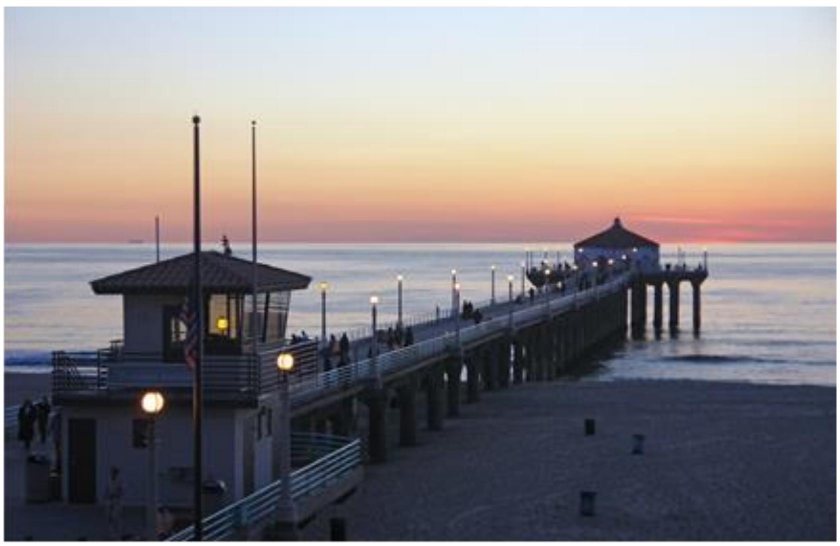
City of Manhattan Beach



Street Lighting Energy Audit

Project Number: 2587.01
Date: 8/17/2016

Newcomb | Anderson | McCormick
ENERGY ENGINEERING AND CONSULTING
201 Mission Street, Suite 2000, San Francisco, CA 94105
Phone: (415) 896-0300 Fax: (415) 896-1900

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SECTION 1:

EXECUTIVE SUMMARY

In 2010 the City of Manhattan Beach (the City) developed a Climate Action Plan to work towards reducing their greenhouse gas emissions levels to 7% below 1990. This Climate Action Plan incorporated findings from a 2009 audit report, which highlighted measures and programs aimed at reducing energy consumption and overall municipal carbon footprint through lighting, HVAC, and water efficiency improvements.

In 2016, the City released a competitive solicitation to update the 2009 energy efficiency audit findings, and the recommended measures, to include an evaluation of solar power generation, energy storage, peak shaving, and micro-grid opportunities. Newcomb Anderson McCormick (NAM) was hired as a consultant to conduct the audit; analyze existing energy use; and update the recommendations to reflect the latest technological advancements with current costs and potential energy savings. Given that the retrofit of street lighting is a priority for the City, NAM prepared an initial report focused exclusively on the City's street lighting. A second report, to follow, will take a more in-depth look at the remainder of the measures, giving a holistic view of how the City can prioritize and implement other energy projects.

The scope of this report will focus predominantly on opportunities for SCE-owned street lighting on the LS-1 rate, which represents roughly 81% of all poles and the City's highest energy and operating street lighting-related expense (Section 3). A plan and approach for the City to purchase and convert all of the street lighting to high-efficiency light-emitting diode technology (LEDs) will be presented, along with the *estimated project costs, potential energy savings*, *carbon dioxide offset* and *utility bill savings* (Section 4). With the implementation of the recommended street lighting measures, the City would see a reduction of an estimated 152 metric tons of carbon dioxide (CO2e)[1]. This is equivalent to removing 32 cars off of the City's streets for one year.[2]

In addition, this report presents options for communications technology upgrades and new revenue generation sources through the incorporation of a wireless mesh network and "smart pole" technology as part of its "Fiber Optic Master Plan" (Section 4.3). The report identifies relevant funding sources (Section 5.2) and implementation "next steps" (Section 5.5) for the recommended measures.

NAM recommends that the City of Manhattan Beach address street lighting recommendations in the following order of implementation:

- **Phase 1:** Purchase "sellable" SCE lights.
- **Phase 2A:** LED retrofit of sellable (City-owned) lights
- **Phase 2B:** Utilize SCE Option E financing for the LED retrofit of non-sellable (SCE-owned) LS-1 lights.
- **Phase 3:** Evaluate the maximum potential revenue generation from smart pole development with Communications Technology Upgrades.

Implementing all three phases would result in estimated annual cost savings of $98,722, estimated carbon offset of 152 metric tons, and estimated annual revenue generation of $333,720.

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[1] Greenhouse gas emission based on 2014 Corporate Responsibility Report, Southern California Edison, 2014.

[2] Greenhouse gas equivalencies calculator, US Environmental Protection Agency, 2015.

SECTION 2:
INTRODUCTION

2.1 BACKGROUND

The City of Manhattan beach (the City) endorsed the Mayors' Climate Protection Agreement in 2007 and made a commitment to reduce its greenhouse gas emissions to 7% below 1990 levels. As part of this effort, in 2010, the City conducted a detailed greenhouse gas emissions inventory and developed a Climate Action Plan. According to the greenhouse gas emission inventory in the Climate Action Plan, 15% of the City's annual carbon dioxide (CO2) emissions resulted from the operation of street lights and traffic signals. [3]

In 2009, the City hired a consultant to prepare a Level II ASHRAE audit report of city-owned facilities and infrastructure. While street lighting was within its scope, the recommended measures include upgrading to induction fixtures, which were considered advanced lighting technology but have been lapsed by a new generation of lighting technology, lighting-emitting diode (LED) technology, which saves considerably more energy and is now commercially-available. Finally, since the 2009 audit, the City has added two new initiatives which extend to its street lighting assets: the launch of its "Fiber Optic Master Plan" to improve City-wide broadband access and a desire to reduce energy and operating costs.

The following Street Lighting report was created to identify pathways to address the City's objectives to reduce its environmental impact and operating costs, to meet Fiber Optic Master Plan objectives and to identify new revenue generation opportunities through the implementation of "smart pole" technology.

[3] Manhattan Beach: Working Towards a Sustainable Community, 2010.

SECTION 3:

EXISTING CONDITIONS

3.1 STREET LIGHTING OVERVIEW

The street lights in the City of Manhattan Beach fall into three categories and rates, as depicted in Table 4. The majority (roughly 81%) are on the LS-1 rate, with ownership, operations and maintenance responsibility belonging to SCE. Street lights on LS-1 are not metered, and customers are billed a fixed monthly cost based on lamp type and wattage. An estimated 5% are on the LS-2 rate; these lights are owned by the City, and billed at a fixed monthly cost based on the lamp type and wattage. Finally, an estimated 13% of the street lights are on LS-3; these are City-owned and billed based on metered energy usage.

TABLE 1 – 2015 STREET LIGHTING RATE SCHEDULE

Rate	Rate Schedule	Owner	% of Street Lights	Energy Use	Options for LED retrofit
LS-1	Lighting - Street and Highway - Unmetered Service Company-Owned System	SCE	81%	Unmetered	1) Customers may have SCE replace existing fixtures with LEDs by paying an upfront lump sum or higher monthly rate. 2) Customers may purchase the street lights from SCE, change the rate from LS-1 to LS-2, and convert to LED (for qualifying fixtures only).
LS-2	Lighting - Street and Highway - Unmetered Service Customer-Owned Installation	City	5%	Unmetered	
LS-3	Lighting - Street and Highway - Metered Service Customer-Owned Installation	City	13%	Metered	

Given that the majority of street lights are on the LS-1 rate, this section will focus specifically on the LS-1 street lights; the best pathway to reduce the energy and operating and maintenance costs; and on converting the LS-1 lights to high efficiency light-emitting diode technology (LEDs). Note that the City has already undertaken several LED retrofits of street lights that they currently own (LS-2 and LS-3).

