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Street Lighting in New York State: Opportunities and Challenges

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NYSERDA Record of Revision

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Street Lighting in New York State: Opportunities and Challenges

Final Report

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Table of Contents

NYSERDA Record of Revision i

Notice iii

List of Figures v

List of Tables v

Summary S-1

1 Street Lighting Inventory for New York State 1

1.1 Estimated Savings and Associated Costs 5

1.2 Estimated Energy Savings 6

1.3 Estimated Installed Costs 6

1.4 Estimated Energy Cost Savings 7

1.5 Estimated Operation and Maintenance Cost Savings 7

2 Street Lighting Technical Opportunities 8

2.1 Performance Characteristics 8

2.2 Energy Savings 9

2.3 Maintenance Savings 11

2.4 Current LED Street Light Costs 12

2.5 Future LED Street Light Cost 13

2.6 Economics of an LED Street Light Retrofit or Replacement 14

[a]Assumes no program administrator incentives. Does not account for cost of money. 15

2.7 Economics of LED Street Light Installations – Investor-Owned Utility Perspective 15

3 Barriers and Challenges 16

3.1 Street Light Ownership and Utility Tariffs 16

3.2 Utility-Owned Street Lights 16

3.3 Customer or Municipality-Owned Street Lights 17

4 Status of New York State Utility-Owned Street Lighting Rates 18

4.1 Analyzing Orange and Rockland's LED Rate 19

5 Future Considerations 20

5.1 Addressing Regulatory Barriers 20

5.2 Addressing Technical and Educational Barriers 20

5.3 Addressing Financial Barriers 21

Appendix: Data Sources and References A-1

List of Figures

Figure 1-1. Existing New York State Street Light Quantities vs. Population 1
Figure 1-2. Existing New York State Street Light Technology Distribution..... 3
Figure 1-3. Existing New York State HPS Street Light Wattage Distribution 3
Figure 1-4. Example of a cobrahead-style street light 4
Figure 1-5. Example of a shoebox-style street light..... 4
Figure 2-1. LED street lights can help to reduce light pollution, due to their inherent directionality 8
Figure 2-2. Replacement of lamps typically requires the use of a bucket truck, which can be costly 11
Figure 2-3. Seattle City Light (SCL) LED Street Light Pricing Trend 14
Figure 4-1. Breakdown of Common Utility-Owned Street Light Tariff..... 18

List of Tables

Table 1-1. New York Total Savings and Cost Projections (assumes 100% municipal ownership) 5
Table 2-1. Performance Characteristics of Common Street Light Technologies..... 9
Table 2-2. Typical Energy Savings Associated with Replacing HPS with LED 10
Table 2-3. Typical LED Street Light Retrofit and Replacement Costs..... 12
Table 2-4. SCL Example of LED Street Light Cost Reduction over 4-Year Period 13
Table 2-5. Retrofit/Replacement Projects: Current Expected LED Street Light Simple Paybacks[a] 15
Table 4-1. Analysis of Existing O&R Street Light Rates 19

Summary

This report presents the results of an initial analysis of the potential savings and barriers associated with upgrading existing municipal street lighting throughout New York State to solid-state light-emitting diode (LED) technology.

Jurisdictions around the country have already begun to realize the benefits associated with upgrading to LED street light technologies. Cities such as Boston, Los Angeles, New Orleans, and Seattle have already completed large-scale conversions of their streetlights. Although there is some LED street lighting activity across New York State, there are no clear options and mechanisms for enabling and facilitating systematic strategies to capture cost-effective opportunities in the State.

S.1 Project Objective

The objective of this project was to understand the opportunity (e.g., benefits, costs, and obstacles) for New York State to transition street lighting from conventional incandescent and high intensity discharge (HID) lighting systems to high efficiency LED lighting. To understand the impact and to develop a roadmap for this transition, this project:

- Developed an estimate of the existing municipal street lighting inventory in New York, in number and type of technology.
- Determined the expected energy and maintenance savings that might be realized by converting to LED lighting.
- Identified the regulatory, technical, informational, and financial barriers associated with large-scale transition to LED lighting.
- Dissected the only currently available utility LED tariff in New York to better understand the street lighting tariff options and trade-offs.

S.2 Project Approach

The overall project approach focused on identifying the magnitude of the opportunity, the financial costs and benefits, and the barriers that need to be addressed. Street lighting tariffs in New York were reviewed. LED-specific tariffs were compared to tariffs for conventional technologies, as well as to LED tariffs offered outside of New York. Although LED street lighting is now a well-established technology, the current state of product development was also explored.

A systematic approach was used to estimate the total number of existing municipal streetlights. Data was collected from several municipalities and the results were extrapolated to estimate the statewide totals. This same approach was used to estimate the current mix of technologies and wattages installed. Recent street lighting projects from around the country provided a wealth of information regarding product, installation labor, and maintenance costs and savings from conversions of conventional street lighting technologies to LED.[1] All of this data was utilized to predict net energy and cost savings impacts of a statewide street lighting strategy.

S.3 Summary of Conclusions

The overall conclusion of this study was that a statewide LED street lighting strategic engagement would greatly benefit New York State for three reasons:

- Taxpayers would benefit from lower municipal street lighting expenditures.
- Utilities and municipalities would benefit from reduced maintenance.
- The population in general would benefit from the significant contribution made toward meeting climate impact goals.

Project conclusions included the following:

- Approximately 1.4 million municipal streetlights across the State have the potential to be addressed by a strategic street lighting strategy. This number includes both utility-owned (approximately 74% of the estimated inventory when excluding New York City) and customer-owned streetlights.
- The potential energy savings resulting from replacing all of these fixtures with equivalent LED fixtures is estimated to be 524 GWh annually.
- The financial savings from energy savings,are estimated to be nearly $28 million per year.
- Savings from reduced maintenance is estimated to be $67 million per year.
- Adding advanced controls where appropriate could add $2.2 million in savings.
- The total annual savings potential, assuming municipal ownership for all existing street lights, is estimated to be over $97 million statewide, as illustrated in Table S-1.

Table S-1. New York Statewide Savings Potential (assumes 100% municipal ownership)

Measure	Annual Energy Savings (MWh)	Annual Energy Cost Savings ($ Million)	Annual Maintenance Savings ($ Million)	Total Annual Cost Savings ($ Million)	Total Installed Cost ($ Million)
LED Retrofit	523,995	$ 27.93	$ 67.05	$ 94.97	$ 435.87
Advanced Controls	41,991	$ 2.24	$ -	$ 2.24	$ 41.41

[1] Actual results in New York State may vary depending on ownership, tariff rates, the existing streetlight technology being replaced, the LED replacement fixtures selected, municipal street lighting standards, etc.

Additional conclusions were:

- The State of New York via the Office of General Services has potential to exercise buying power to negotiate attractive pricing for LED products.
- The majority of New York municipalities are currently unable to pursue LED street lighting conversions with the majority of their streetlights due to lack of cost-effective rate tariffs offered by the utilities for LED technology. A coordinated effort is needed to establish tariffs that represent the economic advantages of LED lighting.
- Technical lighting expertise is needed to ensure effective and successful implementation.

