NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting
for Planners and Engineers

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New York State Energy Research and Development Authority

Table of Contents

i. Introduction

Street lighting is a key element in the development of many urban, suburban and rural districts in New York State. Lighting along New York streets and highways uses an estimated 1 billion kWh annually.[1] Because of this large investment in energy use, methods for specifying efficient products while maintaining aesthetically pleasing installations would not only provide energy efficiency benefits, but provide potential economic benefits by increased commercial activity and tourism in New York State's downtowns and urban areas.

Municipal planners and engineers understand opportunities for effective energy-efficient street lighting from an energy savings and a high-quality design and performance perspective. Currently available street lighting resources and guides provide technology information, design and layout guidance, or recommended photometric performance. However, based on feedback to NYSERDA, municipalities are looking for additional information on how to combine photometric, design, and energy-saving performance of street lighting installations.

Purpose of this Guide

NYSERDA developed this Guide in response to New York's street lighting informational needs. The ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Planners and Engineers*** integrates technical, performance and design guidance for effective energy-efficient street lighting systems. The cornerstone of this guide is the NYSERDA Model Performance Criteria and Design Guidelines for Street Lighting found in Section III. This guide can also be used:

- ❑ To communicate the benefits of effective energy-efficient street lighting to municipal decision makers, such as commissioners and boards.
- ❑ To understand the important elements and issues of effective energy-efficient street lighting, and gain the knowledge to make informed street lighting procurement decisions.
- ❑ To complement existing street lighting design specifications, such as those of the Illuminating Engineering Society of North America.

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[1] Edison Electric Institute. 1962. *Statistical Yearbook of the Electric Utility Industry for 1961*. New York, NY: Edison Electric Institute. Goeke, K. 1998. *Baseline Energy Outlook.* Sacramento, CA: California Energy Commission. Hoffman, M. S. 1990. *World Almanac and Book of Facts: 1990*. New York, NY: Pharos Books.

The ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Planners and Engineers*** offers specific technical and design information for street lighting designers – planners and engineers. The companion guide, the ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*** provides general information so municipal officials will understand street lighting issues and the benefits of an effective energy-efficient design. For your convenience, both guides are offered together, along with a list of existing effective energy-efficient street lighting installations in New York State.

The ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting*** is a valuable resource to help municipalities make informed street lighting decisions, however, this Guide should be treated as a complement to existing resources. Municipalities should work within current tariff structures and continue to use existing industry accepted design specifications, such as recommended light levels from the Illuminating Engineering Society of North America.

I. Effective Energy-Efficient Street Lighting Principles and Opportunities

What is Effective Energy-Efficient Street Lighting?

Effective energy-efficient street lighting uses a balance of proper energy-efficient technologies and design layout to meet performance, aesthetic and energy criteria required by pedestrians, motorists, community residents, municipalities and utilities.

Today, most street lighting is selected based solely on providing a recommended amount of light to a roadway, or as is the case with many business district improvement projects, that need to meet architectural requirements, the general style of the pole and fixture is important. Effective energy-efficient street lighting design integrates efficient lamp technologies, optimum pole placement, efficient fixture photometrics (light distribution), and aesthetics while using the least amount of energy and meeting various requirements for visibility and appropriate light levels.

For example, Table 1 shows five street lighting options that provide similar lighting quantity to the road, but the lighting quality and costs differ. Consider the following:

- ❑ The Mercury Cobrahead option is a typical initial low-cost, inefficient light source. Notice it uses a 400W bulb (consuming more energy) compared to the other lower wattage options, plus its total annualized cost is high.
- ❑ The Metal Halide Cobrahead and Metal Halide Cutoff options are more efficient and have a lower annual cost. The Cutoff option better controls the light and reduces light trespass (extraneous light on adjacent property).
- ❑ The most energy-efficient and highest quality option (in terms of light control, distribution and color rendering) is the Metal Halide Cutoff. Note, pulse-start metal halide (PSMH) lamps provide even greater energy efficiency compared to standard metal halide.
- ❑ The Metal Halide Post Top option is a more decorative option with a lower mounting height that requires more posts, thus the higher costs. Because it uses lower lamp wattage it may help meet design needs such as reduced glare.
- ❑ The High Pressure Sodium Cutoff system is the most energy efficient and will often require fewer poles, thus resulting in lower energy and maintenance costs. However, the color properties of high pressure sodium are only fair and should only be used when color rendering is not critical.

Table 1

Economic Analysis Comparing Several Street Lighting Systems

	Mercury Cobrahead	**Metal Halide Cobrahead**	**Metal Halide Cutoff**	**Metal Halide Post Top**	**High Pressure Sodium Cutoff**
Luminaire name	Cobrahead	Cobrahead	Cutoff	Decorative Post Top	Cutoff
Lamp type	400W MV	250W MH	250W MH	150W MH	250W HPS
Number of luminaires	12	12	12	24	11***
Installed cost	$36672	$36240	$38880	$35904	$35618
Annual energy cost	$2391	$1551	$1551	$1997	$1419
Annual operating cost*	$2536	$1677	$1677	$2509	$1601
Total annualized cost**	$6271	$5368	$5637	$6166	$5229

* Includes energy and maintenance costs

** Includes initial, energy and maintenance annualized over 20 years.

***Assumes a 10% reduction in the number of poles needed because of higher luminous efficacy of high pressure sodium. Color characteristics will be fair.

Effective Energy-Efficient Street Lighting Opportunities and Benefits

Almost all municipalities have opportunities to benefit from effective energy-efficient street lighting. Existing street lighting installations can often be upgraded or improved. However, upgrades to existing systems generally do not take place until a larger capital improvement project is planned. Still, with some inefficient systems, such as those using mercury vapor lamps, upgrading to more efficient technologies can often pay back through energy savings. New, renovated or relocated street lighting installations offer the greatest opportunities given that efficient designs and technologies can easily be integrated into the plan.

Effective energy-efficient street lighting installations offer the following opportunities and benefits to municipalities, drivers, pedestrians and taxpayers. Planners and engineers need to understand these opportunities and benefits to help develop a holistic approach to street lighting design, *AND* help convey effective energy-efficient street lighting principals to municipal officials and decision makers.

- ❑ *Energy savings* – Through use of efficient technologies and design practices, excess energy usage can be avoided. As previously shown in Table 1, converting from mercury vapor to more efficient lamps such as metal halide, or using fixtures that are efficient and spaced properly can reduce energy costs.[1,2]
- ❑ *Capital cost savings* – Using the proper spacing and placement can reduce the capital costs because more efficient systems can use fewer poles and luminaires.

- *Maintenance cost savings* – Using lamps with longer lives and layouts with proper spacing and placement means reduced costs for fixing 'burnouts' and painting or replacing damaged poles, resulting in lower annualized costs even when initial capital costs are more expensive.
- *Improved sense of security* – Selection of efficient equipment and incorporating proper design[3] can make an area appear safer and more secure, and in some cases can assist in reducing crime[4,5] without increasing light levels. In fact, light levels that are too high will ***not*** make an area seem safer.[2] Direct glare and high light levels can reduce perceptions of safety by making visibility more difficult.[6] Attention to uniformity[7] (even light distribution on the horizontal surface) and vertical illuminance[8] (light distribution on the vertical surface of buildings and people) can add to a person's sense of security.
- *Evenly lit roads and sidewalks* – Using good design can improve visibility by avoiding overly bright and dark patches on roads and walkways.[9]
- *Reduced glare and improved visibility* – Overly high light levels often create unwanted glare that decreases visibility. Careful selection of fixtures and lamps that enhance visibility can improve detection of pedestrians by drivers[10-14] and increase seeing distances beyond those provided by automotive headlights alone.[15]
- *Aesthetically pleasing* – Fixtures with historic appearance can be combined with excellent optics to provide quality performance and attractive daytime appearance.
- *Economic development* – Communities throughout the state and country see street lighting as an important part of improving economic development efforts in downtowns.[17-20]

NYSERDA has compiled a list that have had similar benefits, titled ***New York State Effective Energy-Efficient Street Lighting Installations***, of street lighting projects that have realized benefits as described above. This list is located in Appendix B.

