analysis will yield its unique set of results depending upon the project sponsors and site requirements.

Conclusion

This project validated that properly designed LED task lights can provide energy savings of 48% without significantly compromising the lighting performance (as observed by spot measurements) required for task light applications. Since the LED task lights include occupancy sensors, a further reduction of two hours per day is expected, which will further add to the energy savings and lower the payback. While the results of this project indicate significant energy savings potential when LED task lighting is used instead of fluorescent, readers are encouraged to complete a full life cycle cost analysis to gain the complete economic picture of a technological change out.

In this project, the LED life is approximately 29 years. The payback period for retrofit and new construction, 18.3 and 9.4 years respectively, does not include maintenance in the economic analysis. the payback is shorter than the life of the LED solution, it will help numerous facility managers and building owners across the country when considering LED technology as an option for task lighting applications, meeting their energy efficiency and greenhouse gas (GHG) emission reduction goals.

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.