

Municipal Smart City Street Light Conversion & Evolving Technology Guidebook



Saratoga Springs
New York



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Acknowledgments

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MUNICIPAL SMART CITY STREET LIGHT CONVERSION & EVOLVING TECHNOLOGY GUIDEBOOK

Prepared for the Capital District Transportation Committee and
the City of Saratoga Springs, NY

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1 INTRODUCTION AND CONTEXT

Background

City street lighting debuted in the United States in 1860 with a mixed reception. By the early 20th Century, however, it was established as a method to deter crime and support safety and security (Jakle, J.A., 2001).

Urban lighting technologies and methodologies have since undergone drastic changes due to technological advancements and recommendations are constantly being updated to provide design and maintenance guidance (IES, 2018). Traditionally, the focus in urban street lighting research and development has been to improve both safety for the user and overall reduction of energy use to fulfill general sustainability requirements. In more recent years, community sustainability has been increasingly discussed and defined as an important qualification. Criteria to improve factors such as improved physical and mental health (walkability and social cohesion) as well as nighttime economy benefits have entered public design guidelines (Lee, K.K., 2012). Today, cities have opportunities to implement adaptability and innovation, and “smart” lighting is an important part of that strategy.

Currently, energy saving is generally perceived to be the primary benefit from upgraded street lighting technologies. This results from the conversion of older, less efficient lighting technologies to light emitting diode (LED) sources. LED technology requires less power to achieve the same light levels as many traditional light sources. LEDs when properly maintained, can have a long life. Significantly, LEDs can also be dimmed, reducing light output levels when appropriate. The lower (dimmed) light level provides opportunities for even lower energy consumption, along with associated reductions in cost. However, in many cases, such as in New York State, where the local utility does not pass along savings from actual reduced energy usage, even Operations and

Maintenance (O & M) savings alone can justify the capital outlay for street light conversions. Payback or Return on Investment (“ROI”) periods are then calculated using cost savings through utility rebate programs and projected maintenance cost reductions.

In addition to these benefits, lighting conversion provides opportunities to qualitatively improve legibility for open and public spaces at night. This can elevate city and community life and vitality, as well as provide enhancements for safety, economic development, financial, and other strategic advantages. It was customary, in many municipalities, for energy providing utilities to own street lighting, thus limiting municipal options, choices and ultimately control of the infrastructure. In 2015, existing legislation was amended by the New York State Public Service Commission (PSC) enabling municipalities to purchase the street lights from the utilities and take control of their street and pedestrian lighting.

Outside of New York City, the majority of street lights in the state are utility owned high pressure sodium cobra head lights. At the time of writing, the PSC has approved the sale of over 54,500 street lights to 26 municipalities. For example, as of October 2019, the PSC approved the sale of utility-owned street lights to the City of Syracuse, Village of Nyack and the Town of Warwick. The goal of these efforts primarily focuses on conversion from inefficient high pressure sodium lighting to energy efficient LED lighting. Only recently has “Smart Community” technology begun to be introduced into conversion projects. Street light conversion and the introduction of smart technology support Governor Cuomo’s Reforming the Energy Vision (REV) strategy, a comprehensive energy strategy for New York. The Governor tasked the New York Power Authority (NYPA) to implement

the New York's Smart Street Lighting Program, a new statewide program that calls for at least 500,000 street lights throughout the state to be replaced with energy-saving LED technology by 2025. NYPA's program provides a full turnkey solution for local governments that wish to convert their street lights to LED. Services provided include: lighting audits; engineering and design; bidding and procurement; construction management; environmental services; financing; and ongoing maintenance, once installed. Through the new Smart City Technology Grant Program, communities can also incorporate Smart City technology into the conversion project.

National Grid is also working to meet the goals of REV. In the City of Schenectady, they are currently installing an REV street light demonstration project. Schenectady's conversion project will use energy efficient lighting as well as connected smart technologies and a low bandwidth wireless network. This demonstration project will inform National Grid on best practices that they can then implement within their current street light portfolio. Case studies on NYPA and National Grid projects can be found in Chapter 4.

Project Overview

This Guidebook was commissioned by the Capital District Transportation Committee (CDTC) as a part of their Smart Communities Program. This program was established to explore strategies for becoming a "Smart Region," or a region that uses data, applications, and technology to help people and goods move more efficiently.

The goal is to provide Capital District municipalities with the tools to strategize their "smart" lighting needs and start identifying the appropriate "smart" street light infrastructure and technology, features, and functionality for each community beyond LED

light conversions. This Guidebook builds on CDTC's New Visions' commitment to advancing technology to improve safety, operations, and environmental quality (CDTC, 2015).

Information within this Guidebook can enable initial discussions among municipal stakeholders as steps are taken to assess existing conditions, needs, and options. The Guidebook is structured to provide initial planning-level support for conversion efforts to energy efficient LED and related smart street light technologies, and to assist in the evaluation of the purchase of utility-owned street lights. It also provides information to build capacity for improved nighttime environments, whether residential, institutional, or downtown districts. Currently available options, such as WiFi, sensors, speakers, electric vehicle charging, pedestrian safety features, and applications such as wayfinding and real-time information displays, are also explored.

Starting in July 2019, Planning4Places, LLC and the International Nighttime Design Initiative, collaborated with a Study Advisory Committee (SAC), officials from the CDTC, Capital District Regional Planning Commission (CDRPC), National Grid, New York Power Authority (NYPA), Capital District Transportation Authority (CDTA), the City of Saratoga Springs, and other agencies to discuss and develop this Guidebook. Here, the City of Saratoga Springs serves as the case study for other Capital Region municipalities looking to implement updated lighting solutions and smart technologies. The City of Saratoga Springs safety and sustainability goals found in the City's Smart Cities Roadmap, the Comprehensive Plan, and the Complete Streets Plan were reviewed for context.



LightWalk: Studying the corner
NightSeeing™ Downtown Saratoga Springs - Photos by
Planning4Places, LLC



LightWalk: Observing public space

As part of guidebook development, on September 26, 2019, a NightSeeing™, Navigate Your Luminous City event – a walk and talk - was held for City and regional stakeholders. The objective of NightSeeing™ is to expand citizen awareness of nighttime ambiances and public lighting.

Creative lighting design is an emerging discipline, one that is becoming more commonly used and implemented by many professions including light designers and engineers. Simultaneously, city design is increasingly important. Concern with nighttime economy, safety, and culture is rising along with improvements in digital technologies. With the opportunity of responsive (“smart”) lighting on the horizon, the NightSeeing™ methodology provides an experiential, immersive, learning activity which helps communities to better understand their existing after-dark conditions.

The talk was held in the Saratoga Arts Center and included a walk around downtown Saratoga Springs.

Key discussions touched upon the atmospheres and ambiances created by publicly supplied illumination and private light sources, such as shop windows and building mounted luminaires (e.g., sconces, bracketed floods). Observations were wide ranging from concerns about the streetscape, such as safety at crosswalks and sufficient lighting (and overly bright lighting) of parking lots to the pros and cons of commercial signs and projected lighting effects. Critical issues emerged such as sky-glow and lighting’s effect on nature along with the glare of private and public lighting. These healthy debates are to be expected – pointing to the need for placemaking with light, not just for Saratoga Springs, but for other communities’ open space and streetscape usage after dark.

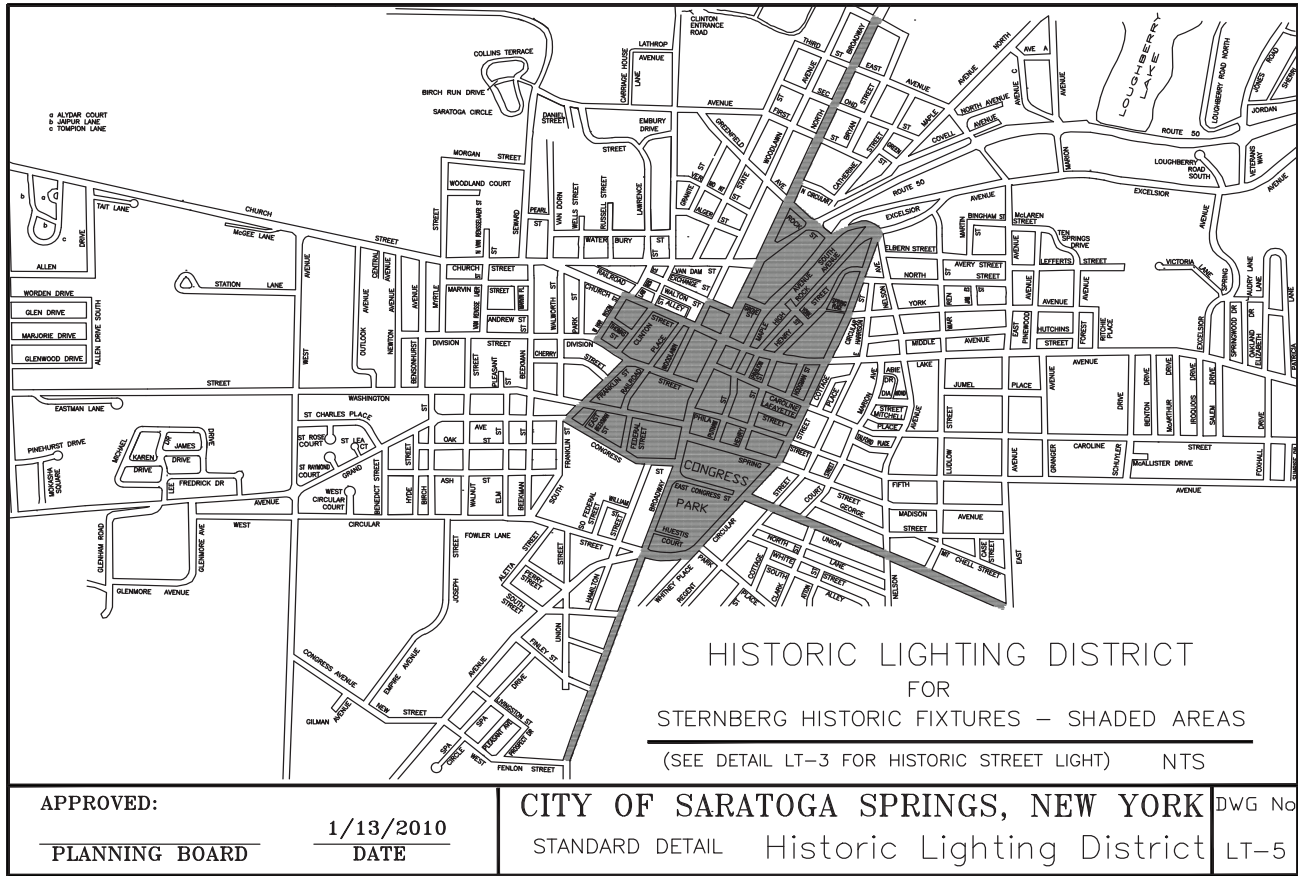


Fig-1: Historic Lighting District

Source: City of Saratoga Springs



LightWalk: Thoughts on sidewalk projection



The Talk: Discussing urban lighting

Saratoga Springs - Existing Conditions

The City of Saratoga Springs has a vibrant downtown filled with restaurants, shops, and an active street scene. Tourism is a vital part of the City's economy and the summer season brings about a significant surge in visitors throughout the City. The City also has a growing residential population, the oldest major sporting venue of any kind in the country, institutional establishments such as Skidmore College and Empire State College, and the Saratoga Spa State Park. The City is generally very pedestrian friendly, but also is car dependent, with a Walk Score® of 42 out of 100. A significant element within the streetscape is lighting – an aesthetic and safety element that is often taken for granted and overlooked by those using the infrastructure as part of their daily routine. In Saratoga Springs, as well as other Upstate New York municipalities, lighting is vital not only for illuminating the street, but for illuminating the pedestrian realm for both mobility and safety.

There are 3,255 street lights in the City (this number should be verified through a lighting audit). Of these street lights, there are three street light types: historic luminaires (a single post top and a triple top), decorative street lights, and standard (cobra head) street lights which are primarily owned by National Grid. A few examples of current lighting specifications are found in the appendix. In the City, Heritage Sternberg-brand post top street and pedestrian lighting is installed as required by the Planning Board for new construction or subdivision projects as well as by the City in parks. Along with private site specific lighting, this lighting adds to the ambiance, attractiveness, and often the uniqueness of the streetscape within Saratoga Springs.

Within the Historic Lighting District there are two types of lighting styles – verde green finish (official color) historic light poles with globe post tops in the

inner Historic Lighting District and acorn-type luminaires with black poles along the outer Historic Lighting District (**fig-1**). The majority of these use high pressure sodium light sources and are not shielded to protect the night sky. High pressure sodium is considered an outdated light source technology as it is energy inefficient and is not dimmable. According to an inventory of lighting assets provided by the City Electrician, 1,307 of the lights are currently monitored by the City, with only approximately 17% of the lights (222 total) utilizing LED technology.

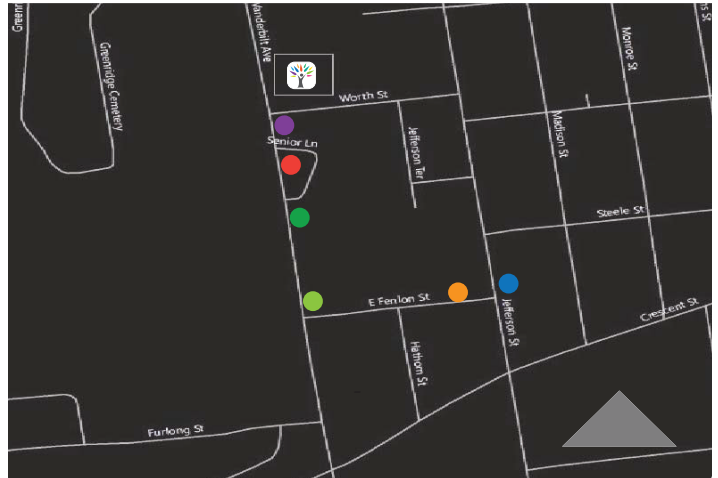
To assess different types of urban areas, three typological areas within the City of Saratoga Springs were selected to illustrate the varied lighting approaches for area-based nighttime needs. The focus areas and typologies help to differentiate unique elements of both the built environment and lighting needs and opportunities.

The three typological areas are:

1. Residential
2. Institutional
3. Downtown/Mixed Use/Central Business District

Typological Area: Residential

Higher density residential areas within the City of Saratoga Springs are mostly lit by cobra head high pressure sodium lights (conventional street lights), with major corridors also having some decorative street lights (and in some cases, the decorative street lights are LEDs). In a field view analysis of residential areas, it was found the majority are dark at night, and those areas that have street lighting generally consist of a patchwork of bright light and areas of shadows, making for inconsistent lighting. There are some variations in the post tops found within the residential areas. The majority of the post tops are the acorn style.