S.4 Future Considerations

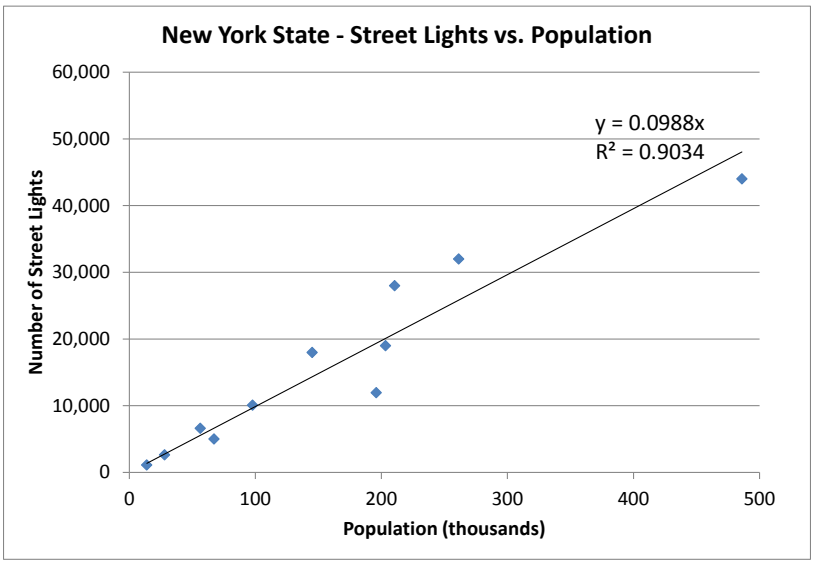
If New York State decides to implement a coordinated statewide LED street lighting program, the following steps would be critical to establishing a successful program:

1. Engage regulators and utilities to accelerate discussion and development of street light tariffs.
2. Produce a guide for municipalities that provides guidance on LED street lighting conversions utilizing best practices from other municipalities that have completed projects.
3. Offer independent technical assistance for LED street lighting.
4. Investigate, develop, and offer LED tariffs and leasing options.
5. Identify benefits/impacts of aggregated purchases (i.e., multiple year procurements, multiple jurisdictions, hybrid deals, etc.), including pricing discounts, enhanced warranties and/or other services provided by manufacturers and service providers.
6. Consider the use of Energy Efficiency Portfolio Standard or Clean Energy Fund to support these steps or | a portion of the capital cost of street lighting upgrades.
7. Explore the opportunity for financing through ESCOs, NY Green Bank, or other avenues. Streetlights can be a prime candidate for financing due to their long service life and municipal/government ownership.
8. Identify funding opportunities available through federal and/or regional programs.

1 Street Lighting Inventory for New York State

Approximately 1.4 million municipal streetlights illuminate New York State and consume more than 990 GWh annually.[2] Streetlight inventory data from 12 cities and towns in the State account for more than 453,000 individual streetlights, and these data were analyzed to estimate the statewide population of streetlights. Detailed inventory data was collected for five cities: New York City, Rochester, Yonkers, Syracuse, and Albany. Total street light counts were collected for an additional seven locations including the cities of Buffalo, Mt. Vernon, and Oneonta and the towns of Brookhaven, Huntington, Union, and Vestal. As shown in Figure 1-1, street light count and population were plotted for each location:

Figure 1-1. Existing New York State Street Light Quantities vs. Population



As shown in Figure 1-1, a strong correlation exists between population and the number of installed streetlights. This relationship, coupled with population data for New York State, was used to estimate the number of streetlights installed statewide.

[2] Municipal streetlights are streetlights that are paid for by municipalities. They may be either owned by the municipality or owned by the utility. They do not include privately funded street lights on private roads or nonmunicipal streetlights that may be paid for by other government or non-government entities such as college or university campus streetlights, street lights on prison roadways that may be the responsibility of the Department of Corrections, or bridge/tunnel lighting in some areas that is the responsibility of the Port Authority. However, many of the findings and recommendations of this report are applicable to all streetlights in New York.

To date, no previous statewide estimates of the total street light inventory in New York State have been published. A 2011 report developed for the U.S. Department of Energy (DOE) attempted to estimate the total number of streetlights installed nationwide.[3] The DOE analysis divided streetlights into two groups: "street lights" illuminating local and collector roads and "highway lights" illuminating interstates, freeways, and expressways. Using this simple population-weighted scaling approach, the results would equal approximately 3.3 million streetlights installed in New York State.

Although there is significant variation between the total street light estimate developed in this study and the estimate adapted from the DOE analysis, it should be noted that the DOE analysis relied on only 25 local government inventories to represent the entire U.S. These inventories may not be representative of jurisdictions in New York State. Furthermore, the DOE analysis divided streetlights into two groups: "streetlights" that illuminate local and collector roads and "highway lights" that illuminate interstates, freeways, and expressways, so the methodology used to estimate the number of lights differed between the two studies. Total streetlights were estimated using a population-based approach somewhat similar to that used for this study, whereas highway lights were estimated using data on the total lit mileage of highways in the U.S. and the typical highway light spacing. However, the majority of highway lights in New York State are the responsibility of the municipality in which they are located and are thus reflected in the inventories of those municipalities. Therefore, using this approach may in fact double-count streetlights installed along highways. Recognizing the deficiencies in the initial DOE analysis, the DOE, through the Municipal Solid-State Street Lighting Consortium (MSSLC), was in the process of developing a new inventory of streetlights installed nationwide as this study was being completed for NYSERDA. The results are now available and help inform overall street light inventories.[4]

The predominant lamp technology in existing streetlights in the State is high pressure sodium (HPS). Research for this report shows that nearly 89% of all existing street lights in the State are equipped with HPS technology.[5] Mercury vapor, incandescent, and metal halide lamps make up the majority of the remaining 11% of existing streetlights. Figure 1-2 presents the distribution by lamp technology, and Figure 1-3 gives the distribution of HPS lamps by wattage bin. Although a small number of LED streetlights are now installed in New York, the percentage of the total is insignificant. No evidence was found to support induction lighting or low-pressure sodium in current use for street lighting.

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[3] U.S. Department of Energy. 2011. *Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications*. Prepared by Navigant Consulting, Inc., http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_january2011.pdf

[4] See http://www1.eere.energy.gov/buildings/ssl/pdfs/msslc_inventory-phase1.pdf.

[5] NYC, which uses only HPS technology, is omitted from the analysis, the statewide share of HPS street lights drops only slightly to 86%.

Figure 1-2. Existing New York State Street Light Technology Distribution

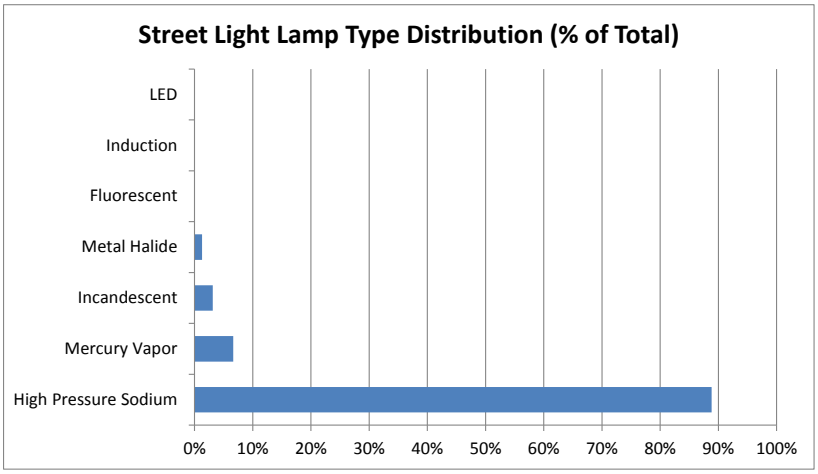
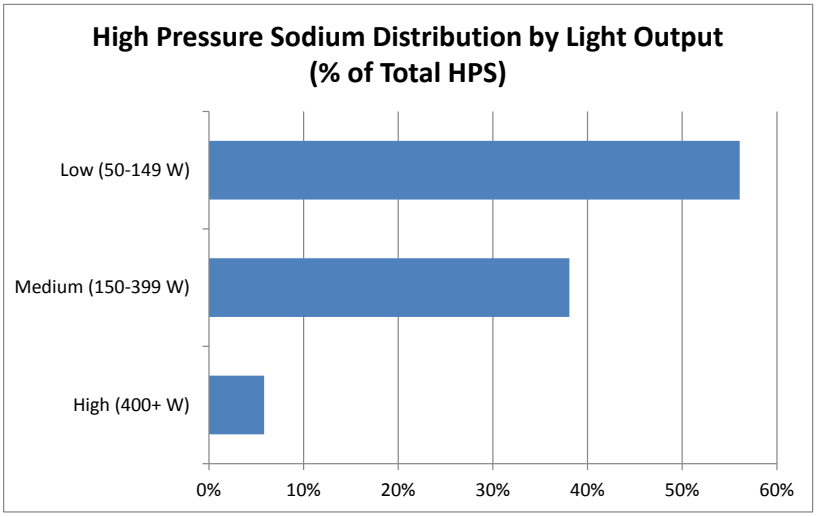