II. Getting Started

The following steps help the planner through the initial activities of a street lighting project. After completing the first steps listed in this section, the NYSERDA Model Performance and Design Guides in Section III will provide technical information to help layout an effective energy-efficient street lighting plan.

STEP 1: Understand the Overall Project Goal

The project planner must have a clear understanding of the municipal officials' overall project goal and the importance of individual drivers that make up the goal. The companion to this document, ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials***, helps municipal officials determine the overall project goal, which usually comprises several individual drivers. There is generally one primary driver, but other secondary drivers will influence the project to a greater or lesser degree. Although this document mirrors some of the steps outlined for the municipal elected/appointed officials, the planner should read Section I, Project Steps in the ***NYSERDA How-to Guide to Effective***

Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials. Reading this section in the companion guide will help Planners and engineers understand the steps and rationale used by the municipal officials.

Individual drivers include:

- ❑ Reduce municipal energy and operating costs (utility costs)
- ❑ Meet public desire for street lighting
- ❑ Replace old dilapidated street lights
- ❑ Meet security requirements
- ❑ Meet traffic and pedestrian safety requirements
- ❑ Minimize glare
- ❑ Limit light trespass
- ❑ Reduce light pollution
- ❑ Support and spur economic development
- ❑ Improve aesthetics

Planners and engineers must meet with the municipal officials to determine the importance of each driver and the overall project goal. An overall project goal can then be written, such as "The overall goal of the street lighting project is to upgrade the existing lighting in the downtown shopping district with energy-efficient stylish architectural fixtures, while maintaining or improving driver visibility and pedestrian safety and security, and keeping operation and maintenance costs low."

STEP 2: Identify and Understand the Design Issues and Constraints

Once the overall project goal is established the majority of the work rests with the planner. Before selecting fixtures and drawing plans, the planner needs to understand the design issues and constraints.

The ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*** helps municipal officials understand the design issues, but it is up to the planner to design a system that meets the overall project goal while staying within practical constraints. This step helps the planner get organized so all design issues and constraints can be addressed.

The impact of the following design issues and constraints will vary from project to project, but they all need to be addressed. As the project progresses, the planner should routinely visit this list to make certain all issues are addressed and the project stays within the constraints.

Retrofit/Replace versus New Construction — For existing street lighting installations, the planner needs to determine whether to use existing poles (luminaire retrofit), replace the luminaires and poles and using the existing bases (replace), or dig up the ground and construct new bases and trenches for wiring (new construction). A thorough understanding of the overall project goal will help the planner determine the best approach.

- Retrofit/Replace – Retrofitting is generally considered for energy and maintenance savings; however, sometimes a luminaire or pole needs to be retrofitted/replaced because it does not distribute the light correctly or has been damaged. Because pole locations do not change, the retrofit options need to be carefully evaluated and selected to achieve the desired performance. The "degree" of retrofitting and replacing is another consideration. For example, if residents are complaining about street lighting shining in their windows, the problem may be fixed by adding a house-side shield to the luminaire or replacing it with an entirely new luminaire with proper cutoff and distribution.
- New Construction – New construction involves either removing the existing street lighting and installing new, or installing a new system where street lighting did not previously exist. Existing systems are generally removed when streets are widened or a major capital improvement project is undertaken to give an area (generally in urban areas) a "face lift." New construction impacts the design with greater flexibility for location and number of poles. If a capital street improvement project is planned, new poles and lighting fixtures are usually the best option for effective energy-efficient design.

Project Funding and Cost Savings — Although project funding is usually determined prior to the planner's involvement, the planner should prepare life cycle cost estimates for various options and present the findings to the municipal officials. A life cycle economic analysis should be conducted to identify capital, operations, *and* maintenance costs. Lifetime energy savings and total costs should be highlighted to make sure initial cost is not the only determining financial factor.

Optional funding from local, state, and federal programs should be identified. Some funding is based on specific technology, while others are based on performance. Refer to Section IV in the ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*** for more information.

Efficiency and Cost Savings — All systems should be designed to minimize energy use, while meeting lighting requirements. To achieve an effective energy-efficient design, first select the proper lamp/ballast combination that produces high lumens per watt, then select fixtures with high efficiency and proper light distribution, and properly space the fixtures to meet design requirements without glare, light trespass, or light pollution. Furthermore, projects should be designed to avoid excessive number of luminaries, poles, wiring, and trenching that would cause unnecessary costs.

Streetlights with five fixture heads per pole

Glare — For purposes of this Guide, glare is defined as excessive bright light shining directly into a person's field of view that either reduces visibility or causes annoyance. Glare can be a safety concern because it could impede a motorist's or pedestrian's visibility. Fixture selection, number of fixtures per pole, pole height and placement need to carefully evaluated to minimize glare problems. Excessive number of fixtures and lamps per pole, inadequate shielding, and unnecessary lamp size (lumen output) can all lead to glare problems.

Glare problems are a sometimes compounded by an excessive number of fixtures per pole. Most often one or two fixtures per pole will meet performance requirements, however 12- to 15-foot high poles are sometimes specified with three, four or more fixtures for various aesthetic reasons. Planners and engineers need to educate other decision makers that the excessive number of fixtures (and lamps) per pole will usually create a glare problem and the desired visual effect can be accomplished with one or two fixtures per pole. Plus you will avoid excessive energy charges and maintenance.

Light Trespass and Light Pollution — Lighting trespass is the excessive and unwanted light that shines directly on property beyond the intended target; light pollution is unwanted light in the atmosphere that contributes to sky glow. Both, light trespass and light pollution design issues need to be carefully addressed, especially given the growing concern among the public. This issue may limit pole height and placement, and luminaire and lamp selection.

New construction projects offer the planner the opportunity to select from a wide variety of well-designed fixtures that are effective, efficient and control light trespass and pollution. A retrofit project is a little more difficult because you may have to work with existing pole spacing, which requires finding a fixture that controls the light while maintaining the existing spacing criteria and providing uniform luminance. A key to success is to closely work with fixture manufacturers, distributors, or with the electric utility to understand the product photometrics. Section III of this guide will also provide guidance on shielding and glare control.

Safety and Security — Whether a retrofit or new construction project, light levels, distribution, uniformity, and glare all need to be addressed and balanced for the area to be perceived as safe and secure. Planners and engineers should follow the Illuminating Engineering Society of North America and fixture manufacturers' recommendations to help avoid "blind spots" and dark areas, and provide the right lighting level and distribution. Avoid the common mistake of adding too much light in hopes of making an area appear safe and secure; in some cases this may reduce perceptions of safety by causing glare and making visibility more difficult.[6] Remember that attention to uniformity[7] and vertical illuminance[8] can add to people's sense of security.