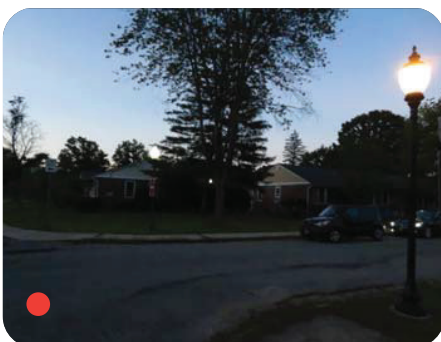
Jefferson Street: Residential street with public decorative post top (unshielded, 360 degree light)



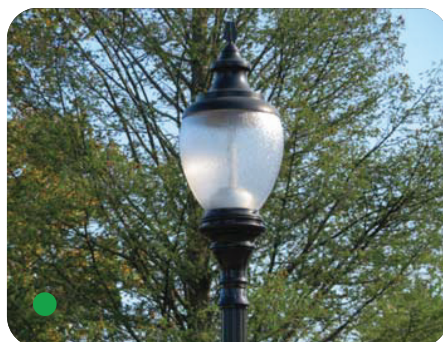
Vanderbilt Avenue: Residential street with public decorative post top (unshielded, 360 degree light) pedestrian lighting and bracket mounted public cobrahead lighting for street illumination



Senior Way: Residential street with public decorative post top (shielded against upward light) and decorative post top (unshielded, 360 degree light)



Senior Way: Residential street with public decorative post top (shielded against upward light)



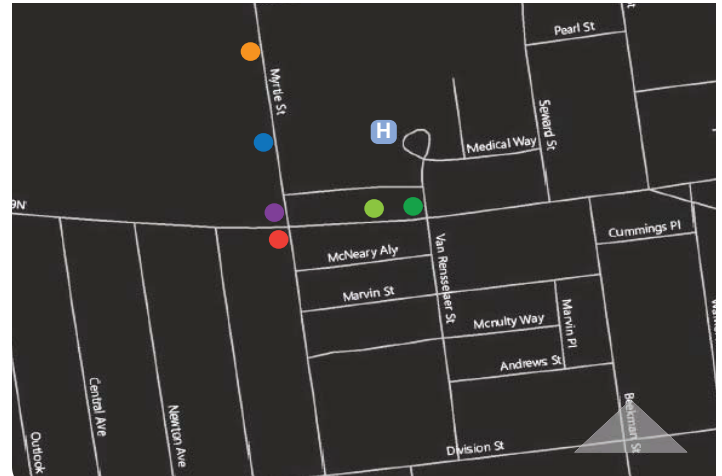
Public Post Top (shielded against upward light)



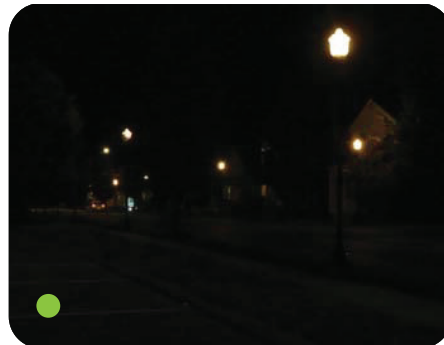
Fenion Street: Residential street with public decorative post top (unshielded, 360 degree light)

Typological Area: Institutional

Institutional areas within the City of Saratoga Springs are mostly lit by cobra head high pressure sodium (standard lights) with major corridors also having some decorative street lights. In the hospital area, the brightest lights are found in the parking lots adjacent to the hospital. The remaining streetscape is largely dark, except along the major corridors where there are decorative LED street lights.



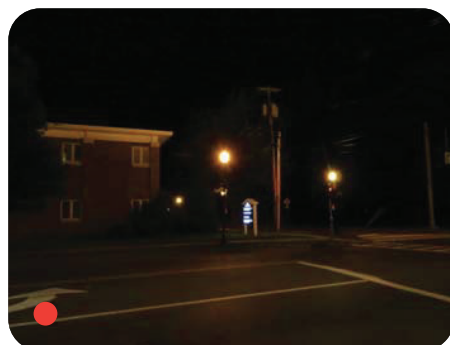
Myrtle Street: Street with sidewalk lit by public decorative post top (unshielded, 360 degree light)



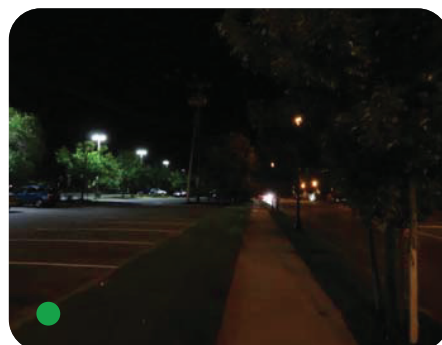
Church Street: Residential street with public decorative post top (unshielded, 360 degree light)



Church & Myrtle Streets: Signage lighting for wayfinding from hospital and private businesses



Corner of Church & Myrtle Streets: Residential street with public decorative post top (possible outage of additional cobra head)



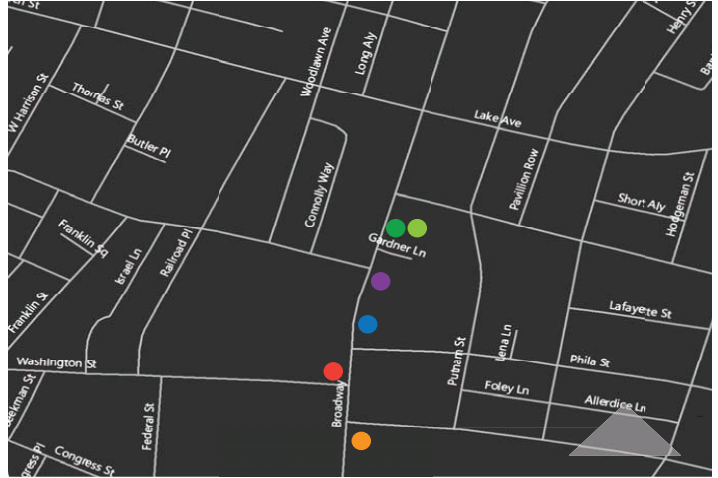
Church Street: Residential street and walkway lighting with public decorative post top and parking lot pole lighting (Note: warm/cool color)



Myrtle Street: Residential street with decorative post top (unshielded, 360 degree light) pedestrian lighting and bracket mounted cobra head

Typological Area: Downtown/Mixed Use/Central Business District

Decorative, historic lights are the primary street light with “private” lighting emitting from storefront shops and the occasional window sign. Signs projected on the sidewalk by businesses, internally illuminated clocks, uplit walls, and façades also provide unique and distinctive lighting throughout the Downtown area. Most of the light is a warm to neutral shade of white with occasional splashes of color, such as purple and greens either as a part of uplighting or a sign face and multi-colored from window signs. Twinkle lights are found on street trees and around restaurants and bars.



Broadway near Washington Street: Sidewalks with public decorative post top (unshielded, 360 degree light) and spill-light from storefronts



Alley near Northshire Bookstore: Private facade mounted pedestrian lighting



Broadway near Division Street: Signage lighting from private businesses



Broadway @ Adelphi Hotel: Private decorative facade lighting



Broadway approaching Lake Avenue: Private lighting on sidewalk



Historic pole-mounted lighting: Public decorative triple post top (unshielded, 360 degree light)

2 WHAT IS “SMART?”

There is no conclusive definition for a Smart City/ Smart Community. The technologies being integrated and systemized are ever growing. A leading expert in sustainability and Smart Cities defines a city that is smart as one that “utilizes information and communications technology to meet the demands of its citizens, and that community involvement in the processes is a necessity for a smart city” (Deakin, M., 2012).

For the purposes of this Guidebook, the term Smart Community is used when discussing community governance and social benefits of neighborhoods in towns, villages, and cities. The term Smart City is used when discussing the related technology and infrastructure aspects.

Opportunities for connected, “smart” technologies range from public safety to asset management. When considering networked “smart” lighting, and the introduction of “smart” technologies, a wide variety of infrastructure and ownership/maintenance practices must be reviewed in detail to develop a Smart Communities strategy. Here, the Guidebook uses quotes around the word smart, because there are a variety of uses of the word. Smart can describe the electronically-based system which connects an assortment of devices that monitor, measure, and surveil geographical areas. However, it can also describe the devices, such as “Internet of Things” (IoT) devices and sensors.

Cities are embracing connectivity and digital technologies to verify and improve service proficiency through data collection. This is done by deploying sensors for environmental conditions and traffic flow through the use of cameras, counters, and triggers that are placed at

key locations along streets and roads. Examples of the optional Smart City capabilities and smart lighting are illustrated to the right (**fig-2**).

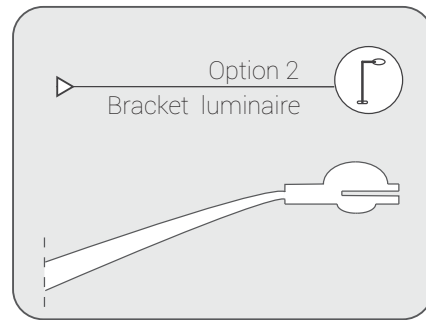
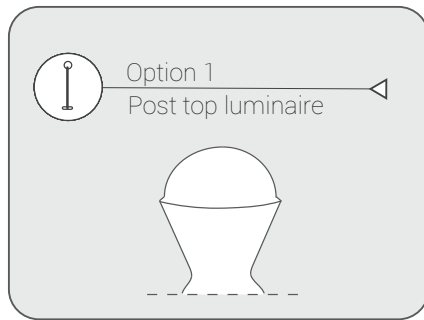
Information retrieved over time, including pedestrian counts, traffic circulation, and city services, can be stored and collated. The data can be used to either inform programs by analysis (trash collection, traffic flow, parking) or to trigger an action, for example, adaptive and predictive traffic signals or real-time information displays during events, rush hour, trash pickup, or in response to weather conditions or as an emergency alert. In addition, this can also include adaptive lighting to support civil behavior.

Saratoga Springs Smart City Vision:










“What is a smart city? It is dependent on technology but it is not defined by that technology. A smart city is an information hub that empowers citizens, supports businesses, and inspires community innovation.

A smart Saratoga Springs will embrace new, creative solutions that ensure the City operates more efficiently, attracts and encourages businesses, and improves overall quality of life - all while leveraging and enhancing its unique history and culture.”


Saratoga Springs Smart City Roadmap 1.0
<http://www.saratoga-springs.org/DocumentCenter/View/5157/Smart-City-Roadmap-10?bidId=>





Optional Smart City Capabilities

-  Sensors
-  Video Monitoring
-  Wireless Network
-  Environmental Sensors
-  Information Display
-  RFID
-  Charging Pile
-  Emergency Call
-  Metering Energy Consumption

Levels of Deployment

- Basic**  LED conversion on/off switching

- Basic +**  Reporting/proactive maintenance
- Computer Monitor/Central management system (CMS)
- NEMA provision for connectivity
- Advanced**  Smart grid/street light dimming

- Advanced +**  Smart city integration

Note: Public programs predominantly replace only luminaires, not existing poles.

In New York State, NYPA and National Grid combine Basic+ and Advanced - they are offered on the same device

Fig-2: Smart Lighting

Responsive and Sustainable Smart Lighting –

The term “Smart Cities” (also sometimes referred to as “Smart Communities”) and “Smart Tech” covers a rapidly-changing, evolving set of functionalities. The word smart in the smart technology context can also include and refer to illumination, typically to poles, luminaires, and their controls. Lighting is at the center of smart technology roll-outs because the sensors and devices indicated above are mounted on street light poles. These poles are spaced throughout cities, typically at around 100-150’ on center, which is generally sufficient for both lighting and smart technology coverage.

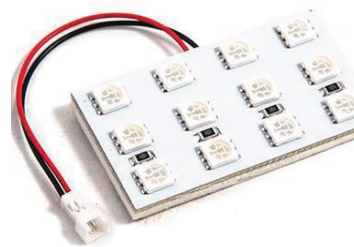
It is useful to think of “smart lighting” as the term that refers just to the lighting systems, and “smart poles” as a potential mounting point for the wide range of technologies available to create Smart Communities. One could also argue that good quality lighting design is in itself smart lighting. However, opportunities have emerged, alongside a desire for advanced design considerations that require enabling, connected technologies, to make lighting responsive, adaptable, and, in short “smart.”

On the technological side, smart lighting is a lighting industry-centric umbrella term for Smart City technologies, as the devices, methods, and communications associated with these technologies provide services over and above night illumination alone. These devices can be integrated with luminaires that house LEDs, shown in **(fig-3)**, and can be remotely controllable, in terms of on/off, dimming, and can report back their status, typically to a central control system. Additional mounting options for devices in addition to integration with luminaires include poles and the light arms themselves.

In addition, placemaking with light can be applied to mixed-use, entertainment and walking districts, housing, and institutional or corporate campuses –

most of the neighborhoods within the City of Saratoga Springs. For advanced lighting to affect placemaking initiatives, the district’s existing open space usage must be evaluated. This can be effectively conducted from a “shades of night” perspective, surveying street and space activities or lack thereof, from dusk to dawn **(fig-4)**. This process provides opportunities to evaluate gaps and put strategies in place to establish extended benefits such as economic development.

Responsive, quality lighting can support community building and thriving nighttime environments. For downtown areas, this can result in nighttime economy improvements - where new businesses associated with nighttime activity can potentially be developed or expanded. Weighing the design options is best undertaken through a process that includes stakeholders and community members. These technologies can be used to support public health objectives such as walkability, transit, and last mile considerations.



Sample of LED Module to replace conventional light source in a luminaire

Image Credit:
<https://www.diode-dynamics.com/led-board-smd12-one.html>



Sample of LED post top

Image Credit:
<https://products.gecurrent.com/outdoor-lighting/decorative-post-top/evolve-post-top-town-country-eptt>

Fig-3: Sample LED Module and LED post top

Quality And Technology

Key smart lighting capabilities include:

- Remote on/off and dimmability
- Self-reporting of status and trouble (“proactive maintenance”)
- Dynamic spectral, dimming, and color changes for special application

In contrast, key smart pole capabilities can include all the above smart lighting capabilities as well as:

- WiFi or Cellular antennas
- Data gathering sensors (temperature, barometric pressure, sound, vibration)
- Visual annunciators (parking, wayfinding, transportation, commerce)
- Video surveillance

As part of the process for determining what technologies would be appropriate, a municipality should first take stock of the existing lighting system

to understand the location and placement of poles, where illumination is needed to support placemaking, and if there are any opportunities to eliminate any unnecessary lights. A lighting inventory typically includes information on light type, wattage, location of each pole or fixture, and ownership.

Both the public and private sector play a role in introducing smart lighting. Government agencies include public works departments, law enforcement and information technology departments, among others. Citizen participation is vital to inform the design of the appropriate systems. State government entities and utilities play a significant role, often with educational programs and incentives, to encourage the use of smart infrastructure. On the private side, either independently or in partnership with a state government entities, manufacturers, consultants, and contractors are employed to design, fulfill procurement, and install systems.

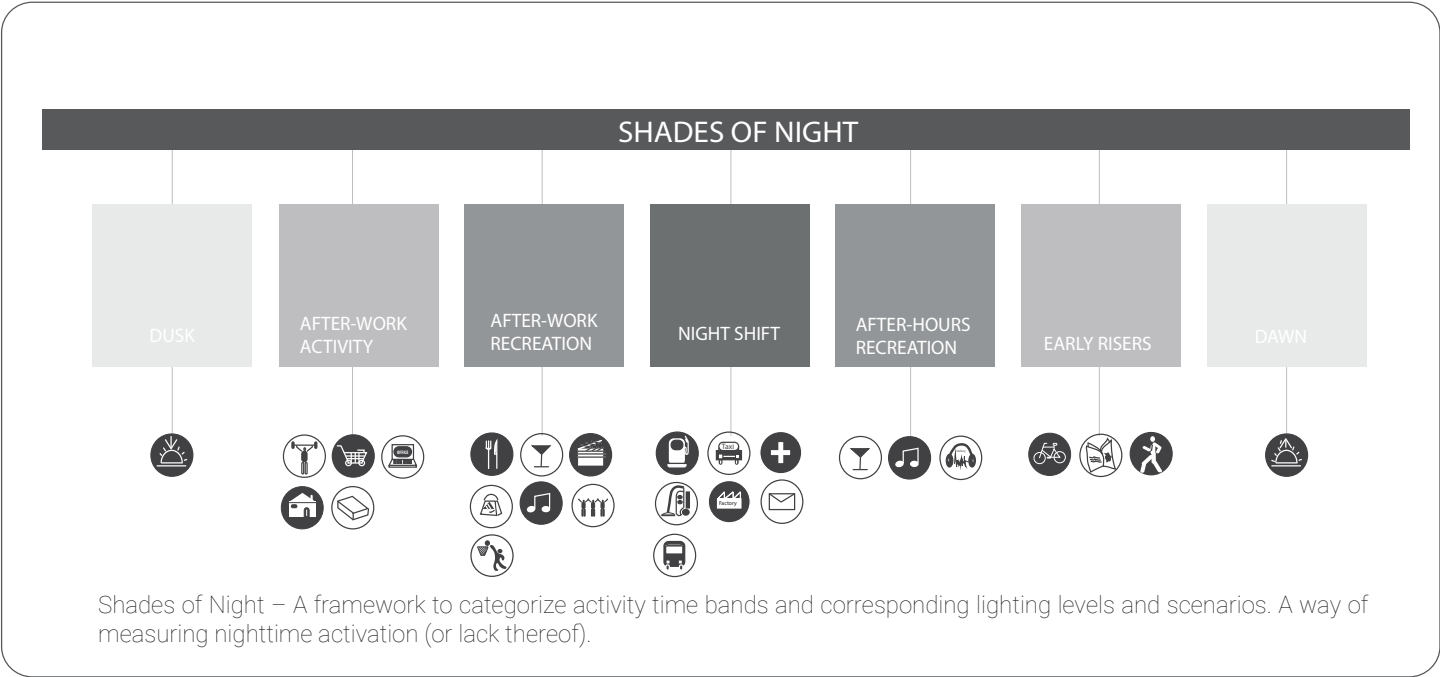


Fig-4: Shades of Night

Overview of Benefits And Challenges For Communities Aspiring To “Smartness”

There are many potential benefits and challenges to implementing Smart City and Lighting technologies (**table-1**). For example, from an economic perspective there is a potential to save operations costs through the use of smart data but this is dependent on many factors such as staffing, type of data, expense to get the data, etc. Improvements in lighting can also assist with placemaking and encourage mobility by foot or bike at night. It is suggested that a municipality undergo a careful analysis and strategic planning before deploying Smart City technologies.