Figure 1-3. Existing New York State HPS Street Light Wattage Distribution



The five detailed inventories received from New York, Rochester, Yonkers, Syracuse, and Albany were used to establish the statewide lamp technology distribution. For analysis purposes, all cities and towns in New York State were distributed into small, medium, and large bins based on total population. For each population bin, the available streetlight inventories for cities within that bin were weighted by population and used to estimate lamp technology distributions for all cities within that bin statewide. Because of New York City's unique characteristics, it was not sorted into the aforementioned bins but instead considered separately using the actual inventory provided. Because no inventory data was obtained for small locales (i.e., towns with populations of less than 10,000), streetlight inventories for all towns in the state of Rhode Island with populations less than 10,000 were used as a proxy. Despite their individual size, towns with populations less than 10,000 account for 802 of the 1,010 cities, towns, and reservations in New York state and represent nearly 13% of the total New York State population.

Of the street light inventories obtained, only three reported the type of fixture. Typical fixtures are the cobrahead style (Figure 1-4) and shoebox styler (Figure 1-5). While these inventories are insufficient to develop a statewide distribution by fixture type, it is noted that New York City, representing 20% of total statewide streetlights, reported that 92% of all street lights were of the cobrahead type.

Figure 1-4. Example of a cobrahead-style street light

Figure 1-5. Example of a shoebox-style street light

1.1 Estimated Savings and Associated Costs

LED street lighting represents an enormous potential opportunity for both energy and total cost savings. If all of the streetlights identified in the inventory were owned by municipalities, replacing or retrofitting all existing street lighting with energy-efficient equivalent LEDs would save approximately 524 GWh annually. To achieve those savings, the total retrofit cost (i.e., total fixture cost and installation labor) is estimated to be approximately $436 million.[6] Installing advanced controls enabling streetlight dimming for some portion of the night could save an additional 42 GWh annually with a total installed cost of $41.4 million.[7] Table 1-1 provides a simplified analysis of the estimated energy and cost savings if all streetlights in New York State were municipally owned and retrofitted to LEDs.

It should be noted that the total annual cost savings are based on economics assuming municipal ownership of streetlights and the ability for municipalities to realize discounted volume pricing for LED fixtures. However only 26% of the estimated streetlight inventory is under municipal ownership. Cost savings for utility-owned streetlights may be different depending on the rates developed by utilities which would include amortization of capital costs, cost of money, and other factors included in tariff rates.

Table 1-1. New York Total Savings and Cost Projections (assumes 100% municipal ownership)

Measure	Annual Energy Savings (MWh)	Annual Energy Cost Savings ($ Million)	Annual Maintenance Savings ($ Million)	Total Annual Cost Savings ($ Million)	Total Installed Cost ($ Million)
LED Retrofit	523,995	$ 27.93	$ 67.05	$ 94.97	$ 435.87
Advanced Controls	41,991	$ 2.24	$ -	$ 2.24	$ 41.41

6 Based on results from street lighting retrofit/replacement projects from across the United States. Actual results in New York State may vary depending on ownership, the existing street light technology being replaced, the LED replacement fixtures selected, level of volume discounts offered, municipal street lighting standards, etc. See Appendix for sources of LED fixture costs and energy savings

7 Energy savings and cost associated with installation of adaptive controls found in the following sources: http://cltc.ucdavis.edu/sites/default/files/files/publication/siminovitch-streetlighting.pdf

http://www.etcc-ca.com/sites/default/files/OLD/images/pge_0913_san_jose_efficient_street_light_report_final.pdf

1.2 Estimated Energy Savings

To estimate the energy savings potential for a statewide municipal LED retrofit, all streetlights were first grouped into bins by lamp technology type and wattage. As informed by the individual inventories, a conservative baseline wattage was established for each bin. For example, for the 100–149 W HPS bin,[8] the baseline wattage was assumed to be 100W. In general, the detailed street lighting inventories presented street light counts including lamp type and nominal wattage. To account for ballast losses, these nominal wattages were converted to actual connected wattages using typical ballast loss assumptions. Next, an average percentage of wattage reduction per fixture (typically 52.5% or 55%, based on savings identified in case studies) was applied to each bin depending on the size of the fixture. Finally, 4,161 estimated annual operating hours were applied to determine energy savings for each bin.[9] The savings for all bins were summed to develop the estimated statewide annual savings. The analysis conservatively omits savings for existing incandescent, induction, and fluorescent fixtures as these represent a small percentage of the overall technology distribution and are not well grouped around common wattages. Further, for analysis purposes, new street light installations are not considered and all existing fixtures are assumed to be the cobrahead type.

Savings were estimated for advanced controls by first assuming that only 30% of existing street lights in New York State are appropriate for controls. This assumption reflects the fact that there are both practical and aesthetic barriers to implementing dimming controls on all streetlights. The California Lighting Technology Center estimates 30–50% savings are achievable based on available data.[10] The analysis conservatively assumes a 30% savings factor. These factors were applied to the estimated post-LED retrofit statewide street light energy consumptions to estimate control savings.

1.3 Estimated Installed Costs

Similar to the approach used to estimate energy savings, costs for the LED retrofit were estimated assuming an appropriate total installed cost (i.e., total fixture costs and installation labor) for each wattage bin. For example, the 100–149 W HPS bin assumes a total retrofit cost of $281 per fixture based on the average cost observed for this range of sizes from recent case studies and market reports. The cost assumptions are further described in Section 3-4.

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8 The street light inventory data was leveraged to develop more discrete wattage bins than those presented in Figure 2-3. For example, the "Low (50-149 W)" bin for HPS street lights was further disaggregated to three separate bins (i.e., 50-69 W, 70-99 W, and 100-149 W). This enabled a more accurate estimate of energy savings potential.

9 The annual operating hours assumption of 4,161 represents the simple average of the deemed annual street light operating hours used by the six investor-owned utilities in NYS, as presented in their respective street light tariffs.

10 Siminovitch, M. 2010, "Taking the Long View on LED Street Lighting," *LD+A Magazine.*

Costs for advanced controls were estimated assuming $100 installed cost per fixture. A 2009 adaptive controls demonstration project in San Jose cited a per-fixture cost of $119.[11] Estimating $100 in this report assumes purchasing power associated with a statewide effort, which would reduce total costs.

1.4 Estimated Energy Cost Savings

As of January 2014, only one of the New York State investor-owned utilities currently offers an established utility-owned tariff for LEDs, making it difficult to predict **total** energy cost savings, given that 74% of the inventory is utility-owned. This hypothetical energy cost savings analysis assumes costs consistent with energy delivery charges from customer-owned tariffs from each investor-owned utility.[12] First, customer-owned tariffs were reviewed to determine the appropriate energy delivery charges for each utility in the State. Next, the cities and towns in the State were sorted into their respective utility service territories. Finally, the appropriate rate was applied to the energy savings for each city and town.