Business and Economic Development — Some projects, generally in urban areas, require planners to design lighting systems that will help increase business. The planner must constantly remember that lighting for these scenarios needs to attract customers and provide a sense or safety and security, in addition to meeting motorists' needs.

Proper placement and quality of light can have an impact on businesses. Lighting should illuminate storefronts, points of interest, building facades and make people feel comfortable and secure. Simply adding more light might have a negative impact, such as creating too much glare. Planners and engineers should also work with local businesses and residents to evaluate the existing lighting or the needs for new lighting. Consider the following:

- ❑ Ask local businesses and residents if they are pleased with the existing street lights.

- ❑ Ask about weaknesses in the existing street lighting system and how they could be improved.
- ❑ Are existing poles located where it is possible to perform secondary functions such as illuminating architectural features?
- ❑ Visit a nearby community, preferably at night, to see a quality street light installation (Refer to the enclosed list of ***New York State Effective Energy-Efficient Street Lighting Installations***).

Aesthetic Requirements — The aesthetics (design) of the pole and fixture are usually a major consideration for downtown business and historic districts. A common mistake is selecting aesthetically pleasing fixtures solely based on their appearance without any attention to their photometric performance. Evaluate fixtures for energy efficiency, light distribution, light levels, uniformity, glare, and light trespass control when used on the relevant pole style and height.

Note that sometimes it is not possible to combine aesthetics and function into one street lighting pole and luminaire type. One option is to install or retain historic fixtures, but use low-output lamps for a decorative appearance. Functional lighting is provided by a second system, usually on taller poles with modern efficient equipment to meet performance requirements.

Lighting Environmental Zones — Lighting environmental zones are becoming more popular with some municipalities. These zones set certain performance requirements depending on the specific area's lighting needs – similar to land-use zoning for residential, commercial, and industrial areas. These zones will impact all aspects of the lighting from number of poles to luminaire cutoff limits (the amount of light allowed to shine above the fixture's horizontal plane). Planners and engineers should investigate any existing lighting environmental zones.

Illumination Levels, Distribution and Uniformity — The most obvious, but sometime overlooked, design issue is basic lighting performance – light levels, distribution, and uniformity. Planners and engineers should work with the fixture manufacturer, distributor, or electric utility to run computer simulations and make sure the proposed fixtures and design meet these lighting requirements.

Illumination levels and uniformity are critical and municipalities often follow Illuminating Engineering Society of North America recommendations found in IESNA RP-8. Furthermore, lighting surrounding walkways and building fronts is also a role of street lighting, especially in urban areas. Select fixtures that not only uniformly light the roadways and control glare, but also adequately illuminate walkways and business fronts.

STEP 3: Assess Design Resources

Design resources can include an in-house designer or engineer, out-of-house architects, lighting designers, engineers, distributors, utility representatives, and manufacturers. These parties can work together or one person may do all of the design work. The project planner should assess these resources to determine who will be involved in the process, and the role they will play. Time, schedule and budget will have a determining role in which resources can be used. Hiring out-of-house may be more expensive, but if the municipality does not have the in-house resources, or the time, this may be necessary. Utility representatives, distributors, and manufacturers may be able to participate in the technology selection and design without additional charge to the municipality.

STEP 4: Use the NYSERDA Model Performance Criteria and Design Guidelines for Street Lighting

Based on the information gathered and activities undertaken in the above steps, the next step is to use the performance criteria and design guidelines, provided in Section III of this guide, and start to layout a lighting plan that meets the overall project goals and works within the design issues and constraints. A successful design will meet the overall project goal and accomplish the following:

Retrofit Installations

- ❑ Mercury vapor lamps replaced (can use mercury-replacement HPS or MH lamps)
- ❑ New luminaires on existing poles meet uniformity and illuminance requirements.
- ❑ Pole height is still adequate for performance and desired architectural look.
- ❑ Luminaire type is of the proper cutoff classification to control light trespass and light pollution.
- ❑ Luminaire prevents unwanted glare.
- ❑ Retrofitted luminaires meet photometric requirements.

New Construction

- ❑ Pole height and spacing meets illuminance, uniformity, glare, light trespass criteria.
- ❑ Pole height is adequate for performance and desired architectural look.
- ❑ Fixtures meet desired photometric performance and efficiency.
- ❑ Lamps meet color and energy efficiency requirements.

IESNA RP-8-2000

- ❑ Design meets recommendations of RP-8 for illuminance, luminance, or small target visibility.
- ❑ Design meets recommendations for uniformity and glare control.

Safety and Security

- ❑ Minimum levels and uniformity are achieved to enhance sense of safety and security.
- ❑ Light levels do not exceed those needed to provide a sense of security.
- ❑ Proper color rendering lamps are used.

Energy Efficiency

- ❑ Luminous efficacy (lumens per watt) of lamp/ballast/luminaire system meets requirements.
- ❑ Luminaire efficiency (percent of light exiting the fixture) meets recommendations.

Lighting Pollution and Trespass

- ❑ Project balances the need for light with concerns about excessive lighting.
- ❑ Luminaire controls unwanted light from falling on neighboring property.
- ❑ Luminaire meets cutoff classification.

Maintenance

- ❑ Lamps with long life and desired efficacy and color properties are used.
- ❑ "Easy access" luminaires are specified.
- ❑ Regular maintenance cycle is established.

III. Model Performance Criteria and Design Guidelines for Street Lighting

Introduction

This section provides planners and engineers a list of performance criteria and guidance for the selection of effective energy-efficient street lighting technologies and design techniques for urban, suburban and rural areas. For purposes of these performance criteria and design guide these areas are defined as follows:

- ❑ **Urban**: Areas where buildings are located adjacent to the edge of the street or sidewalk, such as most downtown areas.
- ❑ **Suburban**: Areas where buildings are located away from the street or sidewalk, and pedestrian and vehicular traffic exists. Residential neighborhoods with large front lawns are generally considered suburban.
- ❑ **Rural**: Areas where buildings are set back from street and sidewalk with no significant pedestrian use. One example is a country-side road where buildings are usually set back 100 feet or more and no sidewalks exist.

For ease of use, the Model Performance Criteria and Design Guideline for Street Lighting section is systematically presented in the following subsections:

- ❑ **Definitions and Rationale for the Model Performance Criteria** – introduces performance criteria that are important when considering street lighting options.

- **Selection of Lamps** – provides a brief overview of the various common lamp types and the benefits of each.
- **Selection of Luminaires** – provides a brief overview of the various common fixture types and the benefits of each.
- **Lamp and Luminaire Performance Criteria Tables** – lists performance criteria values to assist the planner in identifying lamps and luminaires that will meet lighting performance requirements.
- **Design Guidelines** – provides a sampling of effective energy-efficient street lighting design approaches for rural, suburban and urban areas.

These guidelines are not meant to provide "recipes" or "templates" for street lighting design, but rather identify approaches to meeting various design objectives with effective energy-efficient street lighting. They supplement, but do not replace, existing standards and industry-accepted practices for street and roadway lighting design. Planners and engineers are encouraged to consult these sources, including:

- *American National Standard Practice for Roadway Lighting*, RP-8-00, Illuminating Engineering Society of North America, 2000.
- *Recommended Practice for Outdoor and Environmental Lighting*, RP-33-99, Illuminating Engineering Society of North America, 1999.
- *Informational Guide for Roadway Lighting*, American Association of State Highway Transportation Officials, 1984.