It is important to note that there are tremendous changes occurring in the industry. New manufacturers are regularly entering the market, while old ones are regularly exiting it. Authorities are constantly faced with making choices and must anticipate rapid technological and commercial changes and anyone seeking to partner with a single, future-proof manufacturer will be faced with challenges.

Decision making for technological upgrades can be daunting given the complex choices and ever-changing market. Manufacturers often silo their products as a one-stop market solution. Other manufacturers claim that their systems are “open” or that they “interoperate.” So far, however, interoperability between different systems and products tends to be limited as systems often still require the use of manufacturer-specific coding at the functional level. In general, it is recommended that municipalities clearly identify their objectives for interaction of technologies (what responses are triggered by which devices) and then test in pilot installations, mock-ups, and case study projects, either themselves or with support from an independent organization. Identifying whether the

products and systems interoperate as needed is a vital element of the decision making process.

Infrastructure Challenges

Another consideration for a municipality considering deploying Smart City technology or smart lighting technology is the number of infrastructure alternatives. Examples of infrastructure alternatives include selecting power supply options, method of data communication between devices and preferred mounting method, and if devices are to be mounted on existing armatures (e.g. lighting or telephone poles). The following sections describe some of these physical and digital equipment infrastructure challenges and infrastructure needs related to system management, ownership, and personnel.



Street light with smart hardware attached
(Boston, MA)
Photo by Planning4Places, LLC

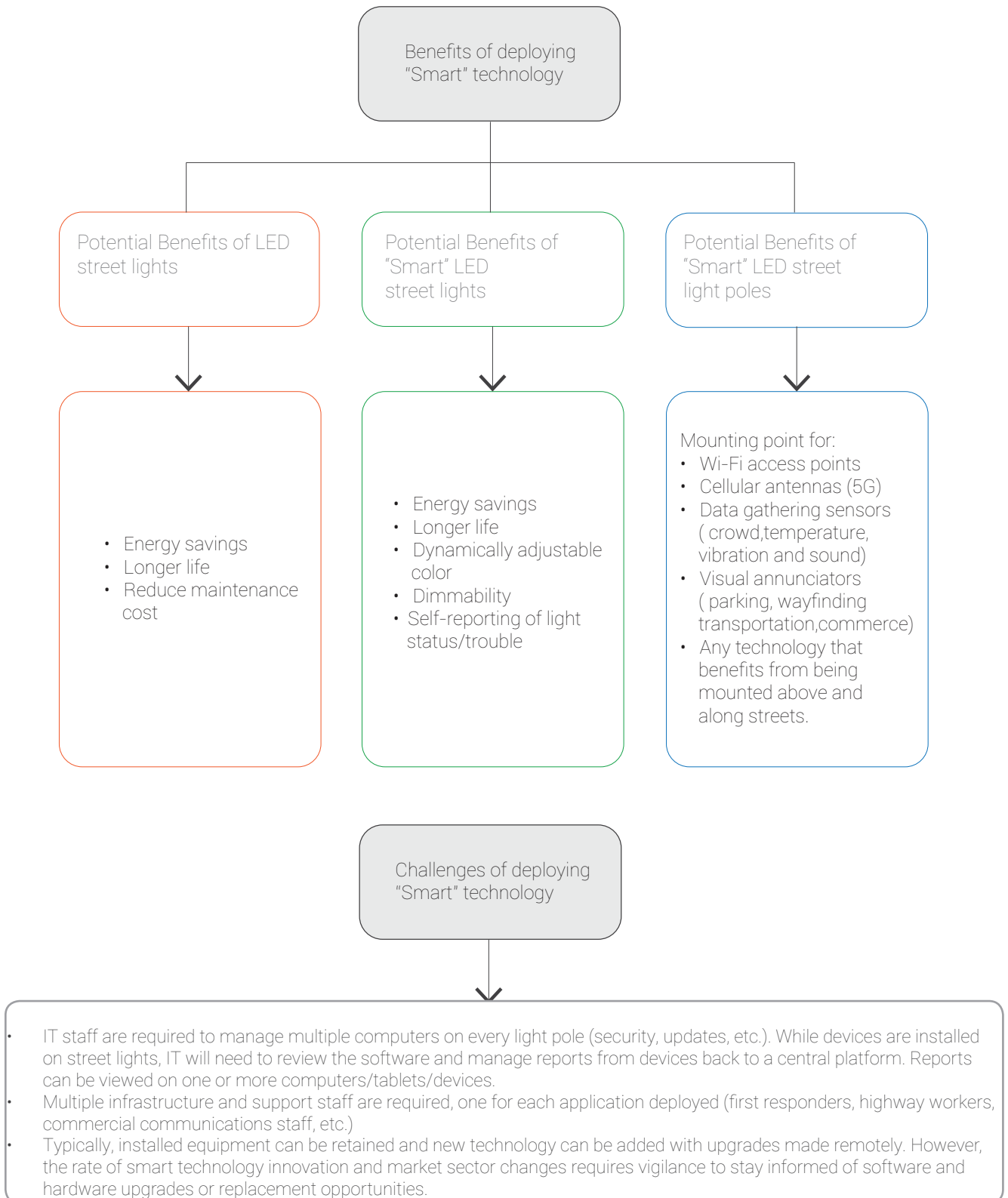


Table -1 Benefits of Smart Technology

Physical Equipment and Digital Infrastructure

Digital Infrastructure

In general, LED-converted street lighting (smart lighting) that are installed as replacements for earlier generations of street lighting technology will utilize the same source of power as had been used by the earlier systems. The choice, however, becomes more complex for Smart City devices (“smart devices”). In many cases, smart devices will be deployed near or on the support systems for street lights (e.g. suspended catenary wires, telephone poles, or street light poles). In those cases, the same systems that power the street lights may be usable for the smart technologies. (As a point of information, there are also cases where the optimal mounting location for a Smart City system might not be near a street light - e.g. video cameras capturing non-street areas; sound-monitoring systems in unlit parkland.) Power-supply choices must be made based upon the power consumption needs of the smart device and the power sources available at or near the mounting location. This element of the Guidebook focuses on smart technologies connected to lighting where power is typically available, either from the grid, or in some cases, solar or battery backup.

Data Communication

A fundamental requirement for smart lighting and other Smart City technology is data communication. Devices must communicate among themselves and with a central control management system (CMS). Devices will have different bandwidth needs, communication interruption tolerances, and range requirements. These needs will affect power requirements (some communication protocols require more power than others) and will impose restrictions on interoperability, which is a current implementation challenge. A key component of interoperability is compatible communication to each other. While there is no preferable data infrastructure from one system (and manufacturer)

communication technology over another, the proper technology is context-specific.

The following factors will need to be considered: topography (e.g. a clear path for successful data transmission from one device to the next and distances between devices short enough to allow error-free communication); capacity (e.g. bandwidth of the communication technology sufficient for data requirements of the device); and fault-tolerance (e.g. can the devices continue to operate, and for how long, when transmission errors occur?).

Among the currently existing Smart City data communication technologies are:

- Wired
 - DALI
 - Ethernet
 - DMX (and its successor technologies)
- Wireless
 - LoRaWAN
 - Cellular
 - WiFi
 - ZigBee

As part of the decision making process, municipalities first need to clearly identify their objectives and needs for the implementation and interaction of technologies. Questions like what services are needed and desired, what responses should be triggered by what input, and what resources for maintenance and operation are available - should be answered. The resulting strategy is a crucial first step to launching system specifications planning, including research into current products and protocols. As mentioned above, system interoperability should be

Considerations

tested before any larger-scale procurement decisions are put in place (see Decision Making Roadmap in Chapter 3).

Physical Interfaces

The actual installation and mounting of technology to enable Smart Communities present an additional set of infrastructure and interoperability challenges. Municipalities should demand the most far-sighted, future-proof mounting systems for their Smart City technology installations.

Most physical mounting systems, such as pole mounting, are inherently long-lasting and durable. However, integrated, Smart City products must be able to be updated with technological changes. It is essential that poles (or other mounting infrastructure) provide the most flexible mounting opportunities, while also upholding the desired aesthetic standard. Design principles must be considered in regard to the appearance of digital device appurtenances. As of this writing, manufacturers are developing ways of hiding devices within luminaires and offering “smart pole” designs. However, if the systems are proprietary, they should not be considered future-proof choices for municipalities.



Art Installation: *Urban Light* by Chris Burden.
Image being used for Los Angeles Smart Light Pole design competition to integrate hardware into light pole (<https://www.lalightstheway.org/about>)
Photo by Nick Ut, Associated Press



Example: Smart hardware visibly attached (Schenectady, NY)
Photo by Planning4Places, LLC



Example: Smart hardware integrated into luminaire
Photo courtesy Felicity Smart Technology

Personnel, Management, and Governance

As municipalities consider smart lighting and Smart City functionality for their communities, it is important to factor in governance requirements. Each department that uses Smart City data or uses Smart City functionality will have different requirements for that data or functionality. New staff and departments may likely be required when implementing functions for Smart Communities using Smart City technologies. With the rise in Smart City technologies and the complexity of municipal services, U.S. cities such as New York and Boston have created new municipal departments to coordinate the Smart City related digital technologies and study their potential.

In Boston, for example, the Office of Urban Mechanics has focused on education, housing, public works, and IT departments. In New York City, the Mayor's Office of the Chief Technology Officer is addressing broadband, Smart City technologies, and digital services. The need for upper level management for deployment of smart networks was emphasized on a panel for the Consumer Electronics Show in January 2020. Dr. Jennifer Harder, with the First Responder Network, U.S. Department of Commerce, commented, "To stay afloat in the sea of devices, cities should hire people who can be responsible for charting the course of emerging technology within government" (Johnston, R., 2020). Small and mid-size municipalities may also need to implement additional resources to coordinate the opportunities and challenges of physical and digital Smart City technologies and related infrastructure.

Police, Fire, other First Responders

The deployment of Smart City technology that supports security functionality could include crowd size estimators; fire detectors; hazardous gas detectors; severe weather detectors; gunshot locators; and more.

The data collected by each of these require staff that is trained in the interpretation of that data and provided with the necessary tools to initiate a proper response when the data requires it. There is a clear need for the security departments that receive this data to have staff that is dedicated to conversion of this data to usable information, and who have the capability to trigger responses to the information when necessary. These capabilities may not typically be present in the respective departments prior to the implementation of these new technologies.

Information Technology (IT)

The deployment of Smart City technology throughout an area is similar to deploying a network of computers throughout that same area – each smart device is itself a computer. The addition of so many computers to the information network of a municipality will place significant new demands on the IT department supporting those computers. Each device will require its own upgrade and security policies, and maintenance techniques. Each device will also require monitoring and regular servicing for status, compromise, and functionality updates.

Marketing

There is potential for annunciator boards mounted on smart poles to provide a creative opportunity for municipal self-promotion. Dynamic Smart City annunciator boards, however, require regular updating by dedicated staff with the skills required for creating compelling information delivery on electronic displays (skills akin to website content development). Additionally, signage applications may require a change in zoning regulations or in cases of state roads, any applicable state signage regulations.

Considerations

Transportation (ITS)

Similar to marketing information, Smart City annunciators can display constant status indicators about public and private transportation. Information about arrival times, congested and alternate routes, parking and availability, etc., can be changed on annunciator boards.

For services to run smoothly and accurately, in addition to the technologies and staff that support automated reporting; staff must also be dedicated to maintaining content and announcements.

Nighttime Transit, Bike, and Pedestrian Support

Technology provides ample opportunities to adjust to the needs of after-dark commuters and visitors of events traveling by bike or foot. During design phases, a lighting inventory or audit is required for LED conversion. At that time, special attention will be paid to the needs of bicycle, sidewalks, and priority pedestrian ways (as well as the preferred future use of such infrastructure), to match the community's targets for non-vehicular mobility infrastructure.

Intersections, crosswalks, and night transit routes should be considered for augmented lighting and digital wayfinding, such as integrating tech with bus stops. New mobility-focused street design innovations can be explored; there are responsive signals for bike lanes and predictive signal technologies being tested as well as integration of street painting technologies with illumination.

Narrow Targeting by Desired Function

The first phase of technological planning is a narrowing of the desired functionality. The set of functions that are included under the broad term

Smart City technology enabling the development of Smart Communities are vast. A municipality should evaluate which function(s) will benefit the municipality most and create a deployment plan accordingly (for only those functions).

Each of these functions will require their own analysis, infrastructure, and staffing plans. While in some cases, infrastructure and staffing might be able to be combined, this will have to be analyzed as the deployment is planned. Data can also be made available via smart phone apps or websites. Below is a selection of some of the available functions to consider. Typically, they involve a combination of data inputs from an environmental sensor to trigger a change in lighting or information displays (see the appendix for a summary matrix of current manufacturers and technologies):

- Dimmable street lights (e.g. in response to natural light conditions, events, time, weather)
- Crowd-responsive lighting
- Emergency-responsive lighting
- Traffic and parking monitoring and maintenance
- Wayfinding
- Commercial advertising

Some functions focus on data collection and other background functions, such as, for example:

- Surveillance (cameras)
- Facial recognition
- Crowd size estimates
- Wireless hubs
- Public transportation information
- Energy monitoring
- Maintenance alerts
- Environmental sensors (temperature, humidity, noise/sound, pressure, lighting, vibration)
- GPS locator

3 DECISION MAKING ROADMAP

Defining and prioritizing the civic challenges that might be solved or improved via smart technologies is key to creating Smart Communities. Municipalities may be looking to simplify, streamline, and make government services more efficient or to improve functionality or find innovative and creative solutions (or all of the above). However, in a market-driven arena, the complexity of choices makes the decision making process challenging and municipalities are seeking clearer explanations about these services.

Municipal departments must work together to identify the problems to be solved by networked and advanced technology, and how and when to deploy onto or into light poles. In addition, data security/ownership and privacy are also critical during the vendor selection process. Smart lighting and smart tech decision making is not a purely operational decision, but requires consideration of governance structures, prioritization, and staging. As municipalities consider their options, it is also important to have a good understanding of their current lighting situation through conducting a lighting assessment and utility billing audit.

Nearly 40% of municipal respondents when asked about interest in smart lighting cited “More information about potential benefits and savings, and specific analysis of how my community/organization might benefit” as the support they need. (Sensus/Smart Cities Dive, 2018). Northeastern cities have chosen different ways to develop smart, innovative tech in the years between 2010 and 2013. At that time, New York and Philadelphia focused on civic-minded software developers to help cities become more effective and efficient. In 2019, Boston issued requests for civic innovators to disrupt the norm by testing “brand new services altogether” (City of Boston, NY, 2019). As of January 2020, Philadelphia, has launched a “Pitch & Pilot program” for technology-enabled approaches, stemming from their Smart City Roadmap (City of Philadelphia, PA,

2019). More information on other municipal approaches and case studies can be found in Chapter 5.

The Stepped Approach To Decision Making

The following Decision Making Roadmap summarizes some of the necessary steps in making these decisions (**fig-5**). To start, there are broadly four categories to determine the appropriate strategy (“the Foundation”):

- The “Basic” category is not yet “smart” per se but provides energy savings through LED conversion and an opportunity to be “smart-ready” for later integration of smart-enabling technologies.
- Basic+ and Advanced define varying levels of lighting controls.
- Advanced+ incorporates Smart City and Community integration.

Municipalities need to select the appropriate category to determine whether working with a utility, state entity, and/or third-party entity is appropriate for them. In New York State, NYPA and National Grid offer partnerships and incentives to municipalities in two areas for deployment: Basic and a combined Basic+ and Advanced (they are offered on the same device). For Advanced+, additional collaborations with private industry partners and turn-key, full service, providers are starting to become available.

First, municipalities need to prioritize the smart technologies they need and come up with a management strategy (“First Step”). Then, municipalities need to create an action plan and learn from case studies and pilot results to come up with a recommendation for implementation (“Second Step”). Finally, municipalities will be ready for procurement and installation (“Third Step”).