1.5 Estimated Operation and Maintenance Cost Savings

Using a simplified approach, operation and maintenance savings for customer-owned street lights were estimated at $50 per fixture annually based on typical replacement lamp costs, labor costs, and re-lamping frequency over the life of the LED street light[13] as compared with HPS. **Note that for utility owned and/or maintained equipment, the customer will not realize these operation and maintenance savings under current tariffs.** However, this exercise is useful to estimate the potential cost savings assuming that customer choice is expanded to include LED tariffs.

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[11] Energy Solutions. 2009. "Pacific Gas and Electric Company Emerging Technologies Program, Application Assessment Report 0913, LED Street Lighting and Network Controls, San Jose, CA."

[12] Investor-owned utilities include Central Hudson, ConEdison, National Grid, New York State Gas & Electric, Orange and Rockland, and Rochester Gas and Electric

[13] Maintenance savings from the reviewed case studies ranged from $20 to $124 per streetlight per year. To refine the estimate, the costs to purchase and install HPS lamps and ballasts and the frequency of lamp/ballast replacements over the life of an LED fixture were used to estimate operating and maintenance savings. The results of this analysis were informed by the case study findings to arrive at the $50 per fixture annual savings. Actual maintenance savings may vary depending on a municipality's street light maintenance schedule for cleaning and replacement, the technology being replaced, the LED replacement fixtures selected, etc.

2 Street Lighting Technical Opportunities

Virtually all types of existing street lighting can be replaced with LED lighting technology that will result in a host of benefits to New York State municipalities and ratepayers. These benefits include:

- Reduced energy use and costs.
- Reduced maintenance and costs.
- Enhanced visibility and safety.
- Greater perceived security.
- Reduced light pollution and protection of night sky visibility.

Figure 2-1. LED street lights can help to reduce light pollution, due to their inherent directionality

Source: https://flic.kr/p/4V4AcM Used with permission (https://creativecommons.org/licenses/by-sa/2.0/legalcode)

2.1 Performance Characteristics

As noted in Table 2-1, the latest generation LED street lights can meet or exceed the performance characteristics of all other incumbent technologies. Table 2-1 provides the typical performance characteristics of various street lighting technologies, including LEDs.

Table 2-1. Performance Characteristics of Common Street Light Technologies[14]

Technology	Efficacy (Net)[a]	Cost	Optical Control[b]	Color Rendering (CRI)	CCT	Life	Ease of Control[c]
High pressure sodium	High	Low	Low - medium	Very low (20-25)	Very warm (≤ 2,100K)	Medium - high (15,000 - 25,000 hrs)	Low
Metal halide	Medium - high (21-34 lm/W)	Low	Low - medium	Medium (60-75)	Warm - cool (3,000K-4,200K)	Low - medium (5,000 - 15,000 hrs)	Low
Mercury vapor[d]	Low (10-17 lm/W)	N/A[d]	Low - medium	Low (20-50)	Cool - very cool (4,000K-6,000K)	Medium - high (15,000 - 25,000+ hrs)	Low
Induction	Medium - high (36-64 lm/W)	Medium - high	Low	High (70-80)	Cool - very cool (3,500K-6,500K)	Very high (50,000 - 100,000 hrs)	Medium
LED	High - very high (36-90 lm/W)	Medium - very high	High	High (70-90)	Warm - cool (2,700K-5,700K)	Very high (50,000 - 100,000 hrs)	High

Notes: CCT= correlated color temperature; K = °Kelvin

a) Net efficacy refers to delivered efficacy, which takes into account optical losses within a fixture.

b) Optical control refers to the ability of a fixture to direct the light emitted onto the desired surface accurately and evenly

c) Ease of control refers to the ability of a fixture to be easily turned on and off or dimmed using street lighting control systems

d) Mercury vapor is no longer available for new street lighting purchases due to a federal efficiency standard that prohibits its manufacture and sale.

2.2 Energy Savings

Energy savings resulting from the installation of LED street lights can be attributed to several factors including:

- Higher net efficacy
- Improved optical control
- Improved visibility with "white" light

For many applications, such as the replacement of cobra-head fixtures, LED street lights often have higher net efficacies than other technologies, meaning that more light is directed out of the fixture per watt than with most conventional technologies. Because of these higher net efficacies, LED fixtures are capable of producing comparable light levels at lower wattages.

LED street lights often have better optical control, thereby reducing or eliminating the wasted light that spills beyond the surface intended to be lit (including light directed into the night sky). For example, better optical control can reduce or eliminate the overlighting that often occurs directly beneath an HPS street light fixture. This improved optical control can also result in more uniform light distribution. Although it is still necessary to meet recommended

14 Clinton Climate Initiative. 2010. *Street Lighting Retrofit Projects: Improving Performance while Reducing Costs and Greenhouse Gas Emissions;* Independent research of current manufacturer data, including cut sheets and other published specifications.

illuminance levels for various roadways, in some cases the more uniform distribution from LED street lights can allow for greater energy savings. A common mistake is to size or compare LED replacements to other light sources solely based on the lumen output of the fixture. When sizing an LED streetlight, the improved optical control must be taken into account in order to maximize energy savings and reduce LED cost.

Finally, the bluish-white spectral content (i.e., cooler color temperature) of LED light sources can offer improved visibility and energy savings benefits compared to traditional light sources with a more yellow-orange color content, such as with HPS. These benefits occur only at low light levels, referred to as "mesopic" light levels, which are applicable to street lighting applications. The Lighting Research Center at Renssaeler Polytechnic Institute in New York State has been an industry leader[15] in identifying and understanding these benefits and enabling adoption by industry standards organizations such as the Illuminating Engineering Society (IES). When applying IES guidelines,[16] LED street lights can provide equivalent visibility as HPS street lights at lower light levels and lower wattages.

When all of these factors are taken together, LED street lights may use 45-70% less energy than existing HPS street lights, which represent the majority of street lights currently installed state-wide. Savings may be even greater when LED street lights are replacing mercury vapor or incandescent fixtures. Table 2-2 provides the average energy savings of LED street lights compared to various sizes of HPS street lights, based on recent case studies of installations across the country[17] (see Appendix).

Table 2-2. Typical Energy Savings Associated with Replacing HPS with LED

Variable	Light Output		
	Low	Medium	High
Base technology	70 W HPS	150 W HPS	400 W HPS
Base input wattage (W)	90	190	455
LED % wattage savings range vs. base	45%-65%	45%-65%	45%-70%
Avg wattage savings	55.0%	55.0%	57.5%
LED equivalent range (W)	32-54	67-114	137-273
LED avg equivalent (W)	40.5	85.5	193.4
LED light output (lm)	2251 to 5827	3756 to 12019	9706 to 26665

15 Lighting Research Center at RPI. 2008. "Mesopic Street Lighting Demonstration and Evaluation Final Report,".

16 IES. TM-12-12: Spectral Effects of Lighting on Visual Performance at Mesopic Lighting Levels.

17 Actual results in New York may vary depending on the existing street light technology being replaced, the LED replacement fixtures selected, municipal street lighting standards, etc.

2.3 Maintenance Savings

Street light maintenance can be costly. Replacing a lamp, ballast, or photocell often requires a bucket truck, specially trained electricians, and, potentially, traffic control. All of these costs combined can amount to hundreds of dollars per component replacement. When used in conjunction with long-life electronic drivers and photocells, LED street lights can significantly reduce maintenance costs by reducing or eliminating the need to change failed bulbs, ballasts, and/or photocells, typically done on an annual basis for HPS systems. Periodic cleaning of streetlights will still be necessary, depending on fixture design and local conditions (Figure 2-2). Thus, the savings can vary widely depending on current practices and costs. Based on recent case studies,[18] LED street lights are estimated to save $50 per fixture per year in relamp/reballast and other maintenance costs.