3.2 BASELINE ENERGY USE ANALYSIS

Historical utility billing data was collected from Southern California Edison (SCE) and compared with data from the City's online Enterprise Energy Management Information Systems (EEMIS)[4].

Table 1 defines the three rate schedules[5] that apply to the City of Manhattan Beach's street lighting:

[4] EEMIS stores energy use data in monthly intervals; more frequent intervals showcasing daily or hourly rates are not available from this system. The compiled data can be sorted by meter account, location, billing rate, or billing month.
[5] Source of street lighting data is valuation data (2015) SCE provided to the City.

TABLE 2 – 2015 STREET LIGHTING RATE SCHEDULE

Rate	Rate Schedule	Owner	% of Street Lights	Energy Use	Options for LED retrofit
LS-1	Lighting - Street and Highway - Unmetered Service Company-Owned System	SCE	81%	Unmetered	1) Customers may have SCE replace existing fixtures with LEDs by paying an upfront lump sum or higher monthly rate. 2) Customers may purchase the street lights from SCE, change the rate from LS-1 to LS-2, and convert to LED (for qualifying fixtures only).
LS-2	Lighting - Street and Highway - Unmetered Service Customer-Owned Installation	City	5%	Unmetered	
LS-3	Lighting - Street and Highway - Metered Service Customer-Owned Installation	City	13%	Metered	

Table 2 summarizes the City's LS-1 street lighting energy usage and energy costs:

TABLE 3 – LS-1 STREET LIGHTING ENERGY USAGE AND COSTS

City of Manhattan Beach LS-1 Street Lighting Usage Summary (Utility Owned)					
Monthly Average (2014-2016)			Annual Total		
Usage (kWh/month)	Monthly Bill ($/month)	Average Cost ($/kWh)	Usage (kWh/year)	Annual Bill ($/year)	Average Cost ($/kWh)
79,607	$ 23,442	$ 0.2945	949,757	$ 262,998	$ 0.2769

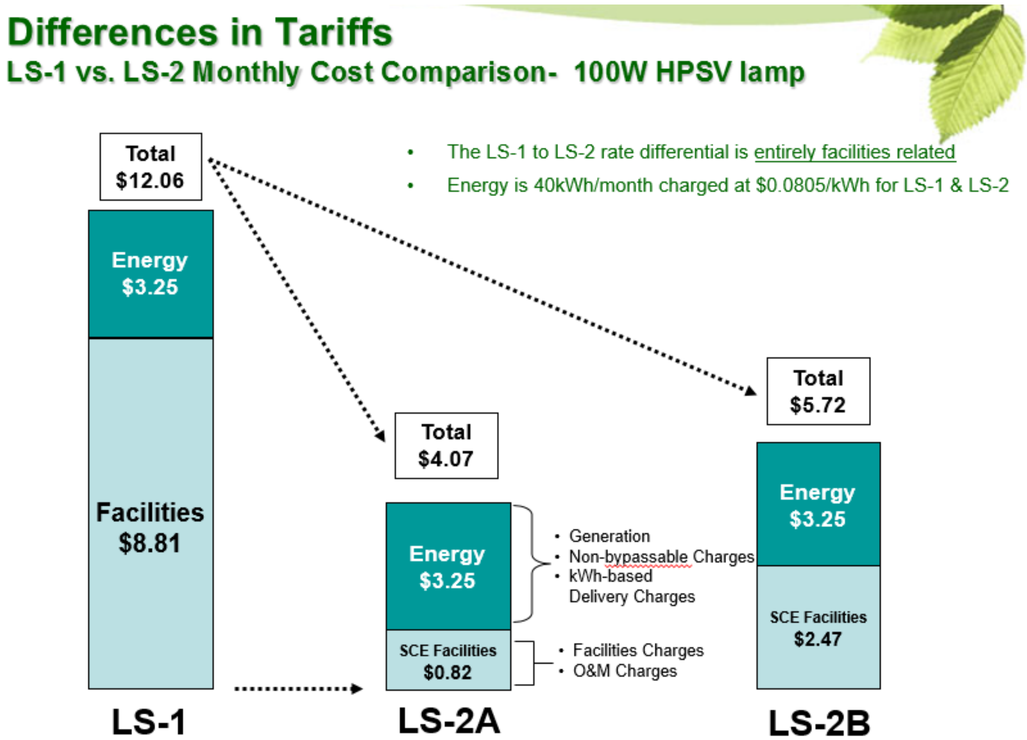
The average energy cost of LS-1 lamps (owned by SCE), is approximately triple the average energy cost of LS-2 and LS-3 lamps, (owned by the City), as seen in Table 3:

TABLE 4 –2015 STREET LIGHT RATE ANALYSIS SUMMARY

Rate	2015 Annual Energy Usage (kWh/yr)	2015 Annual Cost ($/yr)	Average Energy Cost ($/kWh)
LS-1	949,757	$ 262,998	$ 0.277
LS-2	63,384	$ 5,598	$ 0.088
LS-3	164,415	$ 16,185	$ 0.098
Total	1,177,556	$ 284,781	$ 0.242

The disparity between the LS-1 average energy cost and that of LS-2 and LS-3 is due to the service and facilities charge associated with SCE's operation and maintenance of the LS-1 lamps. The following graphic was obtained from a local government SCE account representative depicting the street lighting LS-1 to LS-2 rate differential for a sample 100W high pressure sodium vapor (HPSV) lamp, and demonstrates that the City's utility bill for purchased fixtures could decrease three-fold:

FIGURE 1 – SCE LS-1 AND LS-2 TARIFF DIFFERENCES



SECTION 4:

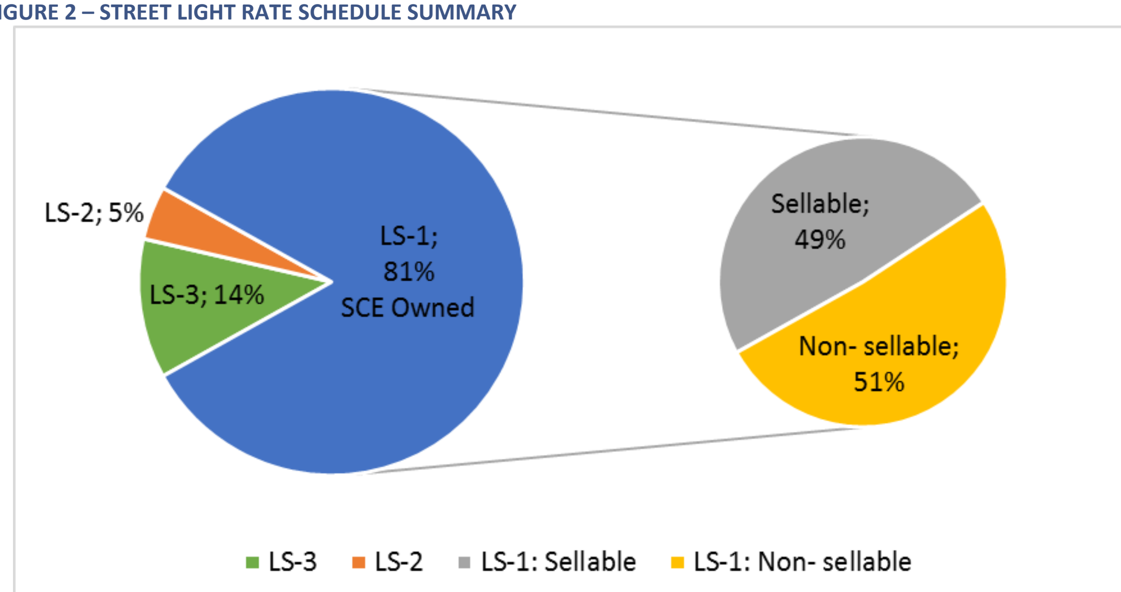
RECOMMENDED PLAN

4.1 PHASE 1: SCE PURCHASE

An estimated 81% of the City's street lights are currently owned by SCE and are on the LS-1 rate. The City is interested in exploring the purchase all eligible poles from SCE in order to convert the lights to LEDs; the purchase would not only result in utility cost savings through reduced energy consumption and service fees, but would also provide the City with revenue generation opportunities.