Electric utilities can often provide guidance on product selection and specification for street lighting.[21] Other excellent sources of guidance for street lighting practice include:

- *Street Lighting Manual*, 3rd Edition, Edison Electric Institute, 1988.
- *The Outdoor Lighting Pattern Book*, Russell P. Leslie and Paula A. Rodgers, McGraw-Hill, 1996.

Definitions and Rationale for the Model Performance Criteria

Listed below are specification criteria that should be considered when effective energy-efficient street lighting is desired. The definition of each criteria and rationale is included.

Lamp Luminous Efficacy

Definition: The amount of light generated by a lamp/ballast system (in lumens) divided by the power it uses (in watts).

Rationale: The use of lamps with low luminous efficacy can often result in wasted energy. High intensity discharge (HID) lamps with relatively high luminous efficacies are generally used for street lighting. Mercury vapor (MV) lamps, for example, have higher luminous efficacy than incandescent lamps, but lower than high pressure sodium (HPS) and metal halide (MH) lamps. An initial lamp/ballast efficacy of 75 lumens per watt is specified in order to ensure that those lamps having high luminous efficacy are selected.

Lamp Color Rendering Index (CRI)

Definition: A relative measure of the ability of a lamp to render colors in comparison to an agreed-upon "good" color-rendering source such as incandescent or daylight.

Rationale: Street lighting often serves an aesthetic as well as a functional purpose. This can be true more so for urban and suburban areas, which will typically have a larger proportion of pedestrians, vehicles parked on the side of the road, and perhaps signage or other objects illuminated only by ambient lighting. In these areas, the ability to distinguish among colors (e.g., to find one's green automobile parked next to a similar blue vehicle) can be important. Higher color rendering index lamps are therefore stipulated for urban and suburban areas (in suburban areas where color rendering is not deemed to be important, a lower color rendering index can be adequate). Rural areas have a lower proportion of pedestrians, parked vehicles or signage, and the functional purposes of lighting (seeing objects in the road or sidewalk) are perhaps more important than color rendering and for this reason, a lower CRI is permitted for these areas. Specifiers should, however, consider using higher CRI lamps in rural locations when color recognition and appearance are important.

Rated Lamp Life

Definition: The amount of time (usually in hours) that a lamp can generally be expected to provide useful service.

Rationale: The life of the lamp used for street lighting applications has an important impact on its economic feasibility. A lamp life of 15,000 hours results in a service life of approximately four years in a street lighting installation. Both HPS and MH lamps have long rated lives; so do MV lamps. However, MV lamps have higher lumen depreciation and do not burn out, but continuously depreciate until very little light is produced so their “useful” life ends before the lamp actually burns out.

Lumen Maintenance

Definition: The degree to which the light output expected from a lamp will be maintained over its service life. For this document, it is defined as the mean rated lumens for a lamp expressed as a percentage of its initial light output. For most metal halide lamps, mean lumens are rated at 40 percent of lamp life; for most mercury vapor and high pressure sodium lamps, mean lumens are measured at 50 percent of rated lamp life. Despite some inconsistencies that these differences cause, this percentage is useful for generally estimating a lamp's lumen maintenance.

Rationale: All lamps undergo lumen depreciation (gradual reduction in light output with time). MV lamps in particular can operate for tens of thousands of hours while generating very little light, becoming dimmer and dimmer with time. To avoid situations where luminaires appear to be on (and in fact use full wattage) but only produce enough light to glow while hardly lighting the street below, lamps with relatively high lumen maintenance percentages are desirable.

Lamp Restrike Time

Definition: The amount of time (usually in minutes) required for a lamp to cool off after being switched off, before it can be switched on again.

Rationale: Because street lighting luminaires are rarely used in solitary configurations, there are likely to be luminaires nearby in the case that the lamp in a luminaire is inadvertently switched off. Near-instant restrike is probably not required for most installations but a restrike time of more than a few minutes can be an inconvenience. All metal halide and high pressure sodium lamp types have some models available with restrike times of five minutes or less, so five minutes is stipulated as the maximum restrike time in the model performance criteria.

Luminaire Efficiency

Definition: The percentage of lumens generated by a lamp that actually leave a luminaire.

Rationale: To control the distribution of light from the lamp inside a luminaire, the luminaire contains optical elements such as reflectors and lenses to reflect and refract light to obtain the desired distribution. In doing so some of these elements absorb light or redirect it in such a way that only a percentage of light emitted by the lamp escapes the luminaire, this percentage is the efficiency of the luminaire. A simple black box around a lamp

with an opening at the bottom will likely have a very low efficiency, less than 40 percent.

Cutoff Classification

Definition: A system of classifying the distribution of light from a luminaire.

Rationale: Light emitted by a street lighting luminaire that is directed upward is almost always wasted light. Many luminaires are equipped with shields or reflectors to redirect such light. The Illuminating Engineering Society of North America (IESNA) has several classifications for the degree to which a luminaire emits light in the upward direction. The two most stringent classifications are cutoff and full cutoff luminaires. Full cutoff luminaires emit no direct light upward and tend to emit very little at angles near horizontal. Cutoff luminaires may emit some direct light upward and also tend to emit little light near horizontal. In suburban and rural areas, which tend to have lower overall ambient light levels, and perhaps greater desire to view the sky at night, full cutoff luminaires are suggested. Urban areas tend to have higher overall ambient light levels and a less restrictive specification is provided, calling for full cutoff or cutoff luminaires. However, it is possible for a semicutoff luminaire to generate no upward light, if it exceeds certain limits for light near horizontal angles. This could lead to increased glare (see below) but might be suitable for environments when vertical illumination is desired for recognition of people or other vertically oriented objects.

Percentage of Luminaire Lumens Between 75º and 90º

Definition: The percentage of a luminaire's light output that is emitted in the zone between 75º from nadir (the nadir is defined as 0º, or directly below the luminaire) and 90º from nadir.

Rationale: These angles are generally considered to define the "glare zone" of the luminaire. This is because the light from the luminaire within this zone can cause discomfort to drivers or pedestrians far enough from a luminaire that it is located within their line of sight. To minimize glare, the maximum percentage of luminaire lumens within this zone is 5 percent for rural areas (where ambient light levels tend to be low) and 10 percent for suburban and urban areas (where ambient light levels are likely to be higher, and higher light levels can therefore be tolerated).

Shut-off

Definition: A mechanism for switching the luminaire off when enough natural daylight is available.

Rationale: As street lights are not needed during daylight hours, the specification requires that they be switched off during this period, either through a clock or photosensor control.

Warranty and Safety

Definition: Provisions from a manufacturer that luminaires will operate and meet implied performance for a specified period of time and not present safety risks to users.

Rationale: The warranty and electrical safety provisions are similar to those found in specifications such as the U.S. Environmental Protection Agency/U.S. Department of Energy ENERGY STAR® specification for outdoor residential luminaires.

Selection of Lamps

Most street lighting installations will use one of three types of high-intensity discharge (HID) lamps; *high pressure sodium* (HPS), *metal halide* (MH) or *mercury vapor* (MV) lamps. HPS is the most commonly used light source in New York State, with a large majority of installations using this source. HPS lamps produce a yellowish-white light having fair color rendering properties (CRI is usually around 22). Despite their less-than-optimal appearance, HPS lamps are quite efficient (from 80 to 100 lm/W, including ballast power), long-lived (most are rated for at least 24,000 hours) and maintain their light output well for long periods of time.