Figure 2-2. Replacement of lamps typically requires the use of a bucket truck, which can be costly

LED lighting systems include drivers, which serve a similar function to that of HID ballasts. Some LED streetlight manufacturers have worked with LED driver manufacturers to develop drivers with lifetimes that coincide with the lifetime of their LED streetlights (e.g., 50,000-100,000 hours). Additionally, common warranties for HPS ballasts were observed to be between 2-5 years,[19] where LED street light manufacturers are developing warranties of 5-10 years for their respective products. Cities that have completed large-scale LED street light conversions including Seattle and Los Angeles have reported LED driver failure rates much lower than failure rates of HID ballasts. A strong specification to ensure long-life drivers and photocells is essential to fully realize the maintenance savings of LED technology.

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18 Actual maintenance savings may vary depending on a municipality's street light maintenance schedule for cleaning and replacement, the technology being replaced, the LED replacement fixtures selected, etc. Sample of maintenance cost references (see appendix for full list of sources): http://www.darien.il.us/government/minutes/2013/Council/130304/Supporting%20Documentation/AttachmentB-2013StreetLightMaint.pdf; http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2011_gateway-msslc_sacramento.pdf, p. 8.1.

19 HPS ballast warranties reviewed include those offered by GE, Osram-Sylvania, and Advance

2.4 Current LED Street Light Costs

The cost of LED street lights can vary widely depending on the make and model selected, the light output of the fixture, the construction of the fixture (i.e., whether components are replaceable), as well as the quantity of fixtures purchased and whether any discount for bulk purchases is provided. However, prices for these fixtures have dropped dramatically over the past several years and continue to do so. For example, some replacement LED street lights for residential roadways are now available for less than $100.[20] Decorative post-top LED decorative fixtures have higher prices and greater cost variations due to the range of aesthetic designs, different light distribution requirements that necessitate a more complex product solution, and lower economies of scale due to the fact there are far fewer decorative streetlights than cobrahead streetlights.

The most important factor that affects fixture cost is the light output. Typically, higher light output means greater cost. Table 2-3 presents the range of costs for LED street lights by size (light output) and type (cobrahead fixture or decorative retrofit kit) based on actual costs from recent case studies and market research.

Retrofit costs for existing decorative fixtures are listed, as opposed to new fixture costs, because retrofit opportunities represent the vast majority of the potential LED street light projects in New York. Although new and complete LED cobrahead replacement fixtures are a cost effective option, new and complete LED decorative fixtures typically incur a cost premium due to the materials and design associated with these types of fixtures. Retrofit kits (including the LED module and driver) for existing decorative street lights typically represent a more cost-effective solution rather than replacing the entire fixture, and are more likely to be used. An overview of the corresponding simple paybacks for these types of products can be found in Section 3-6.

Table 2-3. Typical LED Street Light Retrofit and Replacement Costs

LED Fixture Type	Light Output					
	Low (<50W)		Medium (50W-100W)		High (>100W)	
	Min	Max	Min	Max	Min	Max
Decorative retrofit kit	$350	$615	$550	$950	$750	$1,450
Cobrahead fixture	$99	$225	$179	$451	$310	$720

The range of fixture and retrofit kit costs in Table 2-3 for each of the three light output ranges primarily reflects the range in costs for comparable fixtures across manufacturers, as well as the potential cost reduction resulting from volume pricing for these fixtures.[21]

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20 "Cree Introduces Industry's First $99 LED Street Light as a Direct Replacement for Residential Street Lights," *The Wall Street Journal*. August 6, 2013.

21 Sources for LED fixture costs can be found in the Appendix.

By taking advantage of current market prices, leveraging aggregate purchases to large-scale street light installations, and implementing best practice product selection and procurement strategies from other jurisdictions, it is expected that the typical cost per fixture can adhere to the low end of the cost range presented in Table 2-3.

2.5 Future LED Street Light Cost

The cost of LED street lights has been decreasing rapidly as the technology matures. For example, Seattle City Light (SCL) in Seattle, Washington, has been in the process of a phased LED street light replacement project since 2009. Each year, the cost of equivalent LED street lights has fallen significantly. Table 2-4 tracks the decline in cost of a 70-W LED cobrahead street light used by the city of Seattle, which replaced a 100 W HPS cobrahead fixture.

Table 2-4. SCL Example of LED Street Light Cost Reduction over 4-Year Period[22]

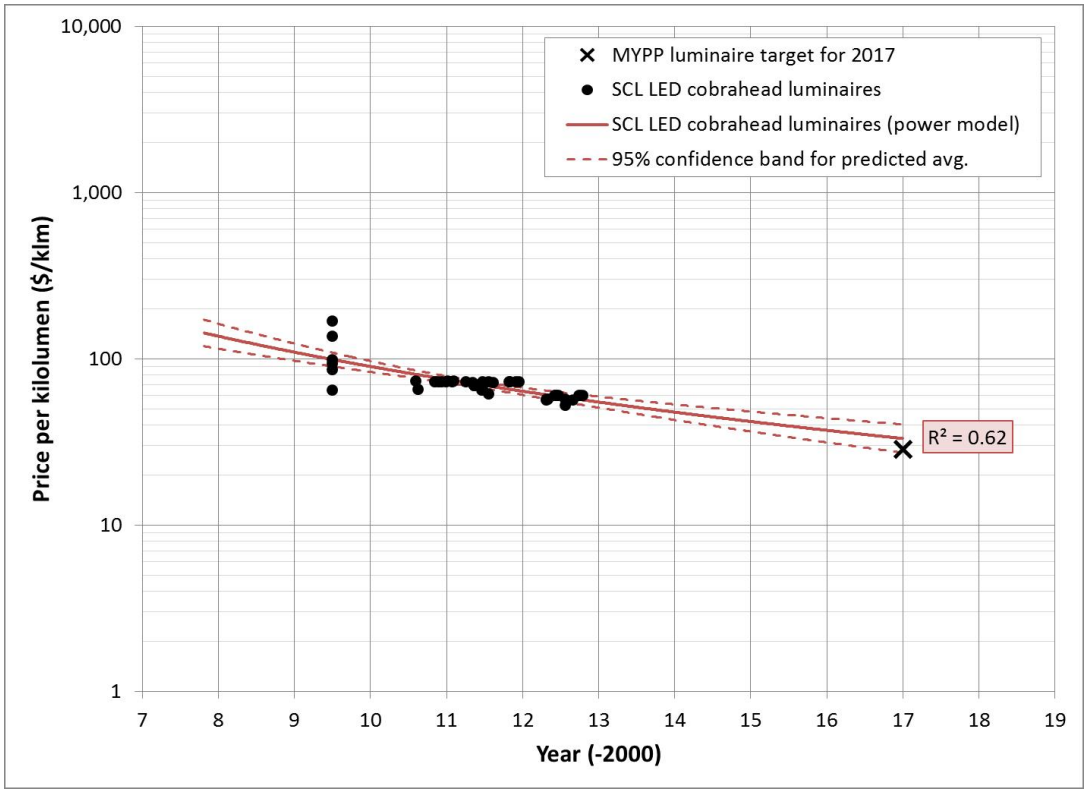
Seattle streetlight experience (for purchases of 2,000+ units)

Fall 2009	Spring 2010	Fall 2011	Winter 2012	Spring 2013
$369	$288	$239	$204	$179

As the technology matures, the price reductions are expected to slow and follow a logarithmic curve. Figure 2-3 is reprinted with permission from a 2013 DOE report regarding SCL's street lighting efforts shows the historical and predicted pricing trend for LED street lights.

[22] U.S. DOE., "MSSLC: Shaping the Future of Street Lighting," September 2013, pg. 5. Per correspondence from Carol Anderson, Seattle City Light, pricing dropped slightly in Summer 2013 to $172.