The following chart shows that 49%, or 927, of all LS-1 street lights are eligible to be purchased by the City, while the remaining 51% must remain under SCE ownership. The "non-sellable" lights are ineligible to be purchased by the City mainly due to street lights being attached to SCE-owned distribution poles.

FIGURE 2 – STREET LIGHT RATE SCHEDULE SUMMARY



The following table indicates the quantity of LS-1 lights that are eligible to be sold by SCE to the City:

TABLE 5 – LS-1 LAMP SELLABILITY

	LS-1 Lamps
Qty of Sellable	927
Qty Unsellable	971
Total	1,898

As indicated previously, the disparity between the LS-1 average energy cost and the LS-2 and LS-3 is due to the service and facilities charge associated with SCE's operation and maintenance of the LS-1 lamps. By purchasing the 927 eligible LS-1 street lights and switching from the LS-1 to LS-2 rate, there is no change in the City's annual energy use but the City will see a *reduced* utility bill. Table 6 depicts the annual cost savings[6] resulting from the rate change and added maintenance cost[7] that the City will incur from taking on the operations and maintenance (O&M) of the purchased lights. Table 7 shows the summary of this analysis. The upfront cost in Table 7 was determined by scaling up the quoted SCE price[8] to reflect the count of sellable fixtures (Table 5) in the evaluation.

TABLE 6 – COST ANALYSIS SUMMARY FROM SWITCHING TO LS-2 RATE

	Annual Energy Usage (kWh/yr)	Annual Energy Cost ($/yr)	Annual Maintenance Cost ($/yr)	Total Annual Cost ($/yr)
Existing SCE-Owned	949,757	$ 262,998	$ -	$ 262,998
Proposed LED Retrofit	949,757	$ 175,440	$ 32,482	$ 207,922
Savings	-	$ 87,558	$ (32,482)	$ 55,076

TABLE 7 – FINANCIAL SUMMARY OF SCE PURCHASE

			Financials									
		Utility Savings	Per Year				One Time			Lifetime		
Phase	Measure Description	Electricity Savings (kWh/yr)	Utility Cost Savings - Yr1 ($/yr)	Maintenance Cost Savings - Yr1 ($/yr)	Total Cost Savings ($/yr)	Revenue Generation ($/yr)	Installed Cost ($)	Incentives ($)	Upfront Cost ($)	Lifecycle Savings ($)	Net Benefit ($)	Lifecycle Payback (yr)
1	SCE Purchase	N/A	$ 87,558	$ (32,482)	$ 55,076	N/A	$ 813,738	$ -	$ 813,738	$ 1,048,803	$ 235,065	15.5
2	LED Retrofit	583,778	$ 27,331	$ 16,364	$ 43,696	N/A	$ 545,474	$ 164,285	$ 381,189	$ 716,069	$ 334,880	10.6
2A	LED Retrofit ("Sellable" Only)	352,848	$ 25,589	$ 16,364	$ 41,953	N/A	$ 545,474	$ 164,285	$ 381,189	$685,711	$ 304,523	11.1
2B	LED Retrofit ("Non-Sellable")	230,930	$ 1,743	$ -	$ 1,743	N/A	N/A	N/A	N/A	$ 30,358	$ 30,358	N/A
3	Communications Technology Upgrade	N/A	N/A	N/A	N/A	$ 333,720	$ 648,900	$ -	$ 648,900	$ 4,158,889	$ 3,509,989	3.1
		583,778	**$ 114,890**	**$ (16,118)**	**$ 98,772**	**$ 333,720**	**$ 2,008,111**	**$ 164,285**	**$ 1,843,827**	**$ 5,923,761**	**$ 4,079,934**	**6.2**

4.2 PHASE 2: LED RETROFIT

A light emitting diode (LED) retrofit analysis was conducted for all existing LS-1 lights—this includes the 927 sellable street lights that are now City owned, along with the 971 non-sellable, SCE-owned street lights.[9] Currently, all street lights operate on an all-night (dusk-to-dawn) schedule.

The LS-1 lights are high pressure sodium lamps (HPS), which are known for their orange appearance and poor color-rendering performance. The benefits of LED include improved visibility, energy savings and longer life spans. LEDs are more efficient than HPS lamps and can produce the same quality light with a reduced wattage

[6] See appendix C for assumptions.
[7] See appendix C for assumptions.
[8] See appendix B for SCE quote.
[9] City-owned street lights on the LS-2 and LS-3 rate tariffs are not included in this LED retrofit analysis.

and less energy consumption. HPS lamps have a rated lamp life of 24,000 hours[10] while LEDs have a life span of up to 50,000 hours[11]; if powered 8 hours per day an LED lamp has about a 17-year lifespan.

Recently, there has been some media coverage over the civic concern for the potentially adverse health and environmental effects from the blue light and glare of LED street lighting. In response, both the American Medical Association and the University of California – Davis's California Lighting Technology Center (CLTC) conducted studies that conclude that "cooler and dimmer" LED options, those with lower color temperature (less than 3,000 Kelvins) and dimming capabilities may be preferable, especially in residential area or areas prone to complaint over warmth and glare.[12] Fortunately, these options are also commercially-available. Furthermore, the Illuminating Engineering Society of North America has developed the Model Lighting Ordinance (MLO) as well as the BUG (backlight, up-light and glare) rating system as a resource for municipalities to make strategic lighting purchasing choices by lighting zone that affect comfort and mitigate the risk of creating lighting pollution. [13]

4.2.1 CITY-OWNED STREET LIGHTS

In addition to converting LS-1 lights to LS-2 lights when the City completes the purchase of these lights from SCE, it is also recommended that the City retrofit these street lights to LEDs.

In the lifecycle cost analysis, the maintenance cost savings are calculated using the CEC Proposition 39 assumption that maintenance cost savings are 3% of project cost (See Table 8). The maintenance savings can be attributed to the longer lifetime of LEDs (~15-20 years) and reducing the frequency of the labor-intensive task of replacing burnt-out lamps, which requires elevated work platforms.

The City is encouraged to select LED products that are eligible for SCE incentives by checking the Design Lights Consortium's Qualified Products List (e.g. SCE has deemed LED street light incentives). It is estimated that the SCE incentive will cover 30% of the total project cost (See Table 9).

[10] HPS Service Guide, American Electric Lighting. October, 2014. (http://www.americanelectriclighting.com/Library/Literature/PDFs/HPS%20Servicing%20Guide.pdf)

[11] Lifetime of White LEDs, US Department of Energy. September, 2009. (http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/lifetime_white_leds.pdf)

[12] Energy Services Performance Contract/ LED Lighting Project. City Council Staff Report. City of Davis, California. December 16, 2014.