MH lamps are the most commonly-used alternative to HPS in new installations (although MV lamps in older installations still outnumber MH). MH lamps are also quite efficient (70 to 90 lm/W) and provide white light with good color rendering (CRI is 65 or higher). The main obstacle to increased acceptance of MH lamps in street lighting has been life (some models have rated lives of 10,000 hours or less) and lumen maintenance (some have lumen maintenance percentages less than 60%). However, recent developments in MH lamps including pulse starting and ceramic arc tubes have shown significant promise for improving lumen maintenance and lamp life, and some models are beginning to approach HPS in terms of these criteria. At present, selection of these newer MH lamps is limited (many models are limited to vertical operating positions, making them unsuitable for many luminaire types) and costs may be higher than conventional MH lamps, but technological improvements are inevitable.

MV lamps are the least efficient of the HID types, having luminous efficacies of only 40 to 60 lm/W. Furthermore, MV lamps have long operating lives but fairly poor lumen maintenance. Many MV lamps in use are drawing full input power while generating little useful light. It is strongly encouraged that MV lamps be replaced with more efficient HPS or MH sources, depending upon the needs of the installation.

Another type of light source used in some locations for street lighting is *low pressure sodium* (LPS) lamps. These lamps produce a very intense yellow color, producing light at a single wavelength of light. Color rendering is essentially impossible under these lamps, and all colors appear yellow, brown or black. The appearance of these lamps is usually too objectionable for common use, except in the near vicinity of astronomical observatories, where their single wavelength output can be easily filtered by astronomers, allowing them to make observations with minimum intrusive sky glow.

Selection of Luminaires

Similar to the previous section, which provided a discussion about lamps used for street lighting, this section briefly discusses luminaire types, including alternatives to the most common luminaires, for optimizing energy efficiency and quality of illumination. The luminaires described as efficient alternatives are often more likely to meet the model performance criteria for luminaires (luminaire efficiency, cutoff control and glare control) described above.

Typical Baseline Luminaries

Cobrahead luminaires. Cobrahead luminaires are the types most often found in street lighting applications. The cobrahead luminaire is so named because of its shape, which resembles the head of a cobra snake. These luminaires use high intensity discharge (HID) lamps, generally of wattages of at least 100 watts. Typical pole heights for these luminaires are between 20 and 40 feet. In these luminaires, a glass refractor distributes the light from the lamp. This refractor drops below the head of the luminaire so that it is visible from horizontal viewing angles and from elevations above the luminaire. While generally having quite high luminaire efficiency, these luminaires do not perform as well in terms of cutoff control and light output between 75º and 90º.

Decorative post-top luminaires. In areas where the daytime appearance of the street lighting fixtures is considered to be important, decorative post-top luminaires are often found. In these luminaires, a lamp, usually an HID type less than 150 watts is mounted in a vertical orientation and is surrounded by a glass or acrylic globe, or a lantern- or acorn-shaped shade. These luminaires are generally mounted on poles between 6 and 16 feet in height and usually have little or no optical control. These luminaires often have relatively low efficiency, and even when efficiency is high, they tend to have poor cutoff and glare control.

Alternatives to Typical Luminaries

Sharp cutoff luminaires. In place of cobrahead luminaires, when the appearance of the luminaire is not of primary concern, sharp cutoff luminaires should be considered in place of cobraheads. These luminaires may resemble cobraheads but without the dropped glass refractor, or may have a rectangular appearance (these are often called "shoebox" luminaires). Sharp cutoff luminaires generally have quite high luminaire efficiency, and because of their design, they have excellent cutoff and glare control. Reflectors inside the luminaire create the distribution of light, and the bottom of the luminaire is generally covered with a flat glass lens. These luminaires most often use HID lamps from 100 to 1000 watts, and are mounted on poles between 15 and 40 feet in height. These luminaires are effective at limiting glare and light pollution. When using sharp cutoff luminaires carefully size the lamp (lumens) to meet target illuminance, and help avoid shining excessive light directly to the ground, only to have it reflected back up into the sky.

Performance post-top luminaires. On the surface, these luminaires often resemble decorative post-top luminaires. They contain a globe or a lantern- or acorn-shaped housing, but the housing, or a sleeve containing the lamp, has additional optical elements that redirect light downward and away from horizontal angles, in order to minimize glare and light pollution. These luminaires use HID lamps up to 250 watts and are generally mounted on poles between 10 and 20 feet high. These luminaires are not designed for maximum control of uplight or glare and they should be used carefully when light pollution and trespass are primary concerns. They may also have lower efficiency than other luminaire types. However, they can still be effective and attractive luminaires for urban areas that tend to have higher ambient light levels and suburban areas where vertical illumination is desired.

Decorative cutoff luminaires. These luminaires are another alternative to decorative post-top luminaires often found in urban areas. They typically use HID lamps up to 250 watts and are mounted on poles between 10 and 20 feet high, like performance post-top luminaires. Unlike other post-top luminaires, however, these are essentially sharp cutoff luminaires with a decorative glass chimney or stem that serve primarily as a decorative element rather than functional purpose. The illumination from a decorative cutoff luminaire comes from the top part of the luminaire, which contains reflectors to distribute light. They are usually quite efficient, although the decorative elements will tend to block some of the light output, and tend to have good uplight and glare control. When using decorative cutoff luminaires carefully size the lamp (lumens) to meet target illuminance, and help avoid shining excessive light directly to the ground, only to have it reflected back up into the sky.

Lamp and Luminaire Performance Criteria Tables

The tables below provide a preliminary specification for lighting equipment selected for street lighting. Separate specifications are given for urban, suburban and rural areas. These specifications are not meant to be mandatory or prescriptive, nor do they replace or supplant authoritative standards or recommendations such as those of the IESNA. They complement those standards, and by making efforts to select lamps and luminaires meeting these criteria, the efficiency and quality of a lighting installation can be improved. Planners and engineers should carefully consider each of these criteria against the specific objectives for an installation during the design process and only select equipment not meeting these criteria when the objectives cannot be met otherwise, and when sufficient documentation is provided to support this claim.

Design Guidelines

As with the performance criteria above, the guidelines in this section are meant to supplement, not to replace, existing standards such as the Illuminating Engineering Society of North America (IESNA) recommended practice for roadway lighting, which is an approved standard of the American National Standards Institute (ANSI). The guidelines provide supplemental information on energy use, technologies and design and outline a recommended approach at selecting lighting equipment based on different types of design objectives, but are not meant as "ready-to-use" designs. As with the model performance specifications, these guidelines are divided into three sections: urban, suburban and rural street lighting areas.

Urban Example — In urban areas, defined above as areas where building footprints are close to the street and adjacent sidewalk, pedestrian traffic is an important consideration for the lighting. Consider an urban street classified by the IESNA as a local roadway with a medium level of pedestrian activity (Figure 1). Such streets are generally found in downtown neighborhood shopping areas. They are local roads for direct access to residential and commercial properties and often have parking on the street.