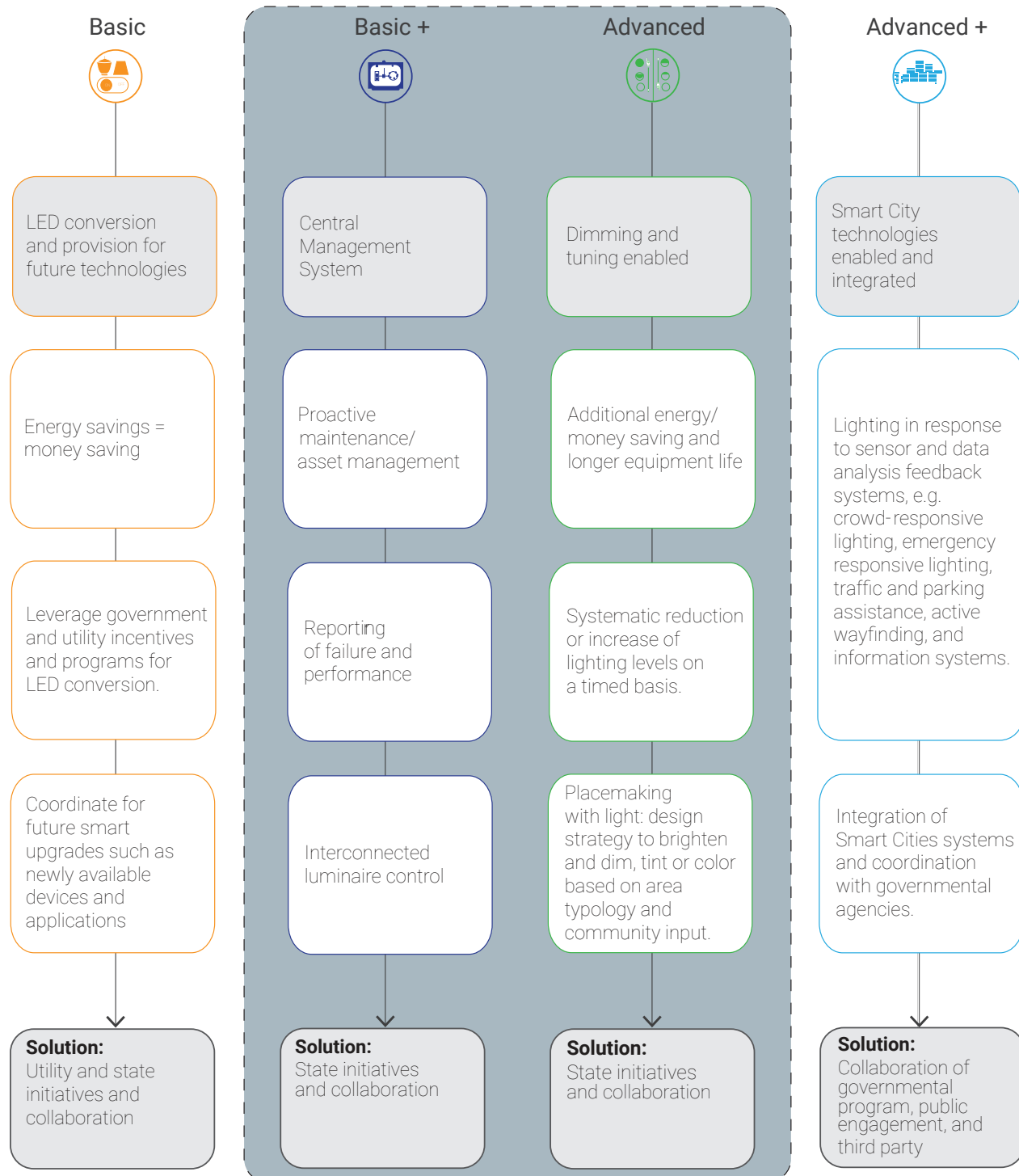
Decision Making Roadmap

Foundation

First Steps

Second Steps

Third Steps



All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management
In New York State, NYPA and National Grid combine Basic+ and Advanced - they are offered on the same device

Fig-5

Decision Making Roadmap

Foundation

First Steps

Second Steps

Third Steps

Outcome of First Steps

- Create prioritized list of challenges that might be addressed by smart technologies and management strategy

- Establish working party to manage smart initiative and departmental staff that will interface smart technology assets

Management:

- Identify municipal department services that might benefit from smart technologies.
- Develop working group to manage smart projects.
- Determine responsible party for budgets.

Coordinate departments to interpret and utilize data collection for management of services (eg. IT, Police, Fire, transit, transportation).

Citizen engagement:

- Use community outreach to create awareness of smart tech aspirations.

Ensure all stakeholders contribute to strategy development early in the process.

Shades of Night Analysis:

- Measure public and open space usage from dusk through dawn in area typologies.

Identify time-based activities as a baseline for future smart technology application.

Establish ownership:

- Identify relevant infrastructure jurisdiction issues or conflicts.

Plan for integration of Smart City systems such as poles, luminaires, telecoms, electric power/wiring and maintenance of systems.

Lighting prioritization:

- Identify civic lighting-related issues.

Consider energy, safety, comfort, orientation and legibility, branding, placemaking, etc.

Leverage programs:

- Identify incentives to finance, offset costs, and implement options.

Review and compare:
Utility buy-back programs, competitions, implementation management, and financing scenarios.

* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Decision Making Roadmap

Foundation

First Steps

Second Steps

Third Steps

Outcome of Second Steps

- Formulate Smart Lighting/ City strategy: incorporating technology and financial research into an action plan

- Translate case study / pilot results into a recommendation for implementation

Engage design services for Smart Lighting:

An urban lighting design firm plus related design consultants will ensure that procurement decisions take into account operations, placemaking, equity, and aesthetics.

Working party and design team to define next steps and grants available.

Engage Smart City strategist:

Develop a phased "Smart City" strategy based on 1st Steps analysis.

Pull together options, prioritize, and develop draft RFQ.

Develop financial strategy:

Verify and align with municipal needs.

Include ROI and cost-benefit analyses based on priorities selected, and technologies, services, maintenance plan and grants available.

Familiarize with technological options:

Prepare civil servants on technological subject matter.

Research and prioritize preliminary technological options, and suppliers, for local conditions.

Implement case-study pilots

Design pilots:

- test concepts
- communication technologies
- interoperability
- quality of light

All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management. NYPA can assist with all procurement including labor and materials for a complete project, including Smart Cities, to simplify the process. They will also bring in vendors to provide technology presentations and live demonstrations to allow a community the opportunity to try different solutions before committing to a particular vendor.

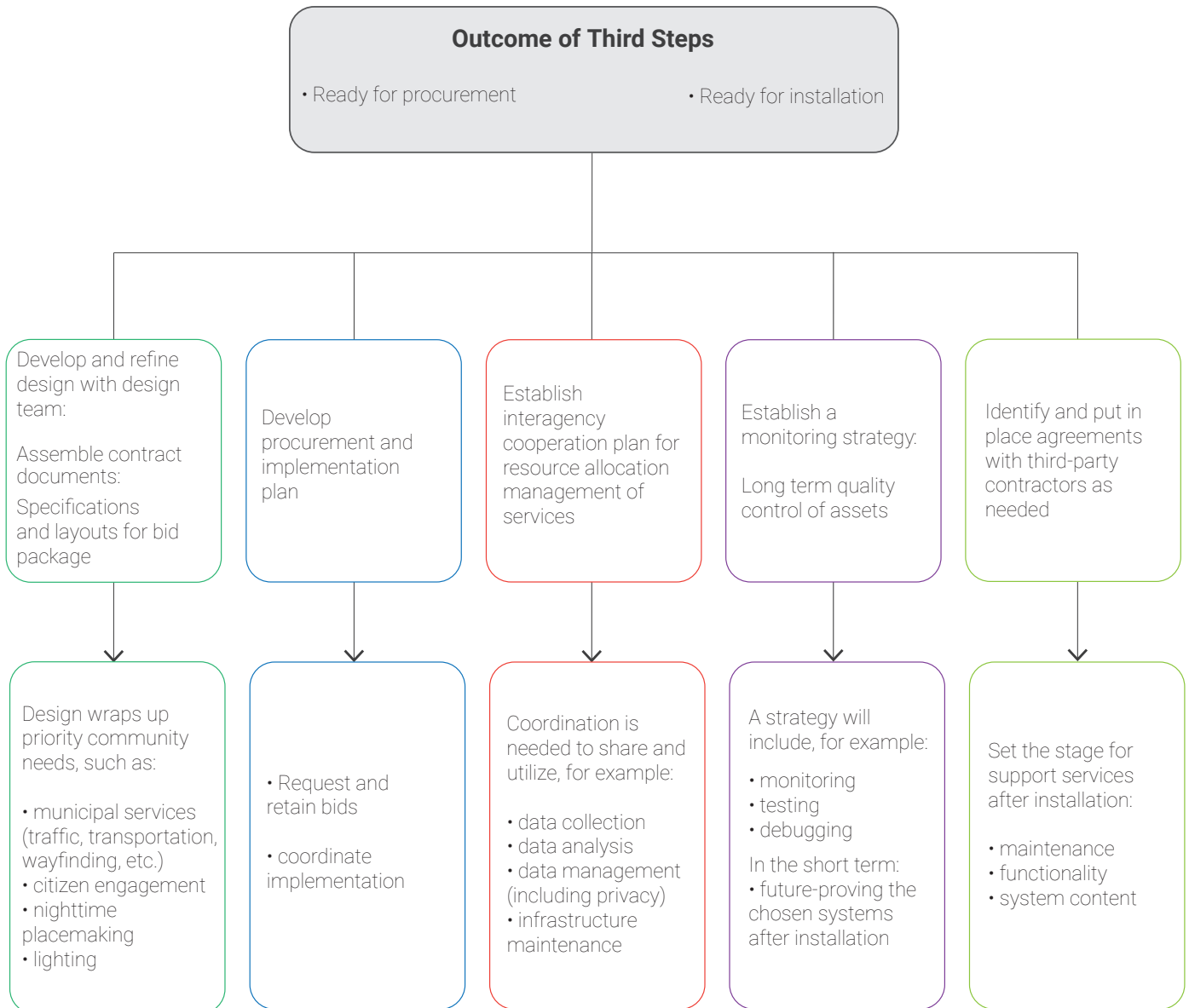
Decision Making Roadmap

Foundation

First Steps

Second Steps

Third Steps



* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Why Pilots?

Pilots are critical to assist with the decision making process. During the research for this Guidebook, it was found that many of the smart lighting deployments are not full-on permanent installations, but rather demonstrations, or pilots. To determine the type and scale of a pilot, it is recommended that a municipality work through Steps 1 and 2 of the Decision Making Roadmap.

As noted earlier, integration of luminaires, poles, and Smart City technologies are likely to have compatibility challenges. Equipment needs to be vetted and tested to ensure compatibility. Replacement or modification of technology on a full roll-out is costly to replace and because of this, pilots are essential.

NYPA states that they focus on open networks to accommodate multiple vendors during the design phase. NYPA offers sample fixtures as part of a project to allow the community to test out different fixtures and light levels before commitment to a selection. NYPA also offers site visits to other communities to see live demonstrations of the technology. Some manufacturers, based upon interviews, have stated that they provide free pilots depending on the scale of the future deployment order. Decision makers can, and should, verify if sample fixtures are provided and also visit existing pilots and installations in communities located throughout the state (see case studies in Chapter 5).

An advisory group should be designated for the life of the pilot. Critical personnel include municipal managers, lighting designers, electrical engineers, manufacturers (suppliers), and installers. Provisions for community engagement and input are also essential for full benefit of a pilot. A Monitoring and Evaluation (M & E) plan may also be required.

Pilots are important for several reasons:

1. Proof of operation/functionality
 - Connectivity, devices, interoperability, compatibility
 - Sensing
 - Asset management demonstration - reporting and managing
 - Proof of security plan, including protection from hacking/viruses; validation of software update capabilities
2. Aesthetics
 - Quality of lighting – focus, color temperature/rendering
 - Lighting levels – brightness, contrast
 - Form factor of equipment – profile and finishes of luminaire, pole, attachments
3. Placemaking with light – Dimming control required
 - Community engagement
 - Digital responsiveness
 - Software program operation
 - Unique applications



Example: Before High Pressure Sodium Cobra Light Example and after LED Pilot Example (Schenectady, NY)
Photos by Planning4Places, LLC

4 DEPLOYMENT STRATEGIES:

Municipalities have the opportunity to own their lighting and related Smart City infrastructure or enter into contracts with state or utility agencies. With each choice, there are different potential revenue streams and tradeoffs that need to be considered. As a municipal owner, for example, attachment fees onto smart pole “real estate” could be charged from other departments or third parties that wish to deploy additional technology alongside the street light sensors and controls. In addition, collected data is an asset that is widely discussed as a potential revenue stream which can also be sold to third parties. Interpreting and leveraging data for parking, garbage collection, etc., provides for some efficiencies and could allow for payment collection opportunities. Ownership provides those opportunities, however, with it, the responsibility of implementing, managing, and maintaining the systems and infrastructures.

As of the date of this Guidebook, the New York Power Authority (NYPA) announced a Smart City Technology Grant Program (“Smart City Grant”), scheduled to run through December 31, 2025. The goal is to support the planning and installation of Smart City sensor hardware and software technology as part of LED street lighting conversions. In order to receive an award, the applicant municipality must enter into an agreement with NYPA for the full turnkey project implementation of an LED street lighting conversion. The Applicant must also execute a cost recovery agreement with NYPA. NYPA’s stated objectives are to support public safety through surveillance (video analytics, noise and motion monitoring, gunshot detection), environmental monitoring (air quality, ice and snow detection, sewer and storm water monitoring, weather detection), transportation management (traffic optimization, traffic monitoring, parking management), and connectivity (digital kiosks, connected vehicles, smart phone applications).

Cost-benefit and ROI analyses for such projects have to extend the customary calculations of cost savings due to energy and maintenance reductions of LED conversions, which are dependent on a municipality’s proposed strategy and needs. In 2019, NYPA proposed a \$5-million dollar project to convert all lighting to LED to enable energy and maintenance savings, and with that, the associated financial benefits. The City of Saratoga Springs and other eligible communities, can finance a conversion project, including the full cost of the project and acquisition of the street lights from the utility. Management and engineering services for all phases from conceptualization through closeout; from design and construction phases, to coordination of strategic sourcing, purchasing, cash flows, rebates, and public outreach are also available.

A model ROI calculation using a “Basic” LED conversion, which is the most economical up-front solution, estimates the payback from energy and maintenance savings to be about 14 years. However, this solution does not yet include any of the above-mentioned provisions for lighting controls, dimming, sensor driven data collection and responsiveness, and smart technologies (Advanced and Advanced+). The ROI and cost analysis for LED street light controls, such as dimming, and/or a street light sensor networks and management systems, that provides additional functionality, needs to be calculated based on the preferred municipal solution. Savings calculators look at construction costs, interest during construction, and energy and maintenance savings. NYPA estimates that customer conversion projects can expect simple paybacks between 7 to 10 years (not including financing costs).

NYPA includes a line item for “maintenance savings” which reflects replacements, truck rolls, and labor required to maintain LED street lights compared to

Financing, Finances, and Tariffs

utility-owned traditional street lights. Also, a NYPA Operations and Maintenance (O & M) program is being launched in 2020. This service has historically been provided by a municipality, a community consortium, the utility, or a third-party contractors working for the utility. The O & M program will provide a turn-key solution for street light conversion and maintenance (related to aging infrastructure, weather-related events, traffic accidents, and defects) of the system.