[13] Model Lighting Ordinance, Illuminating Engineering Society. June 15, 2011 (http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf)

TABLE 8 – ANNUAL ENERGY AND MAINTENANCE COST SUMMARY

	Annual Energy Usage (kWh/yr)	Annual Energy Cost ($/yr)	Annual Maintenance Cost ($/yr)	Total Annual Cost ($/yr)
Existing SCE-Owned	949,757	$ 175,440	$ 32,482	$ 207,922
Proposed LED Retrofit	365,980	$ 148,109	$ 16,118	$ 164,227
Savings	583,778	$ 27,331	$ 16,364	$ 43,696

TABLE 9 – LED RETROFIT FINANCIAL SUMMARY

			Financials									
		Utility Savings	Per Year				One Time			Lifetime		
Phase	Measure Description	Electricity Savings (kWh/yr)	Utility Cost Savings - Yr1 ($/yr)	Maintenance Cost Savings - Yr1 ($/yr)	Total Cost Savings ($/yr)	Revenue Generation ($/yr)	Installed Cost ($)	Incentives ($)	Upfront Cost ($)	Lifecycle Savings ($)	Net Benefit ($)	Lifecycle Payback (yr)
1	SCE Purchase	N/A	$ 87,558	$ (32,482)	$ 55,076	N/A	$ 813,738	$ -	$ 813,738	$ 1,048,803	$ 235,065	15.5
2	LED Retrofit	583,778	$ 27,331	$ 16,364	$ 43,696	N/A	$ 545,474	$ 164,285	$ 381,189	$ 716,069	$ 334,880	10.6
2A	LED Retrofit ("Sellable" Only)	352,848	$ 25,589	$ 16,364	$ 41,953	N/A	$ 545,474	$ 164,285	$ 381,189	$685,711	$ 304,523	11.1
2B	LED Retrofit ("Non-Sellable")	230,930	$ 1,743	$ -	$ 1,743	N/A	N/A	N/A	N/A	$ 30,358	$ 30,358	N/A
3	Communications Technology Upgrade	N/A	N/A	N/A	N/A	$ 333,720	$ 648,900	$ -	$ 648,900	$ 4,158,889	$ 3,509,989	3.1
		583,778	**$ 114,890**	**$ (16,118)**	**$ 98,772**	**$ 333,720**	**$ 2,008,111**	**$ 164,285**	**$ 1,843,827**	**$ 5,923,761**	**$ 4,079,934**	**6.2**

4.2.2 SCE-OWNED STREET LIGHTS

The LS-1 street lights that are "non-sellable" may be converted to LEDs. There are two pathways for an LED retrofit:

1) Customer pays an upfront lump sum to SCE, or
2) Customer pays an Energy Efficiency Premium Charge under LS-1 Option E[14], paying a higher monthly rate over a 20-year term, with no upfront cost. According to SCE, the Energy Efficiency Premium Charge allows SCE to recover the capital cost of the LED fixture. The premium is a fixed amount that remains on the bill for 20 years while other components of the LS-1 tariff fluctuate in accordance with CPUC rate increases or decreases. Customers interested in participating in LS-1 Option E will be placed into a queue after signing the LS-1 Option E agreement, and will enter the queue as agreements are finalized and received by SCE on a first come-first served basis.

The City can explore Option E to retrofit SCE-owned streetlights to LEDs and avoid paying an initial upfront cost, and SCE would phase in the LED conversion over the next few years. The second pathway offers a very practical way for the City to finance the LED retrofit, allowing the City to pay off the project over a 20-year period on the monthly bill rather than managing the burden of an upfront payment.

[14] LS-1 Option E is an SCE rate option that allows municipalities to convert their SCE-owned street lights to LED without paying an upfront cost. Municipalities pay an Energy Efficiency Premium Charge through LS-1 Option E over a 20-year term, which allows SCE to recover the capital cost of the LED fixture (https://www.sce.com/NR/sc3/tm2/pdf/3241-E.pdf).

SCE provided an LED retrofit conversion calculation, using financing Option E, with annual cost savings of $8,791. The calculated cost savings analysis (Table 9) by NAM concludes that the provided value conforms with NAM's evaluation savings. The SCE evaluation shows more savings, while NAM's estimate is more conservative due to the less detailed street light information available during the analysis.

4.3 PHASE 3: COMMUNICATIONS TECHNOLOGY UPGRADE

The following section will highlight the wireless mesh network and smart pole technology that are complementary to the "Fiber Optic Master Plan," an initiative to inventory broadband communication assets and to enhance broadband access within the City. In areas where it would otherwise be cost-prohibitive to install fiber optic hard lines, the wireless mesh network and smart pole technology may offer a more cost-effective implementation roll-out.

4.3.1 FIBER OPTIC MASTER PLAN

As part of the City's 2016-2017 Capital Improvement Plan[15], the Fiber Optic Master plan will include the following:

> *The Fiber Optic Master Plan will be used by the City for the planning, budgeting and implementation of a landmark fiber optic network infrastructure project. The primary objective of the Fiber Master Plan is to collect and analyze information and data that will provide the best path and business model to deploy a fiber optic network that meets the needs of the community. The Fiber Master Plan will assist in identifying businesses located in Manhattan Beach's several business corridors and residential areas. Specifically, the outcomes of this contract will:*
>
> *1. Provide the City with information and data to set its goals and objects to facilitate the design and deployment of a Fiber Optic Network in Manhattan Beach;*
> *2. Research and evaluate the current supply of broadband communication assets, products and services in the City;*
> *3. Produce an inventory and assessment of existing City-owned assets and infrastructure required to support deployment of a fiber network;*
> *4. Define and evaluate potential fiber optic network routes and requirements;*
> *5. Identify impacts of a fiber network including impacts on City right-of-way, City-owned conduit, streetlight pools, traffic lights, existing fiber system and other real property*

[15] 2016-2017 Capital Improvement Plan, City of Manhattan Beach.

4.3.1.1 CURRENT LEGISLATION PRESENTS A CHALLENGE AND OPPORTUNITY FOR THE CITY

In 2012, Assembly Bill – 1027 was enacted, requiring utilities to make street lighting poles available for use by communication service providers and allowing fees to be regulated by the city.[16] Unlike regulated electric utilities, cities, are free to set their own rates. Assembly Bill 57 requires cities to approve applications by communication service providers within a set timeframe or rate approval is automatic.[17] This legislation represents an opportunity to further the City's Fiber Optic Master Plan objectives of improving broadband access within the City. Cities like Palo Alto and Los Angeles, which have municipal electric utilities are subject to regulation on the fees they can charge communication service providers by AB 1027. Cities like Manhattan Beach, on the other hand, are free to set market rates and claim revenue.

4.3.2 WIRELESS MESH NETWORKS

Wireless mesh networks allow the connected devices (i.e. the sensors on street lighting poles) to communicate with all other connected devices, rather than communicating in a linear or radial fashion. Mesh networks are known for being robust, reliable, and scalable, meaning additional nodes or devices may be added easily.

These networks are also capable of "self-healing", so if a communication failure occurs at a single node, the network is able to reroute the flow of data to circumvent the blockage. The more nodes in range of one another, the denser and more reliable the network becomes. For street lighting, a node would be installed on each light fixture, collect energy usage data, and send the information to a central management server.

To implement a mesh network, the City must install central management servers to gather information from the nodes, but each server can serve hundreds of nodes, depending on capacity of the product and distance between nodes. Lighting and electricity usage data for each fixture would be accessible through a web-based interface, so if a specific fixture is malfunctioning, it can be pinpointed immediately. This network can communicate with the City's existing systems and be accessed and controlled remotely, while facilitating the connection of the sensors, meters, and other smart devices. Maintenance of the wireless network is simplified, as city personnel can use a laptop or other device to communicate and perform diagnostics without having to run wires.

Installation costs for the wireless network are estimated on a per-node basis with assumptions listed in Appendix C. The City can install a wireless mesh network to gain increased control and monitoring of street lighting fixtures, with the ability to collect electricity usage data, identify equipment failure, and interface with other smart pole technologies. The enhanced control and monitoring afforded by the wireless network complements the purchase of streetlights from SCE, as the City will take over maintenance responsibility and monitoring of the fixtures.