Table 2

Urban Area Street Lighting

(e.g., buildings located adjacent to street and sidewalk; significant pedestrian use)

Performance characteristic	*Specification*
lamp luminous efficacy	75 lumens per watt
lamp color rendering index (CRI)	50
rated lamp life	15,000 hours
lumen maintenance	70%
lamp restrike time	5 minutes
luminaire efficiency	60%
cutoff classification*	cutoff or full cutoff
percentage of luminaire lumens between 75º and 90º	10%
shut-off	automatic shut-off during daylight hours
warranty	repair or replacement of defective parts of the luminaire housing or electronics (except lamp), 2 years from date of purchase; consumer satisfaction with luminaire operation, 1 year
safety	luminaires must be tested and listed by UL, ETL, CSA or other independent agency acceptable for compliance with NFPA 70, National Electric Code including listing for damp or wet locations (Articles 410-4a and Article 100)

* When vertical illumination is desired, consider the use of semicutoff luminaires directing less than 5% of their luminous flux upward.

Table 3

Suburban Area Street Lighting

(e.g., buildings set back from street and sidewalk; significant pedestrian use).

Performance Characteristic	*Specification*
lamp luminous efficacy	75 lumens per watt
lamp color rendering index (CRI)*	50
rated lamp life	15,000 hours
lumen maintenance	70%
lamp restrike time	5 minutes
luminaire efficiency	70%
cutoff classification†	Full cutoff
percentage of luminaire lumens between 75º and 90º	10%
shut-off	automatic shut-off during daylight hours
warranty	repair or replacement of defective parts of the luminaire housing or electronics (except lamp), 2 years from date of purchase; consumer satisfaction with luminaire operation, 1 year
safety	luminaires must be tested and listed by UL, ETL, CSA or other independent agency acceptable for compliance with NFPA 70, National Electric Code including listing for damp or wet locations (Articles 410-4a and Article 100)

* If color rendering is not important consider using a lamp with a CRI of 20 or higher.

† When vertical illumination is desired, consider the use of semicutoff luminaires directing little or none of their luminous flux upward.

Table 4

Rural Area Street Lighting

(e.g., buildings set back from street and sidewalk; no significant pedestrian use).

Performance Characteristic	*Specification*
lamp luminous efficacy	75 lumens per watt
lamp color rendering index (CRI)	20
rated lamp life	15,000 hours
lumen maintenance	70%
lamp restrike time	5 minutes
luminaire efficiency	70%
cutoff classification	full cutoff
percentage of luminaire lumens between 75º and 90º	5%
shut-off	automatic shut-off during daylight hours
warranty	repair or replacement of defective parts of the luminaire housing or electronics (except lamp), 2 years from date of purchase; consumer satisfaction with luminaire operation, 1 year
safety	luminaires must be tested and listed by UL, ETL, CSA or other independent agency acceptable for compliance with NFPA 70, National Electric Code including listing for damp or wet locations (Articles 410-4a and Article 100)

Figure 1

Downtown Urban Area with Cobrahead Style Luminaires

Typical Standard Urban Design — The Outdoor Lighting Pattern Book describes a typical standard urban design to have mounting heights of a street lighting "cobrahead" luminaire at 35 feet, with a typical lamp wattage of 250 watts and spacing of about 150 feet (the resulting average illuminance is approximately 0.8 footcandles). Such luminaires are rarely in harmony with architectural surroundings, especially in the downtown neighborhood area in the present example. Furthermore, the luminaire is also likely to use a HPS lamp with a low CRI.

Alternative Urban Design — An alternative design for the scene in Figure 1, using decorative cutoff luminaires to provide more attractive appearance and to limit uplight, mounted at a lower height (20 feet) could be used as shown in Figure 2. Such luminaires are available in a range of styles, colors and finishes that can be adapted to the architectural features of the streetscape. The characteristics of the lamp and luminaire in Figure 2 meet the performance criteria described earlier:

- lamp type: 150 watt MH
- lamp lumens: 12,000 lm
- luminaire efficiency: 66%
- color rendering index: 65
- luminaire lumens between 75^{o} and 90^{o}: <3%

As shown in Figure 2, the result is a daytime appearance better suited for this downtown urban area. The resulting average illuminance on the roadway using this luminaire spaced at 100-foot intervals is estimated to be 0.7 footcandles, with an average-to-minimum illuminance ratio of 4:1, which meets IESNA recommendations for this type of street while providing improved color rendering and reduced potential for glare relative to the HPS cobrahead luminaires without increasing energy use, although this alternative does not decrease energy use.

Using careful luminaire selection, historic or otherwise special downtown areas could be similarly illuminated using two luminaires per pole. When specifying two luminaires per pole, lamp wattages should be reduced correspondingly to avoid increasing energy use and creating excessive glare. Such selections will also increase maintenance costs, as the total number of luminaires in the location would be doubled.

Figure 2

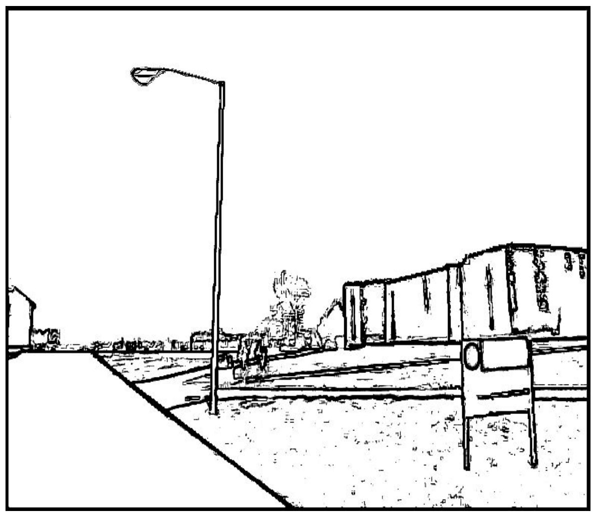
Downtown Urban Area with Performance Post-Top Luminaires

Suburban Examples — Consider a suburban area adjacent to an industrial park, where buildings are situated 30 feet or more from the roadway edge. Sidewalks and bicycle paths might be provided but pedestrian traffic in this area is not very heavy. For such an area, the aesthetics of the area is usually not a prominent concern; at least, a historic or decorative appearance is usually not desired. Efficiency, maintenance costs, and other economic concerns are often the primary drivers in such areas.

Typical Standard Suburban Design — Typical suburban lighting includes cobrahead luminaires spaced about 150 feet apart, each containing a 400-watt MV lamp (see Figure 3); average illuminance is nearly 1 footcandle. Such a street is classified by the IESNA as a local roadway with low level of pedestrian activity. When buildings are less likely to be architecturally significant and are set back from the road, the use of decorative luminaires is less important.