Current Model		
Annual Costs		
	Amount	Savings
Facility	\$ 129,625.68	N/A
Electricity	\$ 125,542.84	N/A
Total	\$ 255,168.52	N/A
Environmental Benefit		
	Amount	Savings
Annual Electricity Use (kWh)	893,289	N/A
Annual GHG emissions (kg)	253,247	N/A

Utility Convert		
Annual Costs		
	Amount	Savings
Facility	\$ 172,162.44	\$ (42,536.76)
Electricity	\$ 35,098.06	\$ 90,444.79
Total	\$ 207,260.50	\$ 47,908.03
Environmental Benefit		
	Amount	Savings
Annual Electricity Use (kWh)	249,737	643,552
Annual GHG emissions (kg)	70,800	182,447

Municipal Ownership		
Annual Costs		
	Amount	Savings
Facility (Maintenance)	\$ 45,021.60	\$ 84,604.08
Electricity	\$ 21,739.01	\$ 103,803.84
Total	\$ 66,760.61	\$ 188,407.92
Environmental Benefit		
	Amount	Savings
Annual Electricity Use (kWh)	190,944	702,345
Annual GHG emissions (kg)	54,133	199,115

Table-2 Energy Saving Calculator Example -
See <https://www.epa.gov/> for the Greenhouse Gas
Equivalencies Calculator
Source: CDRPC/NYSERDA

If a municipality uses the NYPA procurement program, which includes training on the control system and its upkeep reporting system, it would be advantageous to utilize the O & M program.

Actual street lighting ROI calculations must be highly customized to be project specific and based upon the municipal street light inventory. Many factors impact the cost and savings, including the number of decorative lights, the age of the infrastructure, a community's interest in Smart Cities, and other political and community goals. Specifics can be arranged and discussed by meeting with NYPA, the Capital District Regional Planning Commission (CDRPC), and many other organizations that provide technical assistance with street light conversions.

CDRPC, funded by the NYSERDA Clean Energy Communities Program (CEC), conducts cost analyses for purchasing street lights or upgrading through utility programs – using data from the tariffs – as well as helps communities connect with their utility account manager to request pricing and other details for purchase and upgrades. CDRPC has assisted 28 communities in the region with designation in the CEC program, and provided over 30 street light analyses to these communities.

(Table-2) shows an analysis for 2,028 roadway lights in Saratoga Springs. It is based upon the National Grid tariff (PSC No 214). For supply cost, the model uses the Mass Market 12 Month Trailing Weighted Average Prices Ending December 31, 2019, which is \$0.05087 per kWh. The municipal purchase model assumes a \$15 per year operations and maintenance cost going forward. From this analysis, Saratoga Springs purchase ROI is 2.70 years for the municipal ownership model ($\$517,573 / \$188,407.92 = 2.70$ years). However, this does not include any costs as purchasing new replacement LED lighting, installation of the lights, and financing costs.

CDRPC is able to determine ROI once a community receives their prospective utility upgrade/purchase cost from National Grid and additional conversion costs from NYPA. This analysis is also available from third-parties and other regional groups for other areas, such as ANCA in the North County and the Mohawk Valley Economic Development District in the Mohawk Valley REDC. In addition, NYPA includes the full costs of design/construction/commissioning as part of the ROI for the customer owned conversion.

About Tariffs

The Public Service Commission sets tariffs through a formal document. Tariffs are based on a rate of delivery, energy, supply, and facility charges (including under or over ground supply). Facility charges also vary by ownership. If a city owns the street lights, there is a significant reduction in facility charges, and potential savings, even when maintenance costs are included.

In New York State, the tariff portion for energy consumption is based on the light source wattage (HPS, MH, or LED). This is the assumed, fixed, energy charge which is multiplied by quantity. In this case, a luminaire at full brightness/wattage or reduced (dimmed) is charged the same amount. In other words, energy is not metered, and charges are not based on actual usage. National Grid's rate plan (P.S.C. No 214 - Outdoor Lighting Tariff Modifications) established an LED Energy Efficiency Program to encourage street lighting conversions to LED. National Grid provides an incentive of \$50 - \$100 per fixture based on the fixture wattage (National Grid, 2018). The National Grid Incentive Offering is found in **(table-3)**.

Light as a medium allows for increasing and decreasing brightness (dimming), as well as tuning between color spectra (change in color). Prior to the use of LEDs in lighting, the most energy efficient sources could not dim. They could only switch on and off.

A new rate incorporating dimming will, again, be an assumed rate, with a municipal commitment with a set timed dimming schedule, for example:

- $x \text{ hours} - \text{watt hours} = \text{kilowatt hours}$

Some communities would like to have the choice to save on money and energy with the dimming option. NYPA is testing the feasibility of a "dimming tariff" with Orange and Rockland Utilities company (O & R). For the O & R pilot, each of 25 street lights will have a controller and meter. Once installed, the test period will take place for 6 months. NYPA anticipates a 15% reduction.

There are also hidden benefits to dimming. When first installed, LED is brighter than necessary, as the technology, as currently implemented, inevitably reduces light output over time. With the combination of dimming and asset controls, luminaires can be dimmed upon installation, with a gradual reduction in dimming over the 10-15-year lifetime. Additionally, there is a savings in Operations & Maintenance as the life of the LED is extended and does not need to be replaced as often.

The dimming characteristic is of yet underexplored for public, open spaces, and streetscapes for after-dark placemaking. Dimming has an extra benefit: energy reduction. When controllers are installed and used, lower energy usage is a result.

National Grid Tariff Luminaire Reference	LED Luminaire Delivered Lumens (L)	LED Luminaire System Wattage (W)	Proposed EE Incentive Payment (\$)
Customer-Owned	1-2000	0-24	0.00
National Grid B	2001-4000	25-47	50.00
National Grid C	4001-8000	48-95	65.00
National Grid D	8001-14000	96-153	75.00
Customer-Owned	14001-20000	154-209	85.00
National Grid F	20001-30000	210+	100.00

Table-3 National Grid Incentive Offering
Source: National Grid LED Street Light Conversion Program Fact Sheet

Color Rendering Index (CRI)



Image Credit: Don Slater

Using light with high color rendering properties enables the visibility of different object and surface colors (e.g. under most white LED lighting reds, greens, and blues are visible)



Image Credit: Despacio

Using light with low color rendering properties limits the visibility of different object and surface colors (e.g. under low pressure sodium lighting reds, greens, and blues are not visible, all colors look brown-black)

Outdoor Lighting: Quality And Ecological Balance

Many communities are especially concerned about preserving a view of the star filled night sky and the impact of outdoor lighting on nocturnal flora and fauna. There is a desire to retain a balance of nature and urban life cycles which can be interrupted by an unconsidered, badly designed lighting implementation. Recommendations and policies guiding reduced light pollution are sometimes written into regulations such as city ordinances, where compliance is expected. In other cases, the recommendations are guidelines for best practice. Model examples can be found at the International Dark-Sky Association and the Illuminating Engineering Society (International Dark-Sky Organization, 2019).

The following categories comprise “light pollution:” 1. Glare, 2. Sky Glow, and 3. Light Trespass. (IES, 2017 and 2018). Education and awareness campaigns can help to address the issue and target those responsible, such as lighting specifiers lacking appropriate design training, construction operators, and private owners of buildings.

- Sky Glow is the effect of lighting upwards causing clouds and particles in the atmosphere to glow and obscure the night stars and planets, and also reflect back down, causing a “blanket” of light. Ground-facing illumination also can reflect back up to the sky, adding to sky glow. So, in this case, illumination for both a darker sky and social benefit is a balancing challenge.
- Glare is outward, unshielded facing lighting that causes visual discomfort. It can momentarily or continuously blind the viewer, leading to safety problems and interrupted eco-cycles.

- Light Trespass occurs when a luminaire casts light onto an area that is not intended to be illuminated. Two examples of light trespass are, when a garage light pops on when unneeded or when street light illumination strays into residential windows. Mechanical and optical solutions are available to reduce light trespass.

Additionally, poor lighting design can result in “over-lighting” and “under-lighting.” A lack of understanding about contrast, visual adaptation, and lighting needed for support, safety, and the desired atmosphere makes this a complex issue. Due diligence is needed during the design process (e.g. photometric calculations and mock-ups to review the lighting distribution, appearance, and overall spatial effects).

In the US, “Model Lighting Ordinances” have been developed to ensure that the natural environment is considered. Classification systems are available to evaluate a fixture according to its light distribution. Mechanical and optical means to shield stray light are available, and in most cases, are incorporated into street lighting. In addition, the quality of the light itself can help mitigate undesired ecological impacts. Generally good color rendering properties are recommended to improve visibility of colors and details, and the use of warm to neutral correlated color temperatures as research suggests that light spectra with less short wavelength (blue) content might be less invasive (Luginbuhl, C.B., et al. 2014). As seen at right, warm white light has a typical correlated color temperature of between 2200 and 3000 Kelvin (K) while cool white light is between 4000 - 6000 K. Many LED street lighting pilot studies test warm and cool color temperatures to determine community preference.

Correlated Color Temperature (CCT)



Color of light

- Cool white light with typical CCT of 4000 – 6000K
- Warm white light with typical CCT of 2200 - 3000K

Image Credits: Nantes by night (© Didier Robcis photography)

<https://www.lec-expert.com/topics/the-colour-rendering-index-at-the-led-test-bench>

5 CASE STUDIES: City Scale Examples

Syracuse, New York's 'Flagship Smart City'

Many communities have started, and some have completed, smart lighting/ Smart City projects since the Governor enacted the Smart Street Lighting NY Program and increased its funding in 2019. There are case studies and lessons learned throughout the United States and around the globe.

Each town, city and community has its own civic priorities based loosely on safety, health, and economics. The key question for municipalities is "what is the problem we are trying to solve" (with advanced technologies)? Each municipality will have a unique answer and therefore define a parallel technological solution (Johnston, R., 2019).

Two locations, Syracuse and Boston, that have gone above and beyond "Basic" with efforts to achieve community engagement to expand their smart roadmaps.

"Syracuse Surge," a long-term strategy to fund economic growth and workforce development in the Syracuse downtown south corridor, was announced in January 2019. As a part of the overall Surge initiative, NYPA approved a \$500,000 grant for Syracuse to plan for procurement and replacement of the City's street lights with LED luminaires. It is anticipated that through the transfer of ownership the City will save an estimated \$3-million dollars per year and reduce greenhouse emissions by 6,100 tons. The replacement of conventional lighting will provide the basis to design and install an interconnected smart grid with access points for data collection throughout the City, later in the process. The City of Syracuse has established an Office of Accountability, Performance, and Innovation and working with the Planning Division, a "sandbox," or experimental pilot, is being staged.

Syracuse plans to evaluate equipment that can expand WiFi, 4G, and 5G internet connection capabilities on its street lights and to install other digital enhancements to city-wide services. Syracuse received \$500,000 of support from NYPA, which was the first award from the \$7.5 million statewide program (NYPA, 2019).

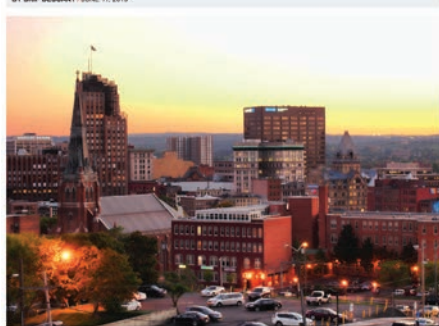
<https://www.govtech.com/smart-cities/Smarter-Streetlights-Are-Just-the-Beginning-in-Syracuse-NY.html>

Photo by
Debra Millet,
Shutterstock

Smarter Streetlights Are Just the Beginning in Syracuse, N.Y.

Syracuse will phase out all of its 17,500 conventional streetlights for an LED-powered lighting network system. But the city also has its eye on pulling in data like never before.

BY SKIP DESCANT / JUNE 11, 2019



Syracuse will phase out all of its 17,500 conventional streetlights for an LED-powered lighting network system. SHUTTERSTOCK/DEBRA MILLET



LED lighting, background (white), High-pressure sodium lighting, foreground (amber)

Photo by Dominic McGraw, Philadelphia Office of Sustainability

Boston, A Holistic Approach To Smart City Planning

In 2010, Boston launched an experimental smart initiative. The Boston Seaport Innovation District was the first such US city district among eighty worldwide.

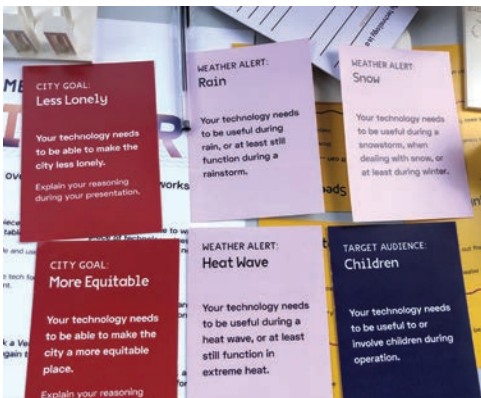
In 2018, Beta Blocks, another Boston initiative, was introduced to leverage smart/IoT capabilities. Today, Boston's tagline is "Sensors are not smart. Digital kiosks do not save the world. Efficiency is not democracy." This provocative program states that "a truly Smart City is one that creates equal opportunities for people to connect with each other and with the world. It allows its residents to decide what their definition of "smart" should be, and what creates real civic value. It provides ample pathways for its people not just to optimize it, but to live in it" (City of Boston, MA, 2019).

The Emerson Engagement Lab is delivering an effective community outreach program. The applied research lab provides a "civic experimentation process" for communities with problems that might be solved with Smart City technologies. The engagement process brings together government, private companies, researchers, designers, and artists. The Beta Blocks Action Research project

responds to local challenges and is looking for creative ways to respond to them and is not "some expansive deployment of sensors or gadgets."

As noted on the City's website, "the Beta Blocks Action Research project is responding to:

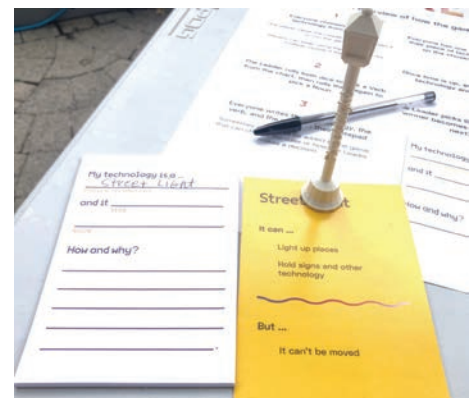
- The lack of public dialogue around the civic values and privacy concerns of Smart City tools.
 - The lack of clear and dynamic processes and policies for civic experimentation.
 - The inability to easily "plug-and-play" new tools and designs in the public realm."
- (City of Boston, MA, 2019).



Question cards



The game



Street light icon

Boston "Beta-Blocks" community engagement exhibition in Chinatown, 2019. Photos by Leni Schwendinger

Capital Region Examples

Overview

The following section provides summary information on projects underway in several Capital Region communities based upon municipal websites and newspaper publications. NYPA, National Grid, CDRPC, CDTC, and other agencies along with private-sector entities are collaborating with municipalities to assess and install LED lights and smart technology into existing systems.

According to NYPA, the majority of Capital Region street lights are currently owned by utility companies, with the exception of the City of Albany which recently purchased their street lights from National Grid. Many communities are exploring options for LED conversion and technologies elaborated in this Guidebook, and NYPA noted in a press release for a City of Albany conversion project (discussed below) that they have installed, or are in the process of installing, more than 128,000 LED street lights in municipalities across New York State.

City Of Schenectady: National Grid (Reforming The Energy Vision)

The City of Schenectady Smart City REV program is being undertaken to utilize technologies that are intended to enhance municipal services focused on public safety, mobility, and sustainability. The project is also expected to bring lower energy costs and a reduced carbon footprint. Upgrades throughout the City are anticipated to provide the City with real-time data and lighting controls which are expected to provide more efficiency and management control of City assets (City of Schenectady, NY, 2019). Testing is underway by National Grid. The effort includes the rollout of smart technologies, including a wireless network, and replacement of 4,200 street lights with LED lights. National Grid is comparing two systems: Cimcon NearSky in one section of the City and GE-AT&T City IQ in another. The entire

project will take place over a three-phase, three-year period that began in 2019 (City of Schenectady, NY, 2019). Phase 1, was a test case in the historic Stockade neighborhood along Union Street between North College Street and Washington Avenue that included retrofitting 18 street lights with intelligent controls and with a mixture of soft-white and daylight temperature LED lamps. This effort was undertaken to determine customer preferences for 4000K or 3000K LED color temperature (National Grid, 2018).

The completed Phase 1 included street light replacement in an area generally following the Mohawk Riverfront, including Downtown, the Vale Park area, and areas of Mt. Pleasant and Hamilton Hill. Phase 2 includes the remainder of the City and is anticipated to be completed in 2020. Phase 3 focuses on evaluating the REV Demonstration Project through 2021. Some of the proposed analytics to be undertaken includes gunshot detection, multi-modal traffic volume analysis, and air quality measurement (City of Schenectady, NY, 2019).