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[16] AB 1027. 2011-2012. Fees charged by utilities shall set fees for communication service providers that are "not higher than the annual costs of ownership of the "percentage of the volume of the capacity of the structure rendered unusable by the equipment of the communications service provider." http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB1027

[17] AB 57, Quirk. Telecommunications: wireless telecommunication facilities. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB57

4.3.3 "SMART POLE" TECHNOLOGY

"Smart pole" technologies are relatively new in the marketplace and have recently gained traction. They have the potential to provide and streamline various services for the city:

- City-wide Wi-Fi
- Energy management and smart metering
- Lighting control
- Temperature and air quality sensors
- Security cameras
- Emergency alert notification
- Gunshot Detection
- Traffic monitoring

Upgrading the City's street lights to include the nodes may also provide the City with opportunities to generate revenue from third party sources through:

- Leasing to cellular network providers
- Selling data to traffic data monitoring services

Given that the City expressed interest in smart telecommunications nodes on City-owned street lights, we inventoried "smart pole" street lighting product features that are currently commercially available (summarized in Table 10).

NAM compiled feedback from other cities that had implemented street lighting communications technology upgrades and LED conversions. Appendix D includes a matrix of all of the installations evaluated and their financing strategy. Appendix E highlights the potential benefits and issues found in a literature review and interviews with vendor and city staff listed by feature.

TABLE 10 – NODE MANUFACTURER COMPARISON SUMMARY

Manufacturer	Product Name	Camera	Cell Carrier	Wi-Fi	Traffic Data	Lighting Controls	Utility Metering	Temperature and Air Quality Sensors	Gunshot Detection	Power Consumption	Range of Service	Existing Municipality Customers
Siemens	Smart City Communication	yes	yes	yes	yes	yes	yes	yes	yes	-	Wi-Fi range is 1000 ft	LED in Manchester, NH
Philips/Ericsson	Zero Site	no	yes	yes	no	yes	yes	yes	no	-	-	Los Angeles, San Jose
GE	LightGrid or Evolve IQ	yes	yes	yes	yes	yes	yes	yes	yes	< 3 W (LightGrid)	Gateways connect to 500+ nodes, communicate up to 1500 feet	San Diego, Hamilton, Oceanside, Calgary, Grimsby
Sensus	Vantage Point	no	no	no	no	yes	no	no	no	1.6 W	Wi-Fi range is 7 miles	Chattanooga
Acuity Brands Lighting	Roam	no	no	no	no	yes	no	no	no	1.6 W	Gateways connect to 2000 nodes, communicate up to	Glendale
Cisco	Smart + Connected	yes	no	no	yes	yes	yes	yes	yes	2.5 W	-	Adelaide

While LED conversions of street lights are becoming a common practice among cities, most examples of communications upgrade projects are in pilot or early stages of operation. The most high-profile, local case study is the application of Phillips “smart pole” street light technology by the City of Los Angeles’ Bureau. The City of LA leases to the telecommunications company Phillips, which in turns sub-leases to a mobile network operator. Each “smart pole” in the LA case study generated roughly $1,200 of annual revenue for the City of LA. Additional partnerships may be pursued with real-time traffic data providers, such as Google Maps or Waze.

The revenue generation analysis presented in this report is modeled after the LA case study. It maintains a conservative estimate by excluding the permitting fee paid to LA by Phillips (one-time fee of $400 per pole). Also, it does not demonstrate revenue from potential partnerships with traffic data monitoring companies. It assumes that only 30% of sellable, SCE-owned street lights will have installed nodes generating revenue (See Table 11). [18]

TABLE 11 – COMMUNICATIONS TECHNOLOGY UPGRADE FINANCIAL SUMMARY

			Financials									
		Utility Savings	Per Year				One Time			Lifetime		
Phase	Measure Description	Electricity Savings (kWh/yr)	Utility Cost Savings - Yr1 ($/yr)	Maintenance Cost Savings - Yr1 ($/yr)	Total Cost Savings ($/yr)	Revenue Generation ($/yr)	Installed Cost ($)	Incentives ($)	Upfront Cost ($)	Lifecycle Savings ($)	Net Benefit ($)	Lifecycle Payback (yr)
1	SCE Purchase	N/A	$ 87,558	$ (32,482)	$ 55,076	N/A	$ 813,738	$ -	$ 813,738	$ 1,048,803	$ 235,065	15.5
2	LED Retrofit	583,778	$ 27,331	$ 16,364	$ 43,696	N/A	$ 545,474	$ 164,285	$ 381,189	$ 716,069	$ 334,880	10.6
2A	LED Retrofit ("Sellable" Only)	352,848	$ 25,589	$ 16,364	$ 41,953	N/A	$ 545,474	$ 164,285	$ 381,189	$685,711	$ 304,523	11.1
2B	LED Retrofit ("Non-Sellable")	230,930	$ 1,743	$ -	$ 1,743	N/A	N/A	N/A	N/A	$ 30,358	$ 30,358	N/A
3	Communications Technology Upgrade	N/A	N/A	N/A	N/A	$ 333,720	$ 648,900	$ -	$ 648,900	$ 4,158,889	$ 3,509,989	3.1
		583,778	**$ 114,890**	**$ (16,118)**	**$ 98,772**	**$ 333,720**	**$ 2,008,111**	**$ 164,285**	**$ 1,843,827**	**$ 5,923,761**	**$ 4,079,934**	**6.2**

[18] Smart pole vendors, like Phillips, have eligibility criteria for poles to qualify for smart pole conversion and revenue generation from subleases to mobile network operators. In Phillips’ case, poles must have underground-fed electrical wires; cobra head (no decorative poles); and be a height of 26’ or higher. According to the SCE valuation data, 195 poles, or 21%, of the 927 sellable poles are under 26’, so these do not qualify for smart pole conversion. Our analysis for CoMB assumes only 30% of sellable LS-1 lights available for sale were converted to smart poles.

ENERGY SAVINGS AND FINANCIAL ANALYSIS

4.4 ENERGY COST, SAVINGS AND CARBON EMISSIONS

As a result of implementing the recommended street lighting measures in this report, the following savings are expected to be achieved in the City's street lighting energy usage, energy cost, and CO2 footprint associated with the LS-1 lights:

TABLE 12 – RECOMMENDATION PLAN SAVINGS SUMMARY

	Annual Energy Usage (kWh/yr)	Annual Energy Cost ($/yr)	Annual Estimate CO2 Emissions (Metric tons)
Existing SCE-Owned	949,757	$ 262,998	247
Proposed LED Retrofit	365,980	$ 148,109	95
Savings	583,778	$ 114,890	152
% Savings	61%	44%	61%