Figure 2-3. Seattle City Light (SCL) LED Street Light Pricing Trend[23]



If Figure 2-3 is applied to the City of Seattle's current fixture cost data, the street light that cost Seattle $179 in 2013 is predicted to cost approximately $125 in 2017.

2.6 Economics of an LED Street Light Retrofit or Replacement

Retrofitting or replacing existing street lights with LEDs can be very cost-effective, especially at scale with conventional "cobrahead" street lights, which make up the vast majority of the installed base. Based on data and analysis from recent case studies, the simple payback of replacing an existing cobrahead street light with an equivalent LED fixture can be between less than four years to up to eight years, before any energy efficiency program administrator (PA) incentives are applied. Decorative fixture retrofits are not always as cost-effective, with paybacks approaching nine years or greater, not taking into account energy efficiency incentives.[24]

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23 MYPP = Multi-Year Program Plan. Figure is reprinted with permission from U.S. DOE, "SSL Pricing and Efficacy Trend Analysis for Utility Program Planning," October 2013, pg. 32

24 To calculate simple payback, a distribution charge of $.055 was used, which was an average rate derived from a review of New York State IOU tariffs. The analysis does not account for the cost of money.

With PA incentives included, some jurisdictions have realized simple paybacks of between one and three years. Table 2-5 provides a range of simple paybacks (without PA incentives) expected for street light retrofits for various fixture sizes and types.

Table 2-5. Retrofit/Replacement Projects: Current Expected LED Street Light Simple Paybacks[a]

Fixture Type	Light Output					
	Low (<50W)		Medium (50W-100W)		High (>100W)	
	Min	Max	Min	Max	Min	Max
Decorative	14.2	20.2	14.1	21.3	12.5	18.6
Decorative kit	9.7	15.1	10.7	17.0	8.9	16.0
Cobrahead	3.6	5.6	4.0	7.7	3.9	7.7

[a] Assumes no program administrator incentives. Does not account for cost of money.

2.7 Economics of LED Street Light Installations – Investor-Owned Utility Perspective

Simple payback is a relatively straightforward metric that can be used to put street light projects into understandable financial terms for streetlights owned by municipalities. However an investor-owned utility's economic perspective is different for the streetlights they own. As investor-owned businesses, utilities must consider the capital requirements and impact on revenues and earnings. Any large-scale conversion of utility-owned streetlights will require a large amount of utility capital. Although this capital is ultimately recouped over time through rates, it can have a near-term negative impact on a utility's financial position. Furthermore if the corresponding LED rate offered by the utility to support the conversion is less than the rates offered for the other technologies that are replaced, the utility's revenue will decrease. Both of these factors may have a negative impact on the utility's financial standing, and can therefore be of concern to utility executives, regulators, and investors.

3 Barriers and Challenges

Despite all of the benefits provided by LED street lighting technologies, significant barriers must be overcome before municipalities can act upon these opportunities. These barrier categories include:

- Regulatory – The lack of options or financially attractive rates offered by utilities for LED street lighting.
- Financial – The capital cost of purchasing and/or upgrading street lights.
- Technical – The technical expertise needed to design or assist in a street lighting upgrade.

Although energy efficiency programs in general have a lot of experience addressing economic and technical barriers of energy efficiency, the unique regulatory barriers make implementing LED street lighting projects particularly challenging. Understanding these barriers requires an understanding of street light ownership and rate structures.

3.1 Street Light Ownership and Utility Tariffs

Streetlights are either owned by the utility customer (including municipalities, towns, cities, etc.) or by the utility. Depending on fixture ownership, there are significant differences in the operational costs, potential savings, options, and the barriers a utility customer will face in pursuing a street light upgrade. An estimated 59% of New York State's municipal streetlights are owned by the utilities and the remaining are owned by municipalities.[25] This number is heavily influenced by the fact that New York City owns all of its streetlights; if the city is omitted, the percentage of utility-owned street lights increases to 74%.

3.2 Utility-Owned Street Lights

When streetlights are owned by the utility,[26] the street lighting service is typically provided through a rental/leasing arrangement in which the utility company retains ownership of the equipment and is responsible for maintenance. The utility customer pays a fixed monthly charge for this service, but does not acquire the ownership or build equity in assets for the streetlights.

When streetlights are owned by the utility, the customer's choice of street light technologies is limited to the utility's current options as defined by the approved rates and tariffs. While utilities generally offer several options for street lighting technologies, as of January 2014, only one New York State utility, Orange and Rockland (O&R), offers an

[25] This estimate was developed using broad assumptions of ownership based on utility territory. For National Grid, RG&E, Orange & Rockland, NYSEG, and Central Hudson, it is assumed that 90% of the streetlights within their respective service territories are utility-owned. PSEG-LI assumes that 50% of streetlights are utility-owned. For Con Edison and all municipal utilities, it is assumed that 100% of streetlights are customer-owned. These assumptions were informed by collected inventories and available literature, but they should only be interpreted as preliminary estimates. Additional data from the utilities would be required to improve the accuracy of the estimate.

[26] For New York State excluding New York City, the estimate is approximately 74% of the streetlights.

LED option within their utility-owned street light tariff. This is important because if a jurisdiction chooses to reduce the cost of their streetlights through a more energy efficient LED option, but does not own their street lights, it will not be able to choose LEDs unless a specific LED street light option and corresponding rate is offered.

The lack of LED implementation options or cost-savings opportunities for utility-owned streetlights has led to legislation in Massachusetts, Rhode Island, and Maine to allow jurisdictions to purchase street lights from their utility so they have the option to replace their street lights if they choose to do so.

3.3 Customer or Municipality-Owned Street Lights

In contrast to utility-owned streetlights, customers, and municipalities that own their street lights[27] may choose any technology that complies with basic technical specifications, freeing them to choose more energy efficient technologies that the utility may not otherwise offer. Furthermore, when customers own their own lights they may upgrade the equipment at any time. In unmetered situations, the customer or municipality typically provides manufacturer specification sheets and other documentation to inform the utility of the expected electricity usage of the streetlights. The utility then develops a fixed monthly rate based on estimated consumption.

Because of the increased flexibility offered when customers own their streetlights, as well as the potential for significant cost savings, a small number of New York State municipalities[28] have purchased their street lighting systems from the local electric utility company. In other states, this practice is more widespread. In Massachusetts, more than 75 out of a total of 351 municipalities have purchased their streetlights from the utility with many more in process. Where these buyouts have occurred, municipalities have reported substantial cost reductions. However, it is the utility company's option to sell the street lighting systems so the potential for cost savings will depend on many factors, including timing, scale, and negotiations with the utility. A 2007 audit by the New York State Comptroller found that if the five audited jurisdictions bonded to buy their street lighting systems instead of leasing their street lighting equipment from their local electric utility, they could save over $13 million over the term of the 20-year bonds.[29] As noted previously, several states including Massachusetts, Rhode Island, and Maine have passed legislation that requires utilities to allow street light system purchases by municipalities.[30]

Given that customers who own their streetlights are able to access the opportunities afforded by LEDs, albeit often with rates for nonmetered assets, overcoming the regulatory barriers with utility-owned street lights is currently the biggest obstacle to overcome.

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27 As noted earlier, this is estimated to be approximately 25% of the total street lights in New York State when excluding New York City.

28 Penfield, NY purchased their street lights from Rochester Gas and Electric in 1995. Union, NY purchased their street lights from NYSEG in 1998.