Village Of Kinderhook

The Village of Kinderhook, in coordination with CDRPC, is assessing how they can reduce costs and energy consumption, while also reducing emissions. A focus of the effort is to determine how new LED lighting can positively impact the historic Village character while at the same time evaluating preferred color temperatures (Village of Kinderhook, NY, 2019).

Village And Town Of Colonie

The Village and Town of Colonie are working with NYSERDA, NYSDOT, the RPI Lighting Research Center (LRC), CDTC, National Grid, the University

Transportation Research Center, and an engineering consultant to evaluate the public sentiment of a recent LED lighting installation along an approximately 3.5-mile section of Central Avenue (NYS Route 5) between Madison Avenue and Reber Street (Village of Colonie, 2019).

This initiative has divided the approximately 3.5 miles into five different sections for the purposes of the analysis. The online survey asked respondents to provide responses about their preferences about the new white light LED luminaires, compared to traditional sodium street lights (which produce yellow/orange light). Additionally survey questions covered visibility and safety in regard to perspectives as a both driver and pedestrian (Village of Colonie, 2019). The Town of Colonie is working with NYPA to upgrade all of its utility and customer owned street lights to LED.

City Of Albany

The City of Albany is in the process of a wholesale change in street light ownership and how their lighting is managed. As part of the Governor's Smart Street Lighting NY program that was announced in mid-2019, the City of Albany purchased its street lights from National Grid. Immediately thereafter, the City announced it was working with NYPA to install nearly 11,000 LED street lights throughout the City (NYPA, 2019).

This project will provide the City with a new asset management system to monitor and control the street light system, provide the option for localized dimming, and automatically report street light outages. New poles will also provide a power source which can be used for future smart technology upgrades and additions. (NYPA, 2019 and City of Albany, NY, 2019).

Prior to a full conversion to LEDs, according to the Mayor's Office of Energy & Sustainability webpage, the City spent/spends 57% of its overall energy budget on street lights and traffic signals (City of Albany, NY, 2019). It is anticipated that the approximately \$20M lighting upgrade project will:

- Save the City \$3.3M+ annually in energy costs
- Reduce greenhouse gas emissions by 2,850+ metric tons per year.

NYPA is financing and implementing the project and providing \$850,000 toward project costs (NYPA, 2019).



Lighting along Central Avenue (Rt. 5).
Left: LED lighting in the City of Albany, NY.
Right: Traditional cobra head lighting in the Town of Colonie, NY.
Photos by Planning4Places, LLC

City Of Glen Falls

The City of Glens Falls is actively working on a pilot program to install street lights with smart technology in the City. The proposals include ideas to dim lights that get brighter when motion is detected, the addition of parking sensors, and air quality sensors.

In mid-2019, the City received a \$50,000 NYSEDA grant and \$34,000 in “savings and rebates” from National Grid earmarked toward the installation of 128 LED lights at East Field to replace the halogen lights. The energy cost, and resulting energy savings, to light East Field was anticipated to be reduced from \$18,000 per year to \$6,000 per year (Woodworth, G. 2018, April 25).

The City’s sustainability consultant undertook detailed assessments of its infrastructure and found that the cost to upgrade street lights was more than originally anticipated. The City’s street light inventory found that they owned more street lights than previously known – 1,569 instead of 1,378. Additionally, the City was going to need to pay a surcharge to National Grid for “hand holes” needed for technicians to maintain the new lights. This was going to increase the cost of LED upgrades from approximately \$2M to nearly \$2.75M. After utilizing a \$75,000 NYPA Smart City grant and \$93,000 in rebates and incentives from National Grid, the cost to the City was estimated at approximately \$2.57M. This cost extended the length of the payback period from 11 to 14 years. This cost did not include smart technology upgrades that the City had been assessing. Three bids for the desired sensors ranged from approximately \$182,000 to \$231,000 (Woodworth, G. 2018, April 25).

Town Of Clifton Park

The Town of Clifton Park has been actively working on LED lighting upgrades for several years. In late 2017, the Town released an RFP seeking proposals to provide a performance-based energy contract to acquire existing street lighting from utility company owners and procure and install necessary upgrades to all LED lighting for street lights under the Town’s ownership. In 2018, the Town awarded a contract to a private vendor to assist with the acquisition of street lights and conversion to LED (Town of Clifton Park Board Resolution 246 of 2018).

The contract noted that the vendor guaranteed savings from energy efficiencies resulting from the use of LEDs, reduced maintenance costs and by eliminating service and maintenance charges that are assessed by utility owners. The private vendor was contracted to proceed with an Investment Grade Audit and related design work which compared the type, wattage, location and pole number for each street light facility, and compared the data with that provided by National Grid and NYSEG. The vendor provided an energy efficiency contract which included specification of replacement luminaires, GIS mapping of all fixture locations and lighting controls proposed to be installed after acquisition of existing street lights from the utility companies, and a performance-based guaranteed energy savings. An audit of existing infrastructure found that the Town had been paying for lights and poles that did not actually exist at the time (Town of Clifton Park Board Resolution 246 of 2018).

The resolution included a proposal to purchase 600 street lights and lamps (not poles) from National Grid and NYSEG. The new lights will improve maintenance efficiencies, allow for dimming, provide smart lighting controls, and provide technology to

monitor air quality, traffic and noise (Parisi, K. 2019, December 3).

The anticipated savings on energy costs was expected to be approximately 60% by converting to LEDs (\$4.5M over 20 years). The total implementation cost was anticipated to be \$1.13M paid in cash with a 6-year payback period (Town of Clifton Park Board Resolution 246 of 2018).

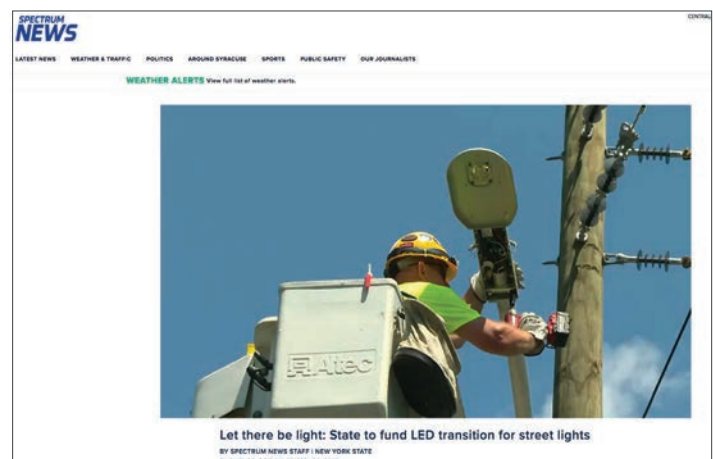
The Town came to agreement with National Grid to purchase and convert just over 400 street lights and bulbs at a cost of just over \$490,000. The anticipated payback is just over \$5M over 20 years with the conversion paying for itself in 7 years. The anticipated energy savings is 60-65% (Parisi, K. 2019, December 3).

Regional Case Study Conclusion

There is significant interest in the Capital Region to assess and undertake street light conversions for LED and Smart City technology. Communities across the Upstate Region have undertaken varied conversion approaches, most doing so in phases, but all with at least a single common goal in common – to save energy and costs over the long-term. Additional common goals include better management of street light systems, improved maintenance operations, reduction of carbon footprint, increased safety, and provision of increased data and information (through smart technology) for both government and citizen benefit. The case studies show that there is not one approach to implementing LED conversions and Smart City technology - any method of working with National Grid, NYPA, or a private vendor is possible.



Announcement Albany street light purchase from National Grid
Photo credit: Will Waldron/Times Union,12/5/2018



News article about Governor Cuomo's "Smart Street Lighting New York" program. Spectrum Local News article, published 8:26 AM ET Feb. 20, 2018 .Photo credit: Will Waldron/Times Union,12/5/2018

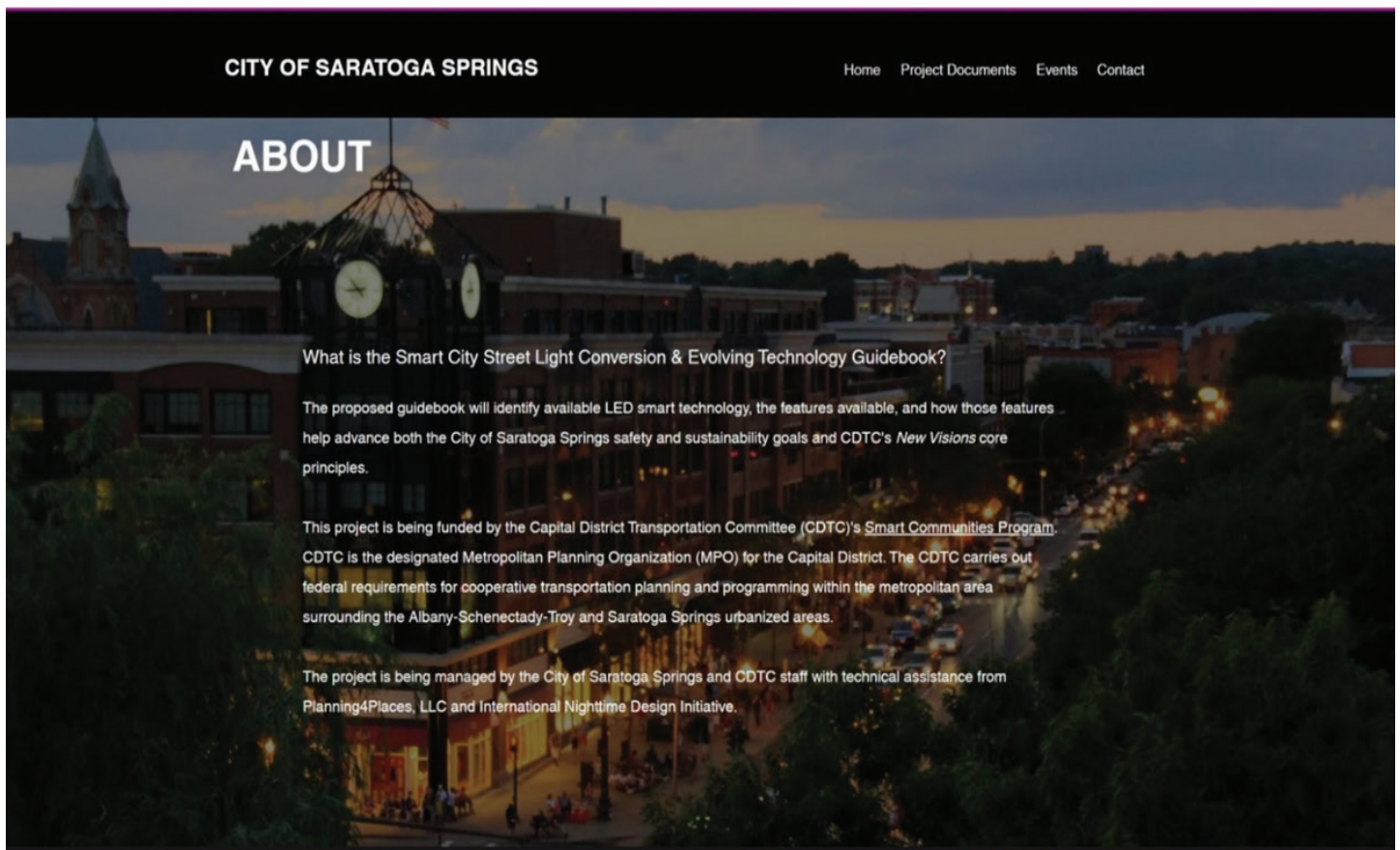


NYPA Smart City Technology Grant Program Website mast head.
Photo credit: Will Waldron/Times Union,12/5/2018

6 Appendix

Community Engagement and Website

A project website was developed to provide information about the project, share project documents, and highlight the NightSeeing™ event held in September 2019.



Project website

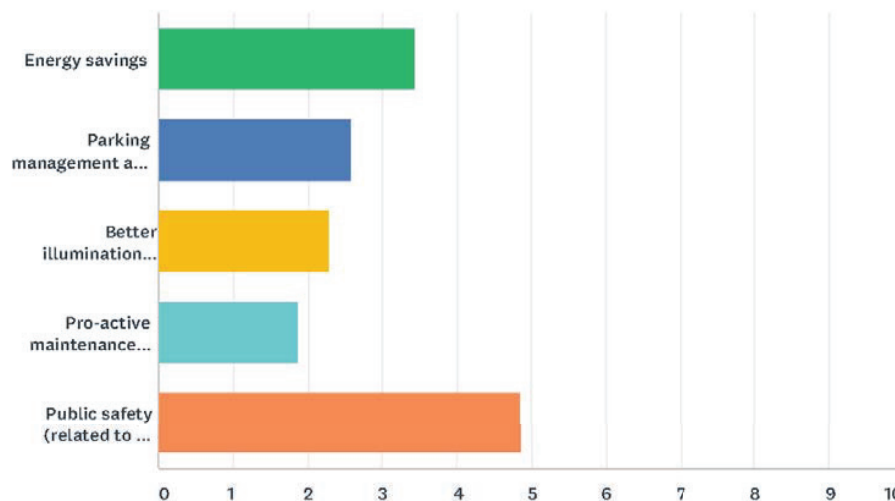
SAC Survey: City of Saratoga Springs Lighting Information and Smart Technology

A survey of key decision makers in the City of Saratoga Springs (elected officials and department staff) and members of the Stakeholder Advisory Committee (SAC) was created to help the Consultant Team understand the City's smart technology goals and to provide an overview for City Staff of cross-departmental ideas, concerns, and priorities. Priorities for smart lighting based upon survey responses, in order of importance, include public safety, energy savings, parking management and wayfinding, better illumination for after-dark activation and safety, with pro-active maintenance needs being identified as the least important.

The survey included a question regarding the ability for smart lighting to dim, brighten, tint, and color lighting. Survey respondents stated a preference for dimming (viewing it as an important priority) and expressed interest in dimming in the institutional area as well as the Downtown and in the residential areas.

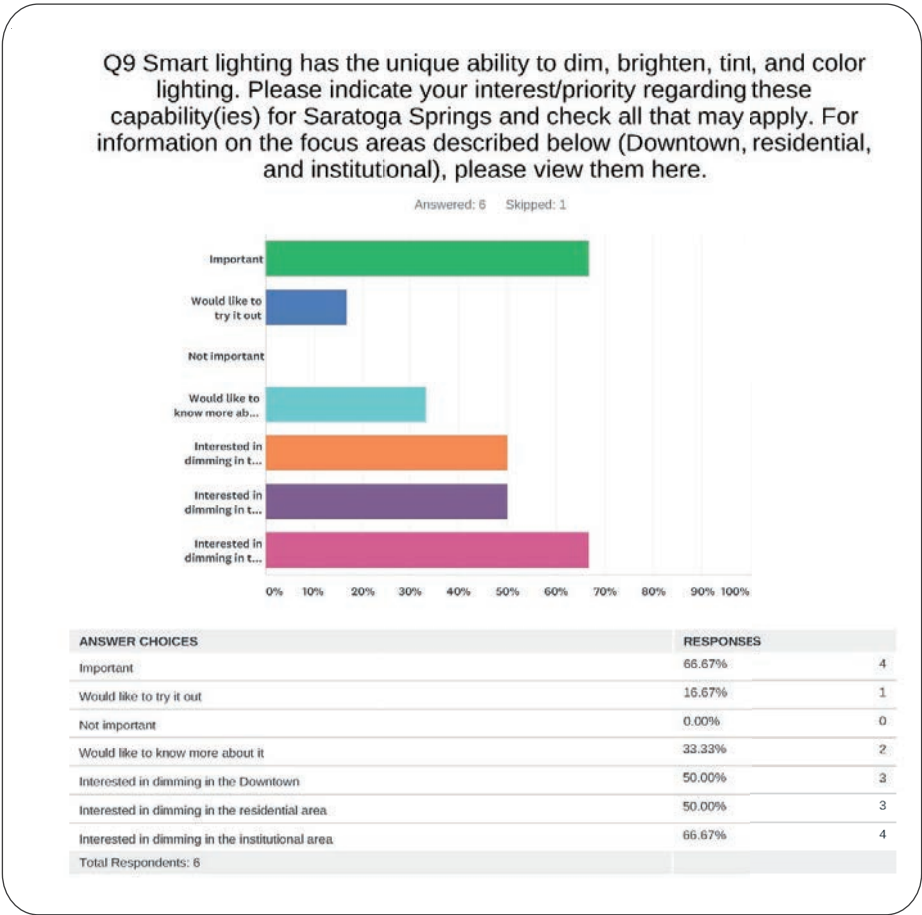
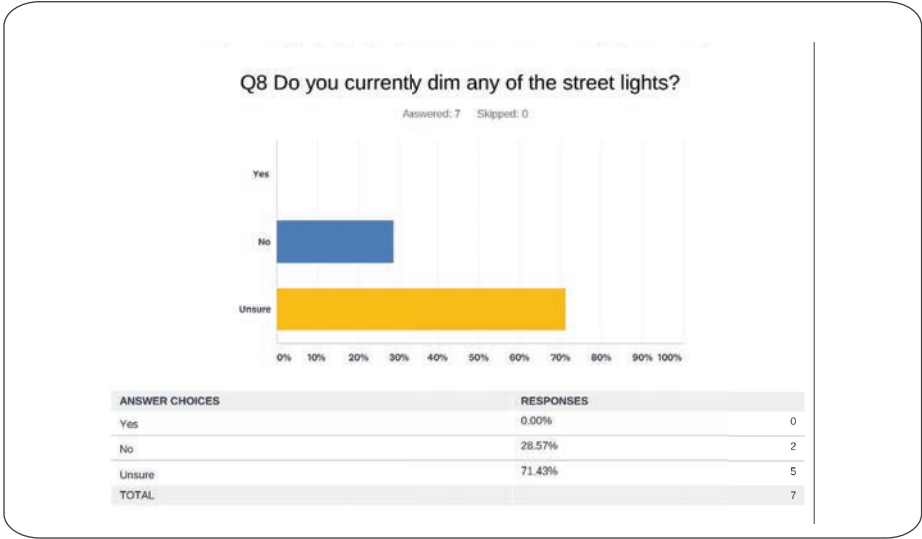
Q4 Please indicate your top priorities for Smart Lighting on a scale of 1 to 5 (with 1 being the highest priority and 5 being the lowest priority).