FIGURE 3 –ANNUAL ENERGY USAGE

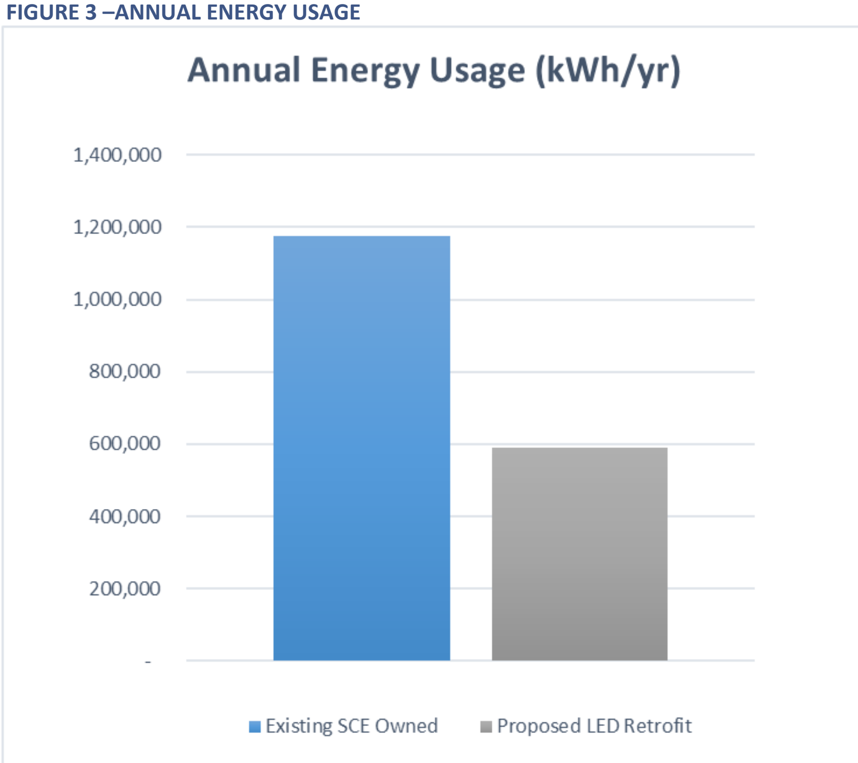
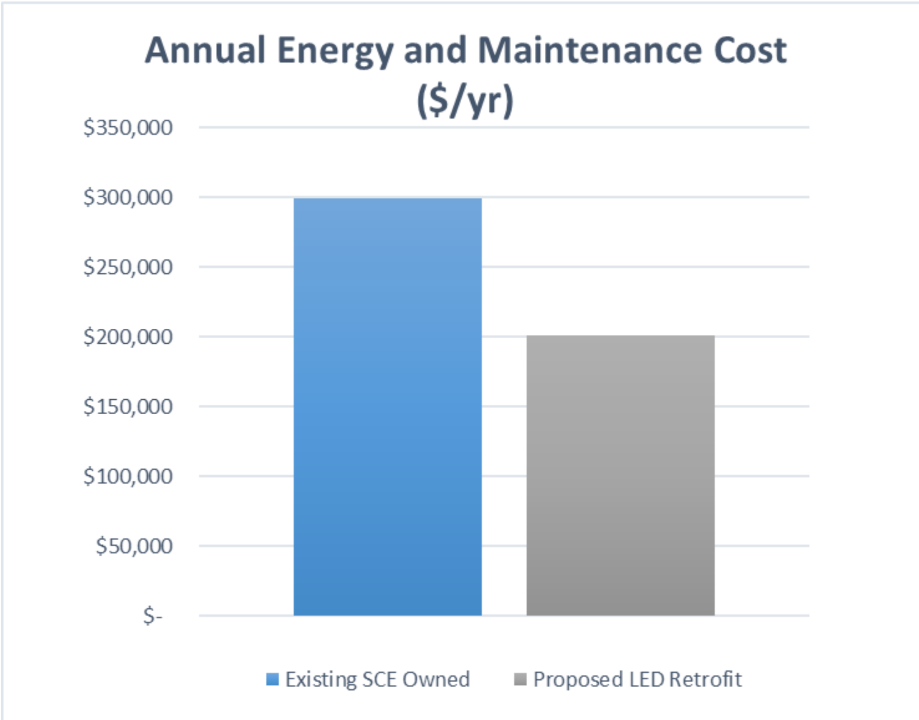


FIGURE 4 –ANNUAL ENERGY AND MAINTENANCE COST



4.5 POTENTIAL FUNDING SOURCES

As a local government SCE customer, City of Manhattan Beach is eligible for a variety of funding and incentives. The current calculations include potential estimated incentives at Energy Leader Platinum rates for LED lighting retrofits and utility financing. The eligibility for incentives and the amount of potential incentives is subject to change, if or when the utilities change or update their program rules and guidelines.

It is recommended that the City contacts its SCE account representative before starting projects. The account rep can help reserve funds for deemed incentives, and coordinate pre-inspections that may be necessary for the custom projects. The City should be aware of that most products associated with deemed rebates must be qualified by the utility.

4.5.1 SCE INCENTIVE PROGRAM

SCE offers fixed energy efficiency rebate solutions for their non-residential customers. The City should be aware that most products associated with fixed incentives must be qualified by the utility; qualifications are discussed in Section 4.2.1.

The City is an active participant in the SCE Local Government Partnership and has achieved the highest level of participation in the partnership, Platinum. As a Platinum customer, the City receives an additional $0.18/kWh kicker on all customized incentives.

4.5.2 SCE ON-BILL FINANCING

SCE's On-Bill Financing (OBF) program offers interest-free loans to energy efficiency projects that qualify for SCE/SCG rebates and incentives. According to the SCE OBF terms and guidelines, "Loan terms and monthly payment amounts are determined by the customer's estimated monthly savings from the installation of the new products. Terms are as follows:

- Government Customers are eligible for loans of up to $1 million on a first-approved, first-served basis;
- Government Customers may designate one Service Account per facility, under the same customer number to receive the $1 million maximum loan amount;
- All other service accounts at facility must abide by the $250,000 Service Account cap;
- Government Customers are eligible for loan periods of up to 120 months (10 years); and
- To qualify for financing through OBF, a project's estimated energy savings must be sufficient to repay the loan during the maximum allowable payment term.

Note that Government Agency Customers that are utilizing OBF to complete comprehensive energy efficiency projects may be eligible to combine multiple premises for a single project. Each premise/location included in the project will be evaluated separately and must meet the OBF funding requirements."

4.5.3 SCE LS-1 OPTION E TARRIF

As noted above, the LS-1 Option E is an SCE rate option that allows municipalities to convert their SCE-owned street lights to LED without paying an upfront cost. Municipalities pay an Energy Efficiency Premium Charge through LS-1 Option E over a 20-year term, which allows SCE to recover the capital cost of the LED fixture.

4.5.4 CALIFORNIA ENERGY COMMISSION 1% LOAN

Another financing option is the California Energy Commission's 1% Interest loan, which offers loans to California Cities, Counties, Public Schools and Universities, Special Districts and Public Care Hospitals/Institutions for energy efficiency and energy generation projects.

Terms are as follows:

- Government Customers are eligible for loans of up to $3 million on a first-approved, first-served basis;
- Government Customers are eligible for loan periods of up to 240 months (20 years); and
- Loans for energy projects must be repaid from energy cost savings within 17 years, including principal and interest

SECTION 5:

SUMMARY OF RECOMMENDED OPTIONS

5.1.1 RECOMMENDATIONS AND NEXT STEPS

NAM's street lighting recommendations are presented in Table 13. The table is broken up into three options explained below; implementation of all three would result in estimated annual cost savings of $98,722 (from Phase 1: SCE Purchase and Phase 2: LED Retrofit), estimated carbon offset of 152 metric tons (from Phase 2: LED Retrofit) and estimated annual revenue generation of $333,720 (from Phase 3: Communications Technology Upgrade). NAM recommends that the City of Manhattan Beach address street lighting recommendations in the following order of implementation[19]:

- **Phase 1:** Purchase "sellable" SCE lights, take into account smart pole and revenue generation potential.

- **Phase 2A:** LED retrofit of sellable (City-owned) lights.

- **Phase 2B:** Utilize SCE Option E financing for the LED retrofit of non-sellable (SCE-owned) LS-1 lights. There is no-upfront cost and an immediate improvement in reducing the carbon footprint of the City (60 metric tons per year of CO2 offset).[20]

- **Phase 3:** Evaluate the maximum potential revenue generation from smart pole development. The Communications Technology Upgrade has the best lifecycle payback potential (conservatively estimated at over $330,000 annually for converting 30% of sellable LS-1 street lights).
  i. Solicit further development terms from vendors in an RFP or the City's desired format, based on the City's street lighting inventory, including SCE's sellable LS-1 units, to confirm smart pole conversion criteria and to refine cost and revenue estimates.
  ii. Request financing proposals from the vendor and through other sources with zero up-front and net operating cost to the City, if so desired for the purchase of sellable LS-1 street lights and for their LED conversion. Note alternative sources of financing for the LED conversion and energy efficiency projects include OBF and the CEC loan (as described in Section 5.2)
  iii. Work with SCE in screening mobile network operator proposals for SCE-owned street

[19] Table 13 summarizes the recommended street lighting measures and Appendix C summarizes assumptions and financing terms used in the life-cycle cost analysis.
[20] Note a preference for low color temperature and BUG-rated LED lighting options that are appropriate to specific lighting zones, like residential areas.

lights in the City to ensure that they are complementary the City's initiatives to enhance broadband access and include other desirable smart pole features.