29 Office of the New York State Comptroller. 2007. "Street Lighting Cost Containment."

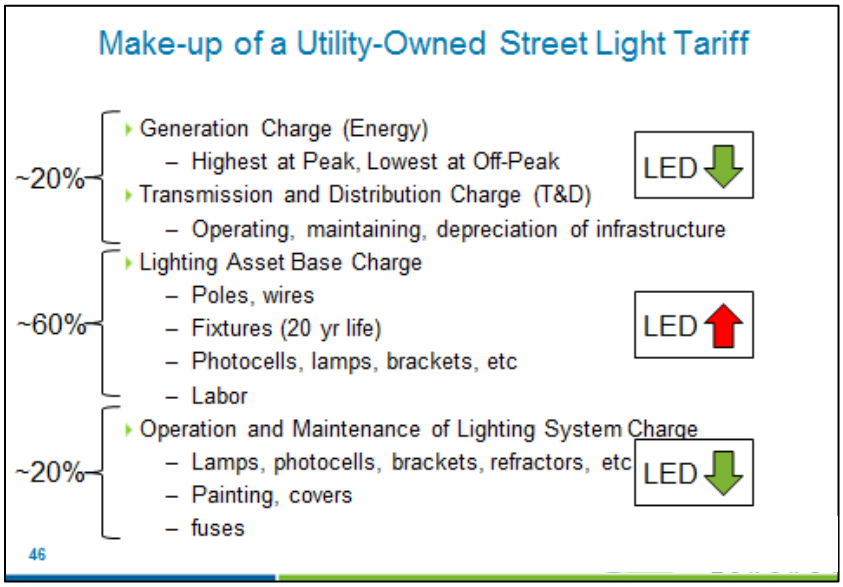
30 Massachusetts Restructuring Utility Industry Act, Chapter 164, Section 34a, 1997. Rhode Island Municipal Street Light Investment Act, 2013. Maine Energy Cost Reduction Act, 2013.

4 Status of New York State Utility-Owned Street Lighting Rates

As of January 2014, O&R is the only New York State investor-owned utility (IOU) that offers an LED rate for utility-owned street lighting. Other IOU municipal customers who do not own their street lights are currently unable to achieve an LED street light conversion via utility tariffs. Interestingly, if a jurisdiction in O&R's territory decided to convert from HPS to LED, the total monthly charge would be 12% higher for the LED fixture.

Street lighting rates are complex and can be challenging to dissect. As shown in Figure 4-1, a general industry rule-of-thumb, the 60-20-20 rule, says that 60% of a street lighting rate is made up of the capital required to install the street light (including equipment costs), 20% is made up of the energy cost including transmission and delivery, and the remaining 20% is allocated for ongoing streetlight maintenance.[31] This breakdown means that while LED fixtures will save on energy and maintenance costs, some or most of these cost savings could be negated if rates are based on a selection of higher cost LED fixtures. This can be seen when breaking down and comparing O&R's rates for HPS and LED fixtures.

Figure 4-1. Breakdown of Common Utility-Owned Street Light Tariff



[31] Stevens, M., 2012. "Investor Owned Utility Financial Perspective." Presented at the August 2012 Municipal Consortium LED Street Lighting Workshop, Boston, MA.

4.1 Analyzing Orange and Rockland's LED Rate

O&R's current tariff[32] contains two LED options: a 70W and 100W rate. Both rates identify the expected lumen output, total wattage, and delivery charge for each option. For this analysis, as shown in Table 4-1, the rates for the 70W HPS and 70W LED options were compared. The monthly rate for the LED fixture is greater than the HPS, yielding an estimated monthly charge for the LED fixture that is 12% greater than the HPS fixture it is intended to replace.

Table 4-1. Analysis of Existing O&R Street Light Rates

	Current O&R Rate 70W HPS	Current O&R Rate 70W LED	ERS/Optimal Estimated LED Rate
Street Light Cost	$71	$531	$150
Watts Used (with ballast/driver)	108	74	43
Monthly Rate for lamp type	$14.56	$19.39	$12.39[b]
Estimated monthly charge[a]	$25.96	$29.27	$20.88[b]

[a] Equals Monthly Rate plus other fixed charges plus variable charges times monthly kWh; see Appendix for assumptions and rates.

[b] A rough estimate only. A specific analysis using O&R's rate methodology would be required to determine the actual rate.

A review of the capital cost assumptions for LED fixtures in these rates found the costs to be substantially higher than what is currently reflected in the market.[33] In addition, the use of a 70W LED fixture in the rate appears to be oversized (i.e., too high a wattage and potentially too much light) compared with the HPS fixture it was intended to replace. A common misconception is that a replacement LED fixture should be selected based solely on lumen output relative to the existing fixture. For a number of reasons, including the improved optical control of LED fixtures and the perceived brightness with higher color temperature light sources, a lower wattage replacement that still meets recommended illuminance levels may be more appropriate and cost-effective. It should be noted that identifying appropriate replacements may call for additional technical analyses and planning. That being said, updated cost assumptions and the selection of a lower wattage fixture, where appropriate, could yield an LED tariff rate that provides an O&R customer as much as a 24% cost savings over an HPS fixture, as shown in the comparison of O&R's rates to a revised estimated LED rate in Table 4-1.

[32] O&R Case 11—E-0408 dated 6/15/12, leaf 283. O&R submitted a rate case filing in November 2014 that will modify the rates used in this discussion.

[33] Estimates in RS Means for LED streetlights are almost double that observed in case studies.

5 Future Considerations

The barriers to the street lighting energy efficiency opportunity are regulatory, technical, and financial. Each barrier will require a specific approach to be addressed successfully. Of these barriers, the most significant is the regulatory barrier: the lack of rate tariffs or financially attractive rates for LED street lighting, especially with utility-owned streetlights. For many jurisdictions in New York State, these regulatory barriers must be addressed before the jurisdiction will face the technical and financial barriers.

5.1 Addressing Regulatory Barriers

The following are options for addressing regulatory barriers:

- Engage New York State regulators and utilities regarding current and proposed tariff options and barriers.
- Propose strategies/methods for developing and/or adjusting LED tariffs to better reflect current market realities and promote efficiency.
- Complete more in-depth research into tariff models found in New York State. Explore financial mechanisms that may motivate utilities to develop tariffs and streetlights to expand customer choice and LED options.
- Publish a report on the street lighting energy efficiency opportunity to equip stakeholders with knowledge. Stakeholders must understand the issues and opportunities.

5.2 Addressing Technical and Educational Barriers

The following are options for addressing technical and educational barriers:

- Develop and publish a guide for LED street light upgrades for use by jurisdictions and municipalities. This guide will include guidance on how to specify the appropriate fixture to ensure high-quality and long-lasting installations. The guide will address technical issues such as selection of LED fixtures for a given application and avoiding over-lighting roadways along with potential technical issues such as comparative component failure rates, etc. The guide will also outline a process for conversions using best practices from other jurisdictions. The Lighting Research Center and the Municipal Solid-State Street Lighting Consortium (MSSLC) recently developed similar guides, which can be used as either a reference or as the framework for future publications:
    - Sustainable Roadway Lighting Seminar (http://www.nyserda.ny.gov/Cleantech-and-Innovation/Transportation/Transportation-Research/Transportation-Reports)
    - U.S. Department of Energy Municipal Solid-State Street Lighting Consortium (MSSLC) Model Lighting Specification (http://energy.gov/eere/ssl/model-specification-led-roadway-luminaires)
    - Examples of guides in other states include the following:
      Efficiency Vermont -
      http://www.efficiencyvermont.com/docs/for_my_business/lighting_programs/StreetLightingGuide.pdf
      Massachusetts Metropolitan Area Planning Council -
      http://www.mapc.org/system/files/bids/Retrofit%20Streetlights%20with%20LEDs.pdf

- Identifying appropriate LED replacements for existing fixtures may call for additional technical analyses and planning beyond the capabilities of local jurisdictions. Assist jurisdictions with the technical aspects of street light conversions, such as establishing baseline inventories, design and technical assistance, etc. This assistance may also include presentations, webinars, and other one-on-one outreach to keep jurisdictions and other stakeholders apprised of current market information and best practices.