Answered: 7 Skipped: 0

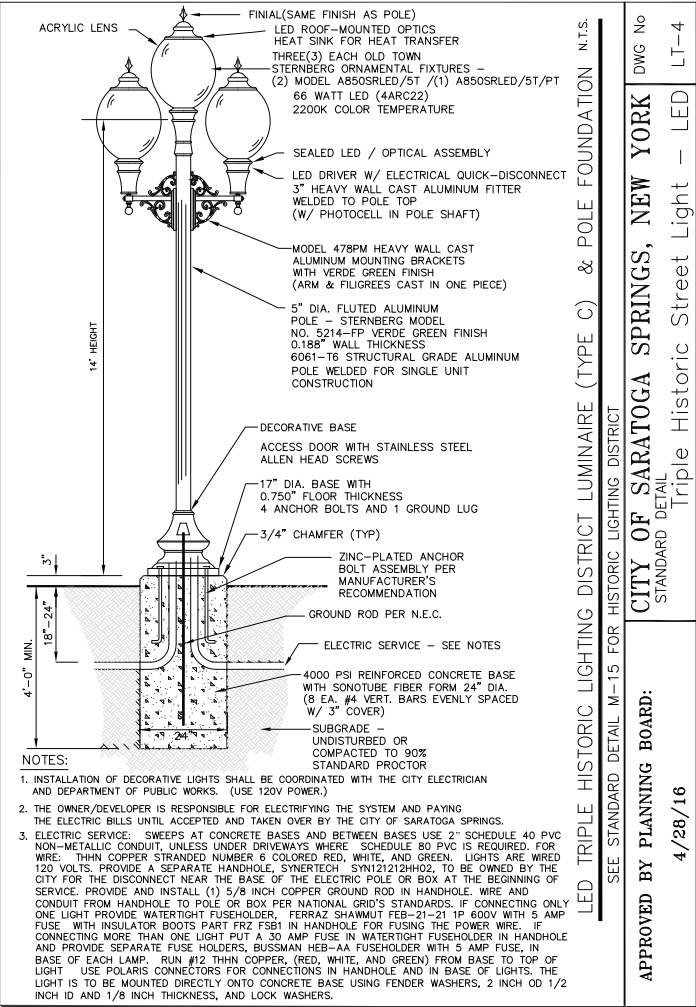


	1	2	3	4	5	TOTAL	SCORE
Energy savings	14.29% 1	42.86% 3	28.57% 2	0.00% 0	14.29% 1	7	3.43
Parking management and wayfinding	0.00% 0	28.57% 2	14.29% 1	42.86% 3	14.29% 1	7	2.57
Better illumination for after-dark activation and safety	0.00% 0	14.29% 1	28.57% 2	28.57% 2	28.57% 2	7	2.29
Pro-active maintenance (Inoperative or malfunctioning lights report back to base)	0.00% 0	0.00% 0	28.57% 2	28.57% 2	42.86% 3	7	1.86
Public safety (related to a feeling of personal security/sense of confidence and physical safety at night i.e. crosswalk lighting, lighting of sidewalks and bike lanes)	85.71% 6	14.29% 1	0.00% 0	0.00% 0	0.00% 0	7	4.86

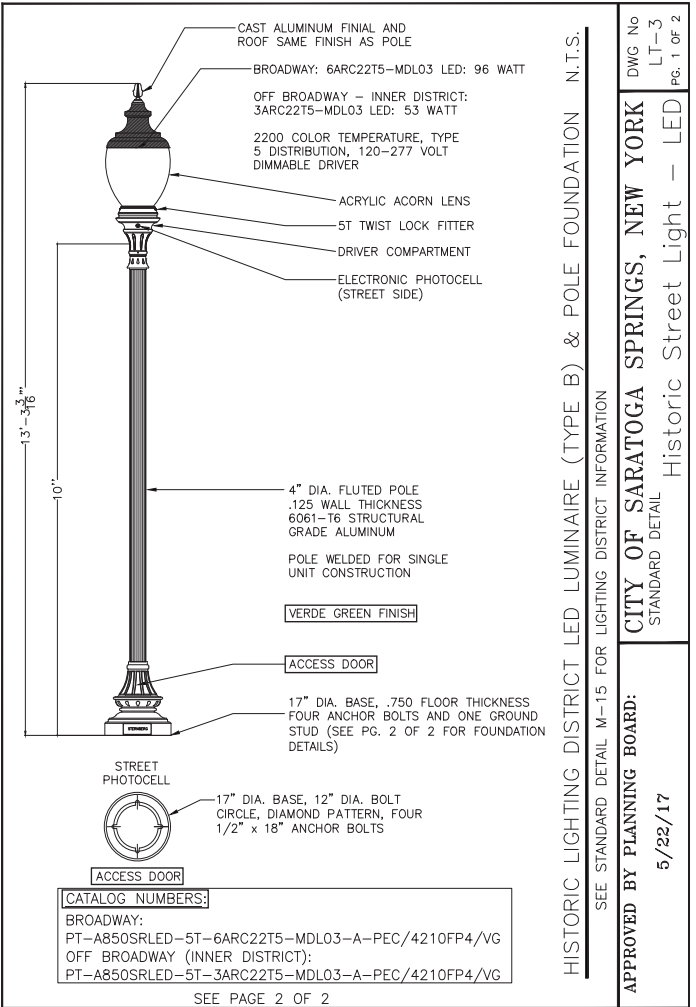
SAC Survey: City of Saratoga Springs Lighting Information and Smart Technology



Saratoga Springs Historic Lamp Post



Current Saratoga Springs Standard Detail: Triple Historic Street Light, LED version



Current Saratoga Springs Standard Detail: Historic Street Light, LED version

Smart City Street Light Technology Guidance Survey – Manufacturers

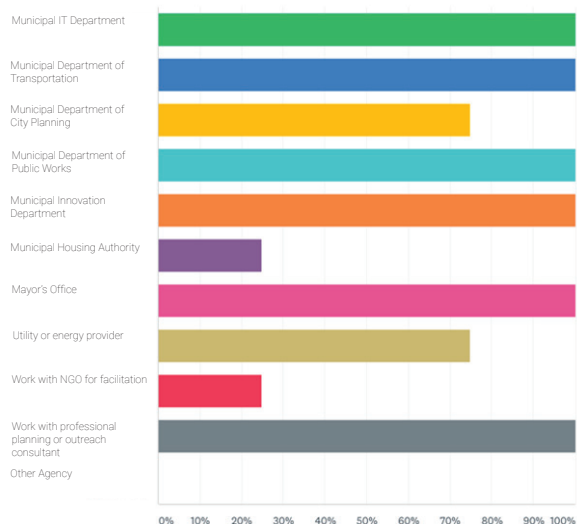
Summary:

We surveyed manufacturers who identify themselves as being in the smart lighting space, such as Signify, Cimcon, Citelum, Telensa, Felicity Smart Infrastructure, Verizon, GE Connect, and Tondo.

When asked about key competition, a consensus emerged which identified the main players in the industry. Those manufacturers who responded saw GE Connect and Signify as being the main competitors in the commercial realm.

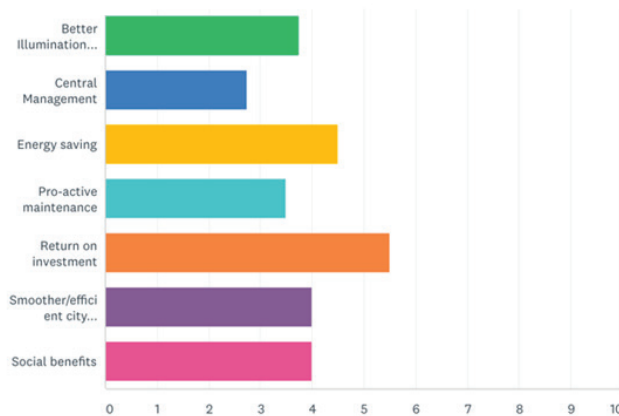
Responding manufacturers identified Return on Investment (ROI) as the most important benefit of smart lighting, with energy savings second, and smoother operations and social benefits coming in third (see graph below). When asked about their key differentiators – the factors that made them most different from their competitors – manufacturers identified their offering of turnkey services as the most significant. All manufacturers reported 100% interoperability, positive-dollar ROI, and reported on their permanent installations. However, please note, these categories have not been independently verified.

What is your smart lighting objective-setting methodology? Which stakeholders do you involve? Check as many as applicable



What are the most important benefits of Smart lighting? Rank in order of importance. (1 is highest)

Answered: 4 Skipped: 0



Communications Technology Options

TECHNOLOGY OPTIONS

Reproduced from "The Benefits of LED and smart Street Lighting. A Performance Benchmark of US Cities."

<http://northeast-group.com/reports/CityLab-Northeast%20Group%20-%20the-benefits-of-led-and-smart-street-lighting.pdf>

COMMUNICATIONS OPTIONS (IN ALPHABETICAL ORDER)

COMMUNICATIONS TECHNOLOGY

HOW IT WORKS

CELLULAR (INCLUDING NB-IOT)

There are a number of licensed low power wide area network (LPWAN) communications options offered by cellular operators. These are public networks as opposed to many of the other options which are private networks. The emerging NB-IoT standard is perhaps the most well-known. NB-IoT is ideal for lower bitrate applications such as street lighting, with costs much lower than traditional cellular applications

LORA

LoRa is an open alliance of member companies and is another LPWAN communications option

POWERLINE COMMUNICATIONS (PLC)

PLC uses existing power cables to send data so it is a "wired" rather than a wireless communications option. PLC can be used for smart street lighting but has become much less common than the wireless options available and is more often found outside of the US

RADIO FREQUENCY (RF)

- MESH
- POINT-TO-MULTIPOINT
- STAR

RF-Mesh networks have been used extensively by utilities and cities for smart metering and other IoT applications, including smart street lighting. The "mesh" configuration involves interconnectiveness between devices on the network to create a resilient, low cost network. The Wi-SUN Alliance is driving open standards and interoperability for RF-mesh devices and networks

With RF Point-to-Multipoint, instead of the "mesh" configuration, each individual device communicates back to a central tower, without "hopping" to another device. Point-to-multipoint networks typically run over licensed frequency

RF networks using Star topology use similar communications as mesh but with fewer connection points between the streetlights

ULTRA-NARROWBAND (UNB)

As its name suggests, UNB communications has a very narrow bandwidth. It is ideal for applications that generate small quantities of data, such as smart street lighting. There are a number of UNB offerings—including proprietary—such as Telensa and Sigfox

Matrix of Current Manufacturers and Technologies

Product	Website	Network Mode	Standards Compliance	Sensor capabilities for functions, such as environmental, parking, traffic	Control Interface
Acuity Brands, nLight Air	https://www.acuitybrands.com/brands/lighting-controls/nlight	Wireless	Bluetooth Low Energy BLE Proprietary IPv4 Proprietary IEEE 802.15.4 Proprietary WiFi IEEE 802.11	Yes	No standard interface reported
Autani, LLC, Energy Center	www.autani.com	Wireless	enOcean ISO/IEC 14543-3-10:2012 Proprietary IPv4 Proprietary – Other Zigbee HA Home Automation	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Eaton, LumaWatt Pro	Eaton.com/lumawattpro	Wireless	Bluetooth Low Energy BLE Proprietary IPv4	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Enlighted, Inc.	www.enlightedinc.com	Wired Wireless	Bluetooth Low Energy BLE	Yes	No standard interface reported
Hubbell Lighting, Inc., wiScape	https://www.hubbell.com/	Wireless	Bluetooth Low Energy BLE Proprietary IPv4 Proprietary IEEE 802.15.4 XBEE PRO	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
LSI Industries Airlink	http://lsi-airlink.com/airlink-synapse/	Wireless	None	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
OmniSolu Technology Inc., MeshSmart	http://meshsmart.com/	Wireless	Proprietary IEEE 802.15.4 Zigbee 3.0	No	NEMA ANSI C136.41 5 or 7-pin controller available

RAB Lighting, LightCloud	http://www.lightcloud.com	Wireless	3GPP Proprietary IPv4 Proprietary – Other Zigbee 2.0	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Telensa PLANet	http://www.telensa.com	Wireless	Proprietary	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Felicity Smart Infrastructure	https://www.felicitysi.com/	Wireless	LoRaWAN	Yes	Proprietary
Signify BrightSites	https://www.signify.com/en-gb/our-company/news/press-	Wireless	4G/5G Cellular WiFi	Yes	Proprietary
Cimcon Lighting	https://www.cimconlighting.com/	Wired Wireless	Proprietary	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Verizon Smart Cities	https://enterprise.verizon.com/products/internet-of-things/smart-cities-and-communities/	Wireless	4G/5G Cellular	Yes	NEMA ANSI C136.41 5 or 7-pin controller available

Notes:

- All information listed reflects manufacturer's claims.
- Actual performance cannot be assumed; must be verified in the field.
- Interoperability claims, even when adherence to open standards and protocols is stated, must be verified in the field.
- There is no independent organization that verifies/validates these claims.
- This list is representative. The industry is undergoing rapid changes. Several of the companies listed will likely no longer be in this industry within the next few years, while new companies will have entered the industry.
- The determination of the applicability of any of these product lines to the needs of a particular Smart Lighting project has as a prerequisite a municipality's production of detailed requirements, planning, and infrastructural support for that project.

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Federal, State, and New York State Resources

Pedestrian Friendly Outdoor Lighting

https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/2013_gateway_pedestrian.pdf

Pedestrian-Friendly Nighttime Lighting Webinar

<https://betterbuildingssolutioncenter.energy.gov/videos/webinar-pedestrian-friendly-nighttime-lighting>

Exterior LED Lighting Projects at Princeton University

<https://www.energy.gov/eere/ssl/downloads/exterior-led-lighting-projects-princeton-university>

National Grid P.S.C. No 214 - Outdoor Lighting Tariff Modifications Fact Sheet (4/2018).

National Grid LED Street Light Conversion Program Fact Sheet

National Grid Technical Assistance

<https://www.nationalgridus.com/pronet/technical-resources/technical-assistance>

National Grid Services and Tools

<https://www.nationalgridus.com/ProNet/Services-Tools?r=10&page=1&locations=Upstate+New+York&interestedIn=Lighting+Solutions>

NYPA Street Light Maintenance Program Overview

<https://nypa.gov/services/customer-energy-solutions/smart-street-lighting-ny>

NYSERDA Clean Energy Communities Program full page resource

<https://www.nyserra.ny.gov/All-Programs/Programs/Clean-Energy-Communities>

NYSERDA Clean Energy Communities Program LED Street Lights

<https://www.nyserra.ny.gov/All-Programs/Programs/Clean-Energy-Communities/Clean-Energy-Communities-Program-High-Impact-Action-Toolkits/LED-Street-Lights>

Smart Street Lighting NY

<https://www.nypa.gov/services/customer-energy-solutions/smart-street-lighting-ny>

Step-by-Step Guidance [PDF]

The slide presentation provides an overview of the Clean Energy Communities Program as well as a detailed description and step-by-step guidance for implementing the LED Street Lights action.