At the discretion of the City, NAM can assist with the implementation of next steps, from writing and managing funding requests and RFPs and technical specifications, to rebate processing, contractor progress oversight and ongoing board and stakeholder reporting. It is anticipated and understood that changes to the scope will occur, resulting from customer decisions, technology costs, and utility incentives. NAM is also available to review contract amendments, value engineering opportunities and make calculation updates as needed.

TABLE 13 – RECOMMENDATION PLAN SUMMARY

			Financials											
		Utility Savings	Per Year				One Time			Lifetime			Annual Estimate CO_2 Offsets	
Phase	Measure Description	Electricity Savings (kWh/yr)	Utility Cost Savings - Yr1 ($/yr)	Maintenance Cost Savings - Yr1 ($/yr)	Total Cost Savings ($/yr)	Revenue Generation ($/yr)	Installed Cost ($)	Incentives ($)	Upfront Cost ($)	Lifecycle Savings ($)	Net Benefit ($)	Lifecycle Payback (yr)	Metric Tons	$/Metric Ton
1	SCE Purchase	N/A	$ 87,558	$ (32,482)	$ 55,076	N/A	$ 813,738	$ -	$ 813,738	$ 1,048,803	$ 235,065	15.5	-	-
2	LED Retrofit	583,778	$ 27,331	$ 16,364	$ 43,696	N/A	$ 545,474	$ 164,285	$ 381,189	$ 716,069	$ 334,880	10.6	152	$ 2,511
2A	LED Retrofit ("Sellable" Only)	352,848	$ 25,589	$ 16,364	$ 41,953	N/A	$ 545,474	$ 164,285	$ 381,189	$685,711	$ 304,523	11.1	92	$ 4,155
2B	LED Retrofit ("Non-Sellable")	230,930	$ 1,743	$ -	$ 1,743	N/A	N/A	N/A	N/A	$ 30,358	$ 30,358	N/A	60	N/A
3	Communications Technology Upgrade	N/A	N/A	N/A	N/A	$ 333,720	$ 648,900	$ -	$ 648,900	$ 4,158,889	$ 3,509,989	3.1	-	-
		583,778	$ 114,890	$ (16,118)	$ 98,772	$ 333,720	$ 2,008,111	$ 164,285	$ 1,843,827	$ 5,923,761	$ 4,079,934	6.2	152	$ 12,148

TABLE 13.1 – PER UNIT ASSUMPTIONS FOR OPTION 2A

Option	Financing	Up-front cost	Utility Cost Savings	Maintenance Cost Savings	Revenue
1	None in Analysis	Yes	Rate Change	No O&M Cost	N/A
2a	None in Analysis (OBF/CEC are applicable, ESCO financing may be an option)	Yes	Energy Savings (rate change to LS-2 already assumed as baseline)	3% of Project Cost (CEC Prop 39 assumption)	N/A
2b	Option E	No	Savings based on Option E “Rate Change” within LS-1	Covered by SCE and LS-1 charge	N/A
3	None in Analysis (Vendor Financing may be available)	Yes	N/A	N/A	Lease to Mobile Network Operator

TABLE 13.2 – PER UNIT ASSUMPTIONS FOR OPTION 3

Sample LED Fixture Capital Cost Estimate		
Equipment & Labor for 72W LED Fixture (replacing 150W HPS)	$	450
Design (10%)	$	45
Project Management (15%)	$	68
Permitting (8%)	$	36
Contingency (10%)	$	45
Total	**$**	**644**

TABLE 13.3 – PER UNIT ASSUMPTIONS FOR OPTION 3

Sample Communications Technology Upgrade Capital Cost and Revenue Estimate			
Initial cost per node:	$	700	Cost estimated provided to City of Manhattan Beach from Siemens
Rent revenue from cell phone carriers ($/pole/year):	$	1,200	City of Los Angeles

APPENDICES

APPENDIX A – HISTORICAL BILLING DATA FOR LS-1 ACCOUNTS
APPENDIX B – SCE LS-1 VALUATION
APPENDIX C – LIFE CYCLE ANALYSIS ASSUMPTIONS & FINANCING TERMS
APPENDIX D – INSTALLATION EXAMPLES
APPENDIX E – A SURVEY OF SMART POLE IMPLEMENTATION EXPERIENCES AND FEATURES

APPENDIX A
HISTORICAL BILLING DATA FOR LS-1 ACCOUNTS

Billing Month	Usage (kWh/month)	Monthly Bill ($/month)	Average Cost ($/kWh)
May 2014	80,558	$ 23,486	$ 0.292
Jun 2014	80,558	$ 23,486	$ 0.292
Jul 2014	79,382	$ 23,888	$ 0.301
Aug 2014	82,012	$ 24,404	$ 0.298
Sep 2014	80,461	$ 24,088	$ 0.299
Oct 2014	78,434	$ 23,307	$ 0.297
Nov 2014	79,436	$ 23,694	$ 0.298
Dec 2014	78,832	$ 23,514	$ 0.298
Jan 2015	80,020	$ 23,819	$ 0.298
Feb 2015	79,463	$ 23,561	$ 0.297
Mar 2015	79,250	$ 23,514	$ 0.297
Apr 2015	79,448	$ 23,491	$ 0.296
May 2015	79,463	$ 23,496	$ 0.296
Jun 2015	78,677	$ 23,162	$ 0.294
Jul 2015	78,751	$ 23,429	$ 0.298
Aug 2015	79,320	$ 23,485	$ 0.296
Sep 2015	79,329	$ 23,486	$ 0.296
Oct 2015	79,332	$ 23,486	$ 0.296
Nov 2015	79,199	$ 23,456	$ 0.296
Dec 2015	79,147	$ 23,416	$ 0.296
Jan 2016	80,254	$ 23,570	$ 0.294
Feb 2016	79,118	$ 22,754	$ 0.288
Mar 2016	78,919	$ 22,677	$ 0.287
Apr 2016	79,146	$ 22,765	$ 0.288
May 2016	82,082	$ 23,294	$ 0.284
Jun 2016	79,203	$ 22,770	$ 0.287

APPENDIX B
SCE LS-1 VALUATION

The City of Manhattan Beach
LS-1 Streetlight System Valuation

June 7, 2016

Overview of the Total LS-1 Streetlight System

Type	Qty	Type	Overhead	Underground
Non-Wood	841	44%	287	554
Wood	1,057	56%	1,056	1
	1,898	100%	1,343	555
			71%	29%
1950-1959	593	31%		
1960-1969	272	14%		
1970-1979	227	12%		
1980-1989	182	10%		
1990-1999	122	6%		
2000-2009	479	25%		
2010-present	23	1%		

Valuation of the Sellable LS-1 Streetlight System

	Qty	RCNLD
Marbelite (Concrete)	725	$508,063
Steel	0	$0
* Wood	86	$75,671
Total:	**811**	**$583,734**
Ad Hoc Replacements		**$45,951**
Additional Asset Components		**$57,896**
Subtotal		**$687,581**
Severance Cost		**$24,330**
Valuation Price		**$711,911**