5.3 Addressing Financial Barriers

The following are options for addressing financial barriers:

- Identify benefits/impacts of aggregated purchases (i.e., multiple year procurements, multiple jurisdictions, hybrid deals, etc.), including pricing discounts, enhanced warranties, and/or other services provided by manufacturers.
- Consider coordination with New York State Office of General Services and entities responsible for street lighting purchase and procurement to specify and manage aggregated purchases.
- Consider the use of Energy Efficiency Portfolio Standard or Clean Energy Fund to support the above steps or a portion of the capital cost of street lighting upgrades. Support can be applied to reducing the cost of new LED fixtures and/or to pay the remaining depreciated cost of streetlights removed before utilities have recovered their costs.
- Explore the opportunity for financing through ESCOs or other similar means. Streetlights are a prime candidate for financing due to their potentially long service life and municipal/government ownership and/or operation.
- Research associated funding opportunities available through federal and/or regional programs.

Appendix: Data Sources and References

The following sources were used to determine fixture wattages, equivalencies, and costs (including fixture, material and labor costs). Only data from within the past year was referenced for LED fixture costs due to the rapid decline in the cost for this technology over the past several years.

- DOE gateway demonstration – Kansas City street light project (June 2013)
  - Replaced a range of HPS street lights, including 100 W – 400 W
  - Mean energy savings was 39%, often with lower light levels. Net increase in average efficacy is 15% http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2013_gateway-msslc_kc.pdf
- LA street light retrofit (July 2013):
  - Replaced a range of HPS street lights
  - Avg. LED fixture cost = $245 in 2012 (covers range of wattages)
  - Goal was 40% energy savings, achieved 63% savings http://www.forbes.com/sites/justingerdes/2013/07/31/los-angeles-completes-worlds-largest-led-street-light-retrofit/ http://photos.state.gov/libraries/finland/788/pdfs/LED_Presentation_Final_June_2013.pdf
- Asheville, NC street light retrofit (May 2013)
  - Avg. fixture cost = $267 (7,583 installed @ $2,024,181)
  - Approximately 50% savings http://www.usdn.org/uploads/cms/documents/asheville-led-streetlights-and-green-capital-improvement-program-best-practices-case-study.pdf http://www.ashevillenc.gov/Portals/0/city-documents/sustainability/Webpage%20City%20of%20Asheville%20LED%20Street%20Light%20Program.pdf
- Iowa case studies
  - 41% – 63% energy savings over HPS (9 projects, 2 outliers = 29% and 78% savings)
  - Some fixtures intended to replace 150 W HPS were used to replace 400 W HPS due to the recognition that the existing illuminance in those areas was higher than necessary. http://archive.iamu.org/services/electric/efficiency/Street%20Lighting/StreetLightingHandbook.pdf
- Ann Arbor, MI case study (2011 – maintenance savings reference):
  - $124/year labor and materials to maintain/replace MH lamps http://www.a2gov.org/departments/systems-planning/energy/Documents/LED_Summary.pdf
- City of Los Angeles "Changing our Glow for Efficiency", June 2013
  - 2009 - $432
  - 2010 - $298
  - 2011 - $285
  - 2012 - $245 http://photos.state.gov/libraries/finland/788/pdfs/LED_Presentation_Final_June_2013.pdf

- Seattle, WA case study
- Field test results
- Economic analysis
  http://www.seattle.gov/light/streetlight/led/docs/SCL%20LED%20Consultant%20Report.pdf
- Tucson, AZ case study
  - Maintenance savings reference
  - $150 per HID lamp replacement
    http://www.tucsonaz.gov/files/ocsd/CMS1_037814.pdf
- Darien, Il case study
  - Maintenance cost reference (street light repair)
    http://www.darien.il.us/government/minutes/2013/Council/130304/Supporting%20Documentation/AttachmentB-2013StreetLightMaint.pdf
- DOE gateway demonstration – Sacramento, CA street light project (December 2011)
  - Referenced for maintenance and installation costs only
    http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2011_gateway-msslc_sacramento.pdf
- Loveland, CO – fixture costs (4/25/2013)
  - Cobrahead: $375 – $1,118
  - Decorative: $600 – $1,609
    http://www.ci.loveland.co.us/modules/showdocument.aspx?documentid=15201
- Orlando, FL article (October 2013)
  - LED fixture costs
  - LED equivalency info
    http://articles.orlandosentinel.com/2013-10-05/business/os-dark-sky-light-pollution-20131005_1_led-streetlights-orlando-utilities-commission-light-pollution
- DOE gateway demonstration – Central Park decorative post-top fixtures (Sept 2012)
  - Pg. 3.1 - maintenance costs
  - $111.60 per luminaire per year:
  - $65.60 for pole/fixture/ballast maintenance
  - $46.00 for lamp replacement
    http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_gateway_central-park.pdf
- DOE report – "SSL Pricing & Efficacy Trend Analysis for Utility Program Planning" (Oct 2013)
  - Page 32: $/klm trend for street lights (data from Seattle City Light)
    http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_trend-analysis_2013.pdf

TableA–1: Analysis of O&R Street Light Rates is based on the following example in which O&R's actual charges were applied according to the technology chosen.

Actual monthly costs may vary depending on the location of the street light and other factors (e.g., underground service, bracket type, etc.). The rates used, with the sole exception of the ERS/Optimal Estimated LED Monthly Rate, are based on the O&R tariff information found on the utility website: http://www.oru.com/aboutoru/tariffsandregulatorydocuments/newyork/index.html)

	Technology Choices and Charges		
Tariff Descriptions and Inputs	**O&R Current 70W HPS Rate**	**O&R Current 70W LED Rate**	**ERS/Optimal Estimated LED Rate**
Watts Used (with Ballast/driver)	108	74	43
Monthly Costs/Rates			
(1) Monthly Rate (Delivery Charge) – (fixed)	$14.56	$19.39	$12.39
(2) Additional charges (if applicable)			
Underground Service – (fixed)	$5.04	$5.04	$5.04
Fifteen Foot Bracket – (fixed)	$0.51	$0.51	$0.51
(3) Competitive Service, Municipal Undergrounding, Energy Efficiency Charges			
25. Energy Cost Adjustment (a) thru (e) variable)*	$0.00208	$0.00208	$0.00208
26. System Benefits Charge (variable)*	$0.00438	$0.00438	$0.00438
29. Transition Adjustment Charge (variable)*	$0.00077	$0.00077	$0.00077
(4) Temporary Surcharge/kWh (variable)*	$0.00549	$0.00549	$0.00549
(5) Merchant Function Charge/kWh (variable)*	$0.0049	$0.0049	$0.0049
(6) Billing and Payment Processing Charge- (fixed)	$1.02	$1.02	$1.02
(7) Market Supply Charge (variable)*	$0.08396	$0.08396	$0.08396
(8) Increase in Rates and Charges (variable depending on municipality)	0	0	0
Sum of all Variable Charges	**$0.10158**	**$0.10158**	**$0.10158**
***prices as of dates indicated by sourced documents**			
Application of Cost Variables (Assuming all Additional Charges apply)			
Assumes 440 Monthly Burn Hours			
kWh= (Total Wattage/1,000)*Monthly Burn Hours	47.52	32.56	18.92
Sum of Variable Costs (kWh times variable charges)	$4.8270816	$3.3074448	$1.9218936
Sum of Fixed Costs	$21.13	$25.96	$18.96
Sum of Total Monthly Charges	**$25.96**	**$29.27**	**$20.88**

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Street Lighting in New York State: Opportunities and Challenges

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State of New York
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