<https://www.nyserra.ny.gov/ny/PutEnergyToWork/Energy-Program-and-Incentives/Lighting-and-Controls-Programs-and-Incentives>

Municipal and Regional Resources

CDRPC Technical Assistance

<https://cdrpc.org/programs/sustainability/new-york-state-energy-research-development-authority-nyserra-clean-energy-communities-program>

CDTC Smart Communities Task Force Summary

<https://www.cdcmpo.org/images/advisorycommittees/smartcomm/CapitalDistrictSmartCities201806.pdf>

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Technical Resources

Illuminating the Smart Streetlighting Landscape, 2018: Industry Insights Survey Report

https://s3.amazonaws.com/dive_static/paychek/sensus_report_smart_streetlighting_smart_cities_dive.pdf

The Benefits of LED & Smart Street Lighting, A Performance Benchmark of US Cities

<http://www.northeast-group.com/reports/CityLab-Northeast%20Group%20-%20the-benefits-of-led-and-smart-street-lighting.pdf>

Glossary

A selected glossary of definitions related to the subject of these guidelines follows. Additional lighting-related terms can be found in:

- IES (Illuminating Engineering Society). (2018). ANSI/IES RP-8-18: American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting <https://www.ies.org/product/american-national-standard-practice-for-design-and-maintenance-of-roadway-and-parking-facility-lighting/>
- IES (Illuminating Engineering Society). (2017). ANSI/IES RP-16-17 Nomenclature and Definitions for Illuminating Engineering <https://www.ies.org/standards/definitions/>

Adaptive – “Smart lighting” can be programmed to adapt to surrounding environmental and social settings (also see “Responsive”).

Annunciator boards – An electronic display which can present messages intended to be viewed by large numbers of people.

Big data – Typically used to describe tools, technologies, analytics, and the results of using those tools, technologies, and analytics, related to very large datasets.

Broadband – A wireless transmission system and/or protocol that utilizes broad swaths of spectrum, typically to enhance security or increase data transmission volume.

Central control management system (CMS) – Software, hardware, and ancillary systems (including staff) that manage dispersed technological systems. Also related to “asset management.”

Connectivity – The ability of devices to communicate, generally digitally, with one another. Also related to connecting people and places.

Devices – For use in this Guidebook, sensors, cameras, switches, triggers – assets that measure and change actions are called devices.

eEnabling technologies – An electronic technology that creates an ability to perform a function.

“Internet of Things” (IoT) – An Internet of Things device is any device that communicates using the TCP/IP protocol, which is the data communications protocol of the internet.

Interoperability – The ability of multiple devices to work together as parts of a multi-device system. Typically, these devices would need to have a high degree of connectivity.

Governance - Used in this Guidebook to point to the people and policies required to make Smart Cities technology work, to be useful, to run smoothly.

Intelligent Transportation System (ITS) – Applies advanced technologies of electronics, communications, computers, control and sensing and detecting in all kinds of transportation system in order to improve safety, efficiency and service, and traffic situation through transmitting real-time information.

Machine learning – The technique by which a device analyzes inputs and produces results using artificial intelligence algorithms.

Metering – Measuring energy usage by luminaires, devices, all electrical outputs.

NEMA 7 pin connector– A receptacle with seven connectors that allows for retrofitting of existing poles to use smart technologies.

Responsive – Smart lighting and Smart City technology can be said to be responsive. Methods to make technology responsive typically include sensors and controls.

Shades of Night – A framework to categorize activity time bands and corresponding lighting levels and scenarios. A way of measuring nighttime activation (or lack thereof).

Smart – A marketing term used to describe a wide variety of technologies, generally which have computing technology within them.

“Smart-enabling” technology provisions to be “smart-ready” – Marketing concepts used to imply that the specific products being described will be compatible with future, yet-to-be-developed, “smart” devices (see “Smart”).

Smart Cities devices – Marketing term used to describe “smart” devices intended to be deployed in urban environments.

TRC – “Total Resource Cost” a test for consumer and public sector measure in regard to costs and energy conservation.

Typological areas – For this Guidebook, useful land use categories in any given city or community for the purpose of light planning, design and nighttime activation as relevant to the uses of the area.

Environmental Justice and Environmental Mitigation Analysis

Environmental Justice: Introduction

Per federal requirements, the Capital District Transportation Committee (CDTC) ensures that no person is excluded from participation in, or denied the benefits of, its metropolitan transportation planning process on the basis of race, color, national origin, sex, age, disability, or economic status. In our studies, we evaluate the impacts of transportation concepts and recommendations on these groups. Impacts may be defined as those that are positive, negative and neutral as described in CDTC's Environmental Justice/Title VI Analysis documents. The goal of these analyses is to ensure that both the positive and negative impacts of transportation planning conducted by CDTC and its member agencies are fairly distributed and that defined Environmental Justice populations do not bear disproportionately high and adverse effects.

This goal has been set to:

- Ensure CDTC's compliance with Title VI of the Civil Rights Act of 1964, which states that "no person in the United States shall, on the basis of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance,"
- Assist the United State Department of Transportation's agencies in complying with Executive Order 12898 stating, "Each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."
- Address FTA C 4702.1B TITLE VI REQUIREMENTS AND GUIDELINES FOR FEDERAL TRANSIT ADMINISTRATION RECIPIENTS, which includes requirements for MPOs that are some form of a recipient of FTA, which CDTC is not.

Data and Analysis

CDTC staff created demographic parameters using data from the 2010 United States Census as well as data from the 2010-2014 American Community Survey (ACS). Threshold values were assigned at the census tract level to identify geographic areas with significant populations of minority or low-income persons. Tracts with higher than the regional average percentage of low-income or minority residents are identified as Environmental Justice populations. Minority residents are defined as those who identify themselves as anything but white only, not Hispanic or Latino. Low-income residents are defined as those whose household income falls below the poverty line.

The transportation patterns of low-income and minority populations in CDTC's planning area are depicted in Table 1, using the commute to work as a proxy for all travel. The greatest absolute difference between the defined minority and non-minority population is in the Drive Alone and Transit categories: The non-minority population is 17.9% more likely to drive alone, slightly more likely to work at home, 9.8% less likely to take transit, and is also less likely to carpool, walk, or use some other method to commute. The greatest absolute difference between the defined low-income population and the non-low-income population follows the same trend, with the non-low-income population 19.9% more likely to drive alone and 10.6% less likely to commute via transit.

By Race/Ethnicity	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
All Workers (16+)	80.5%	7.7%	3.3%	1.2%	3.6%	3.7%
White Alone Not Hispanic or Latino	83.3%	7.1%	1.8%	1.1%	2.9%	3.9%
Minority	65.4%	10.5%	11.6%	2.1%	7.5%	2.9%
By Income	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
At/Above 100% Poverty Level	82.3%	7.6%	2.7%	1.2%	2.7%	3.6%
Below 100% Poverty Level	62.4%	9.7%	13.3%	1.9%	9.2%	3.5%
By Age	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
16-19 Years	58.4%	14.6%	6.0%	3.1%	15.6%	2.4%
20-64 Years	81.3%	7.5%	3.2%	1.2%	3.2%	3.6%
65+ years	81.7%	5.3%	2.2%	0.9%	2.3%	7.6%
By English Ability	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
Speak English Very Well	71.5%	11.0%	4.9%	1.8%	6.8%	3.9%
Speak English Less than Very Well	68.0%	13.2%	5.6%	2.2%	7.6%	3.4%
By Disability Status	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
Without any Disability	81.1%	7.4%	3.0%	1.2%	3.6%	3.6%
With a Disability	69.7%	11.6%	7.6%	2.2%	4.2%	4.7%
By Gender	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
Male	80.8%	7.3%	2.9%	1.5%	4.0%	3.6%
Female	80.3%	8.0%	3.7%	1.0%	3.3%	3.7%

Data: CDRPC, from American Community Survey 2014 5-year estimates, tables S0802, B08105H, B08101, B08122, S0801, B08113, and S1811. Other includes taxi, motorcycle, and bicycle.



MAP-1

Map 1 provides an overview of the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook focus areas. The Guidebook focus areas included in the Environmental Justice area based on the study area Census Tracts having a higher than regional average percentage of minority and low-income residents. The Environmental Justice population is within the downtown focus area and adjacent to both the institutional focus area and residential focus area.

Consideration for including minority and low-income residents in the planning process was given in the following ways:

- The Internet was used to display and advertise information about the study.
- Social media was used to provide information and input opportunities.
- An interactive NightSeeing™ walk was held and open to the public.
- Public comment was accepted throughout the study process.
- Final products will be posted to CDTC's website, the Saratoga Springs website and on social media.

Conclusion

The Municipal Smart City Street Light Conversion & Evolving Technology Guidebook recommends upgrading street lights in different areas of Saratoga Springs with light emitting diode (LED) lighting technology. The proposed LED lights provide for lower energy consumption, better quality lighting for open and public spaces at night, and improved safety for nighttime travelers, including those who work at downtown businesses and visitors traveling to downtown attractions.

CDTC defines plans and projects with a primary or significant focus on transit, bicycling, walking, or carpool as being "positive." As the primary purpose of the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook is to recommend lighting strategies using LED technologies improve areas in downtown, institutional, and residential areas in Saratoga Springs, which includes Environmental Justice populations, it has been determined that the Guidebook will have a positive impact on the affected populations. The Guidebook makes recommendations for improving lighting on roadways, sidewalks and street crossings to increase visibility and improve safety which will provide positive benefits for Environmental Justice populations in the focus area(s).

Environmental Mitigation: Introduction

Per federal requirements, the Capital District Transportation Committee (CDTC) undertakes an Environmental Features Scan as part of its metropolitan transportation planning process. In our studies we encourage smart growth as well as investment and development in urban areas as a method to protect natural resources. Smart growth policies also help to protect rural character and open space, and protect quality of life in the Capital Region. The Environmental Features Scan identifies the location of environmentally sensitive features, both natural and cultural in relation to project study areas. Although the conceptual planning stage is too early in the transportation planning process to identify specific potential impacts to environmentally sensitive features, the early identification of environmentally sensitive features is an important part of the environmental mitigation process. It should also be noted here that as specific projects advance through the project development process, the applicable NEPA and SEQRA regulations requiring potential environmental impact identification, analysis and mitigation will be followed by the implementing agencies as required by federal and state law. CDTC is not an implementing agency.

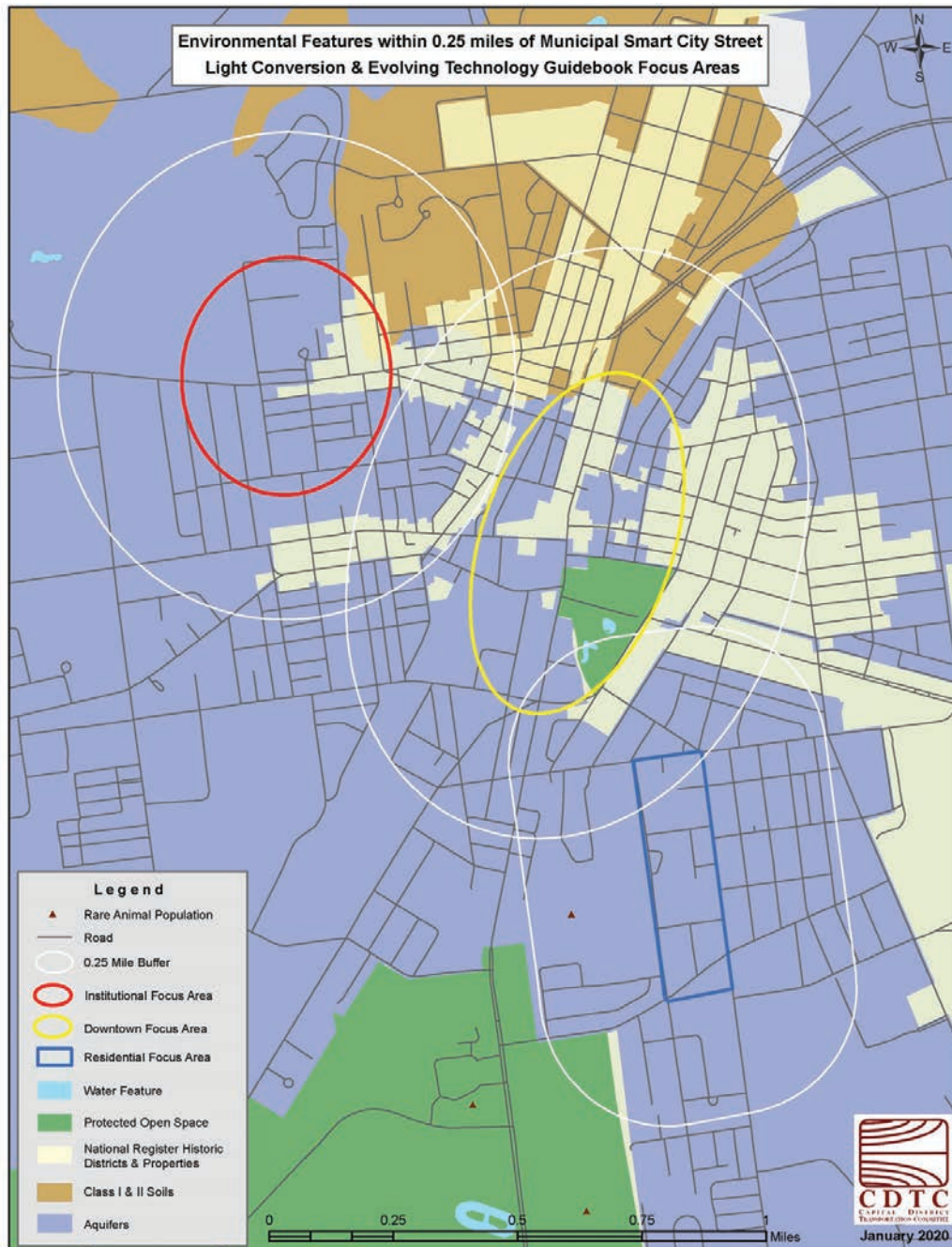
Data and Analysis

CDTC staff relies on data from several state and federal agencies to maintain an updated map-based inventory of both natural and cultural resources. The following features are mapped and reviewed for their presence within each study area as well as within a quarter mile buffer of the defined study area boundary.

- sole source aquifers
- aquifers
- reservoirs
- water features (streams, lakes, rivers and ponds)
- wetlands
- watersheds
- 100 year flood plains
- rare animal populations
- rare plant populations
- significant ecological sites
- significant ecological communities
- state historic sites
- national historic sites
- national historic register districts
- national historic register properties
- federal parks and lands
- state parks and forests
- state unique areas
- state wildlife management areas
- county forests and preserves
- municipal parks and lands
- land trust sites
- NYS DEC lands
- Adirondack Park
- agricultural districts
- NY Protected Lands
- natural community habitats
- rare plant habitats
- Class I & II soils

Conclusion

The Municipal Smart City Street Light Conversion & Evolving Technology Guidebook recommends lighting strategies using available LED technologies to improve the quality of Saratoga Springs at night time. These lighting features will have no impact on environmentally sensitive features within, and in close proximity to, the focus areas. These include: water features, open space, National Register Historic Properties (District), Class I & II Soils, and aquifers.



MAP-2

Map 2 provides an overview of the environmentally sensitive (cultural and natural) features located within the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook focus areas as well as within a quarter mile buffer of the defined study area boundary.

Public Comments

During the 30-day public comment period, five comments were received. Most of the comments related to recommendations and preferences for how the City of Saratoga Springs could consider implementing LED and smart lighting upgrades. Some comments related to differences of opinion on some of the context of the Guidebook, while others related to specific elements of the Guidebook that were generally provided to the Consultant Team during the Study Advisory Committee review period. The Guidebook is intended to be a general overview of issues related to LED conversion and smart lighting. All comments have been filed with CDTC and are available for review upon request.

Clarifications were made to the extent feasible under the scope of work for the development of the Guidebook related to: the installation options for smart lighting, tariffs, Dark Sky terminology, and elements of the City of Boston case study. Edits for clarity were made on Pages 12, 28, 30, 33, and 46.