Figure 3

Suburban Area Lighted by Cobrahead Style Luminaires



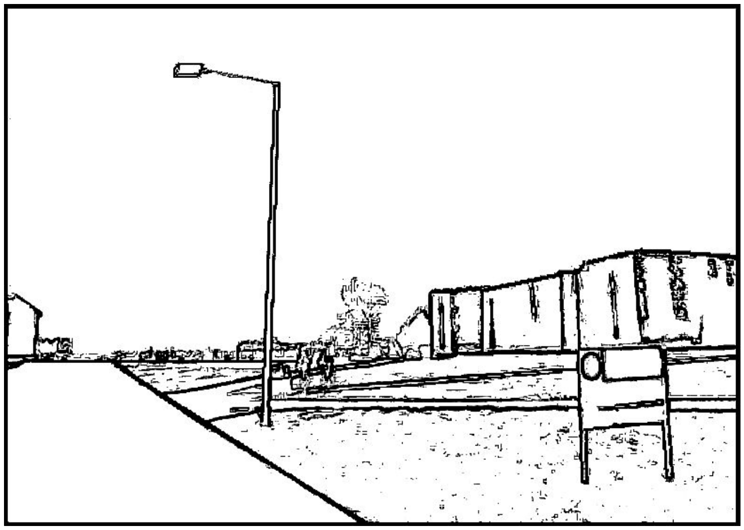
Alternative Suburban Design 1 — In this situation, high-efficiency full cutoff luminaires should be used to minimize energy use (Figure 4). The use of MH lamps is appropriate for this area in order to assist drivers with color identification and wayfinding. The characteristics of the alternative lamp and luminaire system for this location are as follows:

- lamp type: 250 watt MH
- lamp lumens: 23,000 lm
- luminaire efficiency: 84%
- color rendering index: 65
- luminaire lumens between 75º and 90º: <2%

The resulting average illuminance on the roadway with this installation is estimated at 0.7 footcandles, with an average-to-minimum illuminance ratio of 5:1, meeting IESNA recommendations for this type of roadway installation.

Figure 4

Suburban Area Listed by Full-Cutoff Luminaires



Alternative Suburban Design 2 — If color rendering is not important for a suburban area (e.g., if off-street or way finding are not critical tasks), a similar installation using HPS lamps could have been provided as follows:

- lamp type: 250 W HPS
- lamp lumens: 25,000 lm
- luminaire efficiency: 81%
- color rendering index: 22
- luminaire lumens between 75º and 90º: <2%

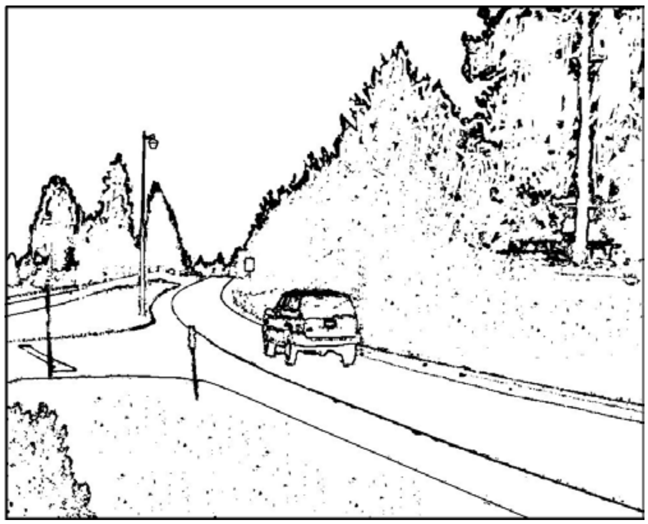
The selection of HPS would have slightly increased the estimated average illuminance to 0.7 footcandles without affecting uniformity (average-to-minimum illuminance would be 5:1), again meeting IESNA recommendations. Either installation (MH or HPS) would reduce energy use by more than 30% from the existing conditions and meet the model performance specification in Table 3, in addition to reducing potential for glare because of the cutoff distribution of the luminaire.

Alternative Suburban Design 3 — Many suburban residential areas also have large building setbacks. In these areas, when a more decorative approach is desired other than the cutoff luminaires described above, an approach similar to that described for urban areas can be taken, using performance post-top luminaires or decorative cutoff luminaires at lower mounting heights and lower wattages to provide street and pedestrian lighting. Such an alternative would probably also require shorter pole spacing than the higher-mounted cutoff luminaires.

Rural Example — Consider a rural area where two two-lane roadways intersect and where one of the roads contains stop signs for traffic control. Aesthetic concerns for these kinds of areas are usually minimal, with traffic safety being the primary consideration. Along such roads, continuous street lighting is often not provided or warranted, but partial lighting of the intersection might be desired to assist drivers in detecting traffic along the adjacent roadway, and especially within any area comprising the overlapping area of two roads (Figure 5).

Figure 5

Rural Area Lighted with "Yard Light" Type Mercury Vapor Luminaires



Typical Standard Rural Design — Typically, there might be one or two cobrahead or "yard lights" luminaires adjacent to the intersection, perhaps mounted at heights of around 30 feet, containing 250 or 400 W HPS or MV lamps. An existing MV installation is more likely to be older and less likely to provide adequate illumination for the intersection, even though it might appear to be functioning properly, because of MV lamps' properties of long life but high lumen depreciation over time.

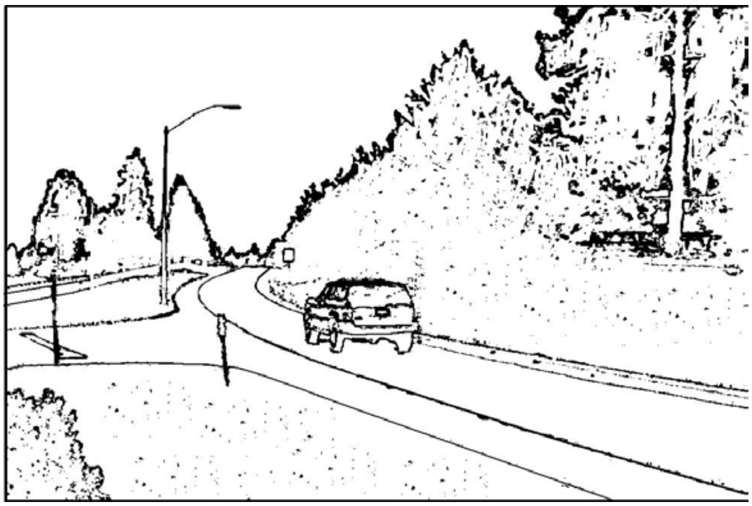
Alternative Rural Design — In such an installation, driver safety is the most likely primary concern. The use of one or two sharp cutoff luminaires, each located along the major road and adjacent to the intersection and containing MH or HPS lamps, will provide higher illumination and similar uniformity (approximately 20 lx in the intersection conflict area with an average-to-minimum illuminance ratio of approximately 4), and to meet the guidelines of the IESNA for partial lighting at intersections.

- lamp type: 250 W HPS (or 250 W MH)
- lamp lumens: 25,000 lm (for HPS; 23,000 for MH)
- luminaire efficiency: 81%
- color rendering index: 22 (for HPS; 65 for MH)
- luminaire lumens between 75º and 90º: <2%

The installation minimizes glare (reducing the output between 75º and 90º by two-thirds). The installation also would minimize light shining directly into the sky. (The amount of light reflected up from the pavement and surrounding areas would be approximately the same for the sharp cutoff luminaires in this example as for the cobrahead luminaires.) For such an intersection, the use of 400 W lamps would most likely not be needed unless both roads were heavily traveled, major roads with significant traffic. In this case, eliminating the use of MV lamps will result in a more effective and efficient system, as would switching from 400 W to 250 W lamps. Changing lamp wattage from 400 to 250 W regardless of lamp type would result in energy savings of about 35% from the baseline.

Figure 6

Rural Area Lighted by Full-Cutoff Luminaires



IV. Demonstrating the Benefits of Effective Energy-Efficient Street Lighting

While municipal officials will be important in the goal-setting phase of a street lighting project, planners and engineers must work to ensure that their goals are met in the actual installation. In communicating the benefits of efficient, quality street lighting design, it is important to emphasize the benefits of such design rather than the elements of the lighting installation itself. The following table is an easy-to-use reference that outlines some of the features and benefits of efficient, quality street lighting design.