APPENDIX C
LIFE CYCLE COST ANALYSIS ASSUMPTIONS & FINANCING TERMS

Assumptions and Financing Terms

Financing Terms		
Inflation:	2%	CEC Prop 39 (http://www.energy.ca.gov/2016publications/CEC-400-2016-005/CEC-400-2016-005-CMF.pdf)
Maintenance Savings (% of project cost):	3%	CEC Prop 39 (http://www.energy.ca.gov/2016publications/CEC-400-2016-005/CEC-400-2016-005-CMF.pdf)
Energy Cost Escalation:	4%	CEC Prop 39 (http://www.energy.ca.gov/2016publications/CEC-400-2016-005/CEC-400-2016-005-CMF.pdf)
Discount Factor:	5%	CEC Prop 39 (http://www.energy.ca.gov/2016publications/CEC-400-2016-005/CEC-400-2016-005-CMF.pdf)
EUL (yrs):	20	SCE Option E payback term
Operating & Maintenance Cost ($/pole/yr):	$ 35.04	California Lighting Technology Center (http://cltc.ucdavis.edu/sites/default/files/files/publication/FINAL_DRAFT_BC_Adaptive_Area_Lighting_140613.pdf)
CO2 Emissions Factor		
CO2 emissions factor (metric ton CO2/kWh):	0.00026	SCE 2014 Corporate Responsibility Report (https://www.sce.com/wps/wcm/connect/c0fceef5-e04a-4287-8301-8e66e3e5fbac/2014_Corporate+Responsibility+Report_FINAL+single-page.pdf?MOD=AJPERES&ContentCache=NONE)
(metric ton CO2/th):	0.00531	U.S. Energy Information Administration (http://www.eia.gov/oiaf/1605/coefficients.html)
Revenue Generation		
Initial cost per node:	$ 700	Cost estimated provided to City of Manhattan Beach from Siemens
Rent revenue from cell phone carriers ($/pole/year):	$ 1,200	City of Los Angeles
Soft Costs for LED Capital Cost Calculation		
Design	10%	
Project Management	15%	
Permitting	8%	
Contingency	10%	

- The financing assumptions reference California Energy Commission (CEC) Proposition 39 financing terms.
- The carbon dioxide offset calculation references the emissions factor from the SCE 2014 Corporate Responsibility Report This emissions factor is the most updated value available from SCE, and reflects SCE's current portfolio mix. It should be noted that SCE's emissions factor has decreased over the last 10 years, due to the increase of renewables in the energy generation mix.

APPENDIX D
INSTALLATION EXAMPLES

Public Entity	Features	# of Poles	Installed Cost - LED Retrofit/Pole	Vendor and Product/Model Installed	Vendor Financing/Terms	Revenue Generation	Revenue Generation Source	Cost Savings (Energy & Maintenance) /Pole/ Year	Simple Payback (Years)	Contact
Los Angeles	Communications Upgrade	100 (600 by 2018)	-	Philips CityTouch "Smart Pole" and Ericsson Zero Site, equipped for Verizon	Philips financed	$1,200	leasing to wireless providers	-	-	-
San Jose	Communications Upgrade	50	none	Ericsson Zero Site, equipped for Verizon Wireless	Pilot Program, Philips funded LED conversion in exchange for pole use for cell service	none	none	-	-	Kevin O'Connor - Kevin.O'Connor@sanjoseca.gov
San Jose	LED Conversion	750	none	Philips CityTouch "Smart Pole"	Pilot Program, Philips funded, covert 15 poles for every 1 Smart Pole installed	N/A	N/A	-	-	Guixiang Chen - Guixiang.Chen@sanjoseca.gov
San Jose	LED Conversion	20,000	-	LED through Opterra	loan from Opterra Energy Systems, federal grants	N/A	N/A	-	-	-
UC Davis	LED Conversion + Network	1,347	$ 1,214	RoadStar and EcoSwap LED and SFPH4 fixture colar by Philips Lumec, PIR motion sensors by WattStopper, TOP900 network control by Lumewave	SEP loan, UC IOU, ETAP Incentive	N/A	N/A	$79	12.9	Pedram Arani - pmarani@ucdavis.edu
Davis	LED Conversion	2,600	$ 315	Leotek Ecobra	Roadway Impact Fund, tax-exempt municapal lease/purchase with Siemens, 2.8% rate, and potential 1% interest CEC loan	N/A	N/A	$15.20	15	Mitch Sears - MSears@cityofdavis.org
Ohlone College	LED Conversion	80	$ 1,169	GE Evolve LED	Prop 39	N/A	N/A	-	-	Thomas Moore - tmoore@ohlone.edu
San Diego Miramar College	LED Conversion	-	$ 1,302	LED Round area light by CREE	Prop 39	N/A	N/A	-	-	Paul Prizer - pprizer@sdccd.edu
San Diego Mesa College	LED Conversion	352	$ 1,347	LED Round area light by CREE	Prop 39	N/A	N/A	-	-	Mark Doubleday - mdoubled@sdccd.edu
CalTrans	LED Conversion	1,800	$ 644	Leotek Ecobra-head	Operating Budget, applied for SCE Incentives	N/A	N/A	-	-	Gonzalo Gomez - gonzalo.gomez@dot.ca.gov

APPENDIX E

A SURVEY OF SMART POLE IMPLEMENTATION EXPERIENCES AND FEATURES

Feature #1: Financing, Contract and Performance Terms

- **Benefit:** Vendors are capable of offering creative financing packages with zero up-front cost, fixed payments, maintenance agreements, etc.
- **Issue:** One California City staff warned that his team was left with an under-performing product and higher than expected ongoing costs and energy payments. Once the contract was cancelled with the vendor and the units disconnected, staff had to take on responsibility for the removal of hundreds of units.
- **Mitigation Solution:** This City staff recommended to other cities, "Be sure your contracts are clear in who is paying the energy, so you don't get stuck with the energy bills or have that energy counted towards your City's annual energy consumption. Be sure that the contract is clear about who will be responsible (financially and physically) for maintaining, and eventually removing the equipment."

Feature #2: ***Separate utility metering and usage of smart pole hardware from lighting***

- **Benefit:** The nodes are capable of automatically metering utility usage and transmitting data directly to utilities.
- **Issue:** Vendors may not be transparent or forthcoming about energy and operating costs.
- **Mitigation Solution:** With nodes, users would be able to pay per electrical use rather or by a pre-determined flat rate fee. Establish ongoing cost and performance guarantees with terms that cover the life of the system.

Feature #3: ***Global Positioning System (GPS)***

- **Benefit:** Each node is equipped with GPS mapping. Poles equipped with nodes will have reduced commissioning times and more efficient maintenance because the exact location of poles needing attention is provided.
- **Issue:** The initial node purchase will add expenses to the LED retrofit project.
- **Mitigation Solution:** The reduced operations and maintenance costs may help offset the project cost.

Feature #4: ***Dimming and Monitoring Lighting Control***

- **Benefit:** The node networks have remote online dimming, usage and monitoring capabilities as well as programmed schedules in case of outages. This will improve visibility, adjust the brightness accordingly with occupancy sensors, and deter crime.
- **Issue:** The initial node purchase will add expenses to the LED retrofit project.
- **Mitigation Solution:** Install will save electricity and provide lighting levels that are appropriate to the lighting zone.

Feature #5: ***Video Camera and Sensors***

- **Benefit:** Many nodes are also equipped with video surveillance and sensors. The data can be used to mitigate traffic, pollution, crime and accidents. These video cameras and sensors would monitor pollution levels, crowd size, have facial recognition, provide accident surveillance, and analyze traffic.

- **Issue:** The initial node purchase will add expenses to the LED retrofit project.
- **Mitigation Solution:** Traffic analysis may optimize parking by providing drivers with the location of empty spots. This would reduce the number of cars on the road, lessen greenhouse gas emissions, and has the potential to increase parking revenue. Crime-related financial burdens may be reduced.

Feature #6: *Wi-Fi and Cellular Network Infrastructure*

- **Benefit**: Wi-Fi distribution and cellular network infrastructure availability. The City may lease these services to third parties to generate revenue or provide additional coverage to residents to enhance internet access.
- **Issue:** These networks require additional energy input that can offset the energy reduction from converting lights to LEDs. Additional fees and operations costs accompany the network.
- **Mitigation Solution:** Details must be carefully discussed with partner companies. Third parties must sign a thorough contract or master license agreement with the City. The contract should outline who is covering the energy payment, attachment fees, installation and product costs, and eventually the removal of attached products.