Features	*Benefits*
Proper pole height and spacing	❑ Provides uniform light distribution, which improves appearance for safety and security. ❑ Meets recommended light levels for safety and security. ❑ Minimizes the number of poles, reducing energy and maintenance costs.
Proper luminaire aesthetics	❑ Blends in with the surroundings. ❑ Provides an "architectural element" to a business or historic district.
High lamp efficacy and luminaire efficiency	❑ Minimizes energy costs.
Good color rendering	❑ Helps objects appear more natural and pleasing to the public in the downtown areas. ❑ When security is a concern, allows better recognition of colors of clothing, hair, or eyes of potential criminals.
Long lamp life	❑ Reduces lamp replacement costs.
High lumen maintenance	❑ Reduces lamp replacement costs because lamps operate for longer periods before light levels are reduced below minimum standards.
Short lamp restrike	❑ Allows the lamp to quickly come back after a power interruption.
Proper light distribution	❑ Provides required light on the roadway and, when applicable, the walkway, for pedestrian-friendly lighting.
Proper cutoff	❑ Provides adequate optical control to minimize light trespass on neighboring properties and unnecessary uplight that causes unwanted sky glow.
Automatic shutoff	❑ Saves energy and maintenance costs by turning lamps off when not needed.

Of course, some of the benefits listed above are tangible and can be expressed readily in monetary form, such as energy cost savings and maintenance cost savings, which directly affect the municipality. Other benefits are indirect: well-integrated aesthetic design might indeed have a higher initial cost. Benefits from such a decision, such as increased tax revenues from a larger number of shoppers in a downtown district, for example, will usually be more difficult to document. Safety benefits of lighting are also difficult to assess directly. Refer to IESNA and AASHTO publications for information on street lighting and safety benefits.

Both the direct and indirect benefits of a street lighting installation can be communicated to municipal officials, and to the public, through written and oral communications. Section IV, Promoting Effective Energy-Efficient Street Lighting Projects, in the ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*** provides sample language that can be used to promote and document a lighting project in simple, understandable language.

Some of this communication can and should occur even before the installation is completed. NYSERDA has evaluated and compiled a list of effective energy-efficient street lighting installations throughout New York State, entitled ***New York State Effective Energy-Efficient Street Lighting Installations***. Site visits to one or more such installations with municipal officials, business owners, police officers, and other stakeholders can be very helpful in understanding what lighting can and cannot accomplish. In addition, the ***NYSERDA Street Lighting Showcase*** is another document that provides municipalities in-depth information about a successful effective energy-efficient street lighting project.

V. Conclusion

Quality street lighting installations need not be very expensive or energy intensive. Attention to the design objectives set out at the beginning of a project, and communication of these objectives to all participants in the planning and design process, will greatly assist in meeting these objectives. Asking members of the municipal planning team, electric utility representatives, architects or engineers, and equipment vendors to consider the effective energy-efficient lighting criteria in this Guide and to document the rationale behind decisions for selection of lamps, luminaries, and their layout will make the resulting installation more effective and energy efficient. This in turn will provide municipalities with opportunities to demonstrate added value to the public, business community, public safety officials, and those interested in energy savings and environmental concerns. It is NYSERDA's hope that the information in this Guide as well as other information in the ***NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*** will provide useful advice, tools and pointers to additional resources to optimize quality and efficiency in street lighting throughout New York State.

APPENDIX A

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APPENDIX B

New York State Effective Energy-Efficient Street Lighting Installations

The New York State Energy Research and Development Authority (NYSERDA) provides the following list of New York State street lighting installations that show different ways of meeting various design objectives, including increasing energy efficiency, improving perceptions of safety, or enhancing aesthetic appearance. This list is intended as a reference for municipal officials, planners and engineers to use and visit the sites when considering street lighting projects.

Albany, Albany County — Several colleges and universities in Albany are located adjacent to a parcel of land (University Heights) that is shared for offices, classrooms and student housing. The complex includes pedestrian walkways as well as roadways and parking facilities. The lighting in this location was designed as a new installation. Post-top refractive globe fixtures and teardrop fixtures were used for roadway and pedestrian walkway lighting to complement the existing lighting in the adjacent Sage College campus. The lighting was part of the overall master plan for this campus-like area, and equipment selected for its daytime appearance as well as its nighttime performance. ***Contact: Mara Berman, University Heights Association, (518) 434-9603***

Amherst, Erie County — Over the past fifteen years, the town of Amherst has replaced many fixtures containing inefficient incandescent and mercury vapor lamps in its residential neighborhoods with fixtures using more efficient high pressure sodium lamps. The fixtures are performance post-top luminaires with 100 to 200 foot spacings, containing 70 to 100 watt lamps. Since the locations are suburban neighborhoods, color appearance was not critical and the high pressure sodium lamps provided sufficient color rendering. The fixtures are leased from the local electric utility. The energy use has dramatically been reduced by using the maximum pole spacing and reducing wattages.
Contact: Scott Charleson, Town of Amherst, (716) 631-5990

Buffalo, Erie County — The city of Buffalo has a large downtown commercial district containing a major sports arena, with heavy pedestrian traffic. Because of this, maintaining perceptions of security and safety was important. The city installed performance post-top fixtures, containing 175-watt metal halide lamps, spaced about 80 feet apart. The fixtures are shielded so that they limit upward light, while at the same time providing sufficient uniformity and vertical illumination for recognition of faces and other objects. ***Contact: James Zern, City of Buffalo, (716) 851-5621***

Cheektowaga, Erie County — The town of Cheektowaga is home to the Airborne Business Park, a business complex managed by Uniland Development Company. It is located on a privately-owned road, Airborne Parkway. The lighting for the road was designed to meet the town's standards for lighting, so that the road could be readily turned over to the town in the future. The fixtures are modern, cutoff-style luminaires containing 400 watt metal halide lamps. They are mounted along both sides of the road and are spaced approximately 250 feet apart on each side of the road in a staggered pattern. The spacing and layout results in effective lighting with modest energy use. ***Contact: Brian Cook, Uniland Development Company, (716) 834-5000***

Kingston, Ulster County — The city of Kingston recently installed new street lighting in its commercial downtown district. Historic-looking fixtures and relatively high light levels were desired to improve appearance and to increase the sense of security in this location. It was also recognized, however, that meeting these objectives would result in increased energy use. A combination of decorative post-top and teardrop fixtures were used to provide pedestrian and roadway illumination, respectively. The teardrop fixtures have cutoff optics to limit light from being directed upward. The post-tops contain 100 watt metal halide lamps, and the teardrops contain 250 watt metal halide lamps. ***Contact: John Kwak, City of Kingston, (845) 331-0080***

Tully, Onondaga County — To save energy, reduce light pollution and light trespass, the town of Tully retrofitted 24 lighting fixtures along Route 80. The previous fixtures, cobraheads containing 175 watt mercury vapor lamps, were replaced with flat-lens fixtures containing 100 watt high pressure sodium lamps. The primary purpose of the lighting in this installation is to aid driver and pedestrian visibility. ***Contact: William Lund, Town of Tully, (315) 696-4693***

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203
1-866-NYSERDA (1-866-697-3732)
www.NYSERDA.org

This guide prepared for NYSERDA
by ICF Consulting, Inc. and the
Lighting Research Center,
Rensselaer Polytechnic Institute.