Street Light Audit and Acquisition Report

Prepared by

LightSmart Energy Consulting

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TOWN OF STOCKBRIDGE AUDIT and ACQUISITION REPORT
September 2021
Prepared by
LightSmart Energy Consulting, LLC

At the request of the TOWN OF STOCKBRIDGE, LightSmart Energy Consulting LLC conducted an audit of all streetlight locations within the boundaries of the Town of Stockbridge, "Town", to verify the existing wattages and collect other asset details including GPS coordinates. The audit details were then compared against the billing details of each of the billed entities to determine the accuracy of the billing.

In addition to the audit findings this report will detail the costs and savings associated with the acquisition of the lights, and their conversion to LED technology and suggest an organizational structure for managing the lights once owned by the various political entities that will both meet their needs and the requirements of NGRID to permit the acquisition as provided for under Massachusetts General Law 134 section 34A

Audit Findings

The audit revealed that overall the inventory information supplied by NGRID was reasonably accurate. Two hundred and thirteen lights were audited of which 7 were listed as inactive that are private lights. We found five lights listed that did not exist -Train Hill Road pole 4, Averic Road Pole 1 (this pole was new so it appears it was replaced but NGRID did not restore the streetlight), Hawthorne St pole 2, Glendale Road pole 1, and Interlaken Road pole 1422. There were two streets listed on the inventory that were incorrect-River Road and Furnace Road. Two lights listed on Furnace Road were actually on Apple St. River Road is now Housatonic Court and North Housatonic Court. On Main Street two poles were tagged with the number 1 and in addition there are more lights on Main then listed on the inventory. Several of these appear to be very new aluminum poles. There is a 50w light on one of the older green metal poles that would ostensibly be pole 2 in the sequence but is not numbered by the entrance to Bidwell Park. The inventory shows this as a 100w light. There are no 50w lights listed on the inventory on Main Street. There is a wooden pole number 5 listed as being in front of the Town offices but it no longer exists. Pole 1 on East Main is listed as a metal pole underground fed but it is in fact a wooden distribution pole. This means the Town is likely charged for the metal pole that is not there. We found a number of locations in the Town where there was no cellular service and the GPS signal was poor. The information was recorded and we applied the NGRID location data if it was available or manually plotted these locations. Finally there were evidently many lights that are not working and have not been working for many years that the Town is paying for. This was based on observations as to their overall condition and not based on a night time visual inspection. Half of the lights were

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the old Admirals Hat fixtures that have not been used since the 1920's. They are not labeled so there is no way to determine if the listed wattages are correct. Another 33 lights are the mercury vapor lights than have not been used since the late 1980's. We did find two lights on Park Street listed as 50w HPS that are in fact 100w HPS (Poles 2 and 9) and one 250 watt fixture on Main Street (Pole 2) that is actually a 100 watt fixture.

The table below summarizes the results:

Table 1. Audit vs Inventory

Fixture	Inventory Counts	Audit Counts
LUM HPS RWY 100W	18	21
LUM HPS RWY 250W	20	19
LUM HPS RWY 50W	34	32
LUM INC RWY 105W	104	101
LUM INC RWY 205W	1	1
LUM MV RWY 100W	23	22
LUM MV RWY 175W	5	5
LUM MV RWY 400W	1	1
No Light	0	5
Grand Total	**206**	**207**

Preliminary Design

The Town's lighting is at best mostly very old and with a portion that is not currently working. This is somewhat concerning as the condition of the equipment may drive up conversion/upgrade costs. The Town does not appear to be committed to retaining the old Admirals Hat incandescent fixtures but is willing to move to the more modern LED fixture.

The overall design goal is flexibility and simplicity while providing light levels that meet or exceed existing levels without over lighting. The design process is to look at each street and each light and assign the appropriate high pressure sodium wattage for that location. Once that is done it is a simple process to substitute the correct LED to replace the assigned HPS wattage. Examining the types on lights on each street it would appear that there are a significant mix of lights, wattages and types but if reviewed from the perspective of general lumen output and nature of the road this greatly simplifies the design recommendation leaving only the below listed streets where we need to identify if the mix of wattages is appropriate based on the conditions at that site. These are listed on the following page.

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Table 2. Multi-wattage Streets

Street Name	HPS 50W	INC 105W	INC 205W	MV 100W	MV 175W	HPS 100W	HPS 250W	MV 400W	No light	Grand Total
EAST		6		1	1		1			9
EAST MAIN		5		1			1			7
GLENDALE	2	19	1	6		1	1	1	2	33
MAIN	2					11	8			21
PARK	1	1			1	2				5
SOUTH	1						4			5
WEST STOCKBRIDGE		2		2		1	2			7

It is important to note that from a lighting perspective the lamps highlighted in yellow can all be treated as the same. If the utility were to convert these to high-pressure sodium lights they would be replaced by a 50w HPS fixture. The 50w is the predominate HPS fixture for residential streets and rural areas in MA. Both the mercury vapor and incandescent all produce less overall illumination than the 50w HPS lamp. Our goal is to have all lighting on a street be the same except where something different is justified. This simplifies both the project and future maintenance of the lights as well as providing uniformity. For example if we look at East Street, the only light there we need to consider is the one 250W HPS fixture. This light is the first light at the intersection with Main and that section of Main is a busy Commercial area and predominately lit with 250w lights, so that light on East street is appropriate for the location.

In this analysis it is important to keep in mind that the recommendations are not based purely on attaining IESNA, (Illuminating Engineering Society of North America), now called IES, (Illuminating Engineering Society) recommended average luminance values on the pavement. While IES guidelines are useful they do not properly address the current situation in communities but rather apply to new construction. IES further fails to account for the way the human eye perceives differing color rendering and color temperature lights. Streetlights in a community are located not based on some thoughtful design but, rather, where the utility poles happen to be. In addition, communities cannot afford the cost of trying to achieve these guidelines given the existing conditions and the cost of moving lights, adding lights and poles, etc. Determining changes is an exercise in looking at existing lighting levels and making reasonable improvements and adjustments based on multiple factors besides just recommended luminance levels. There is no legal requirement to light roadways and you should avoid adopting any form of standards that could create a legal liability if those standards are not being met. Lighting provides a perceived sense of security, so where a community is trying to promote commercial activity, good lighting is important. Hence the downtown area and the areas

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peripheral to it should be well lit to attract both foot traffic and retail enterprise and to promote growth of the area.

The review of the higher wattage lights shows that in most cases they occur at busy intersections and therefore are justified. Main Street has a mix of 100w and 250 watt lights and a couple of 50w lights. The majority of the 250w fixtures are between the Town Offices and South Street The lights are closer together in this same zone. Outside of that they are 100w fixtures. We have two choices here. Stay with the 250w Equivalent fixtures from South Street to the light at the cross walk in front of the Town Offices and use the 100w Equivalent lights outside of that area or make them all the same at a 150w equivalent level. Making them all 150w should provide adequate lighting especially if the trees along Main were trimmed back away from the lights and use slightly less electricity. I believe the overall ambiance of area would be improved. An option would be to install a sample of each and then make a determination. The final by street listing with adjusted to HPS lights is as follows;

Table 3. Design Recommendation

Street Name	50w	100W	150w	250W	Grand Total	Higher wattage Locations
AVERIC	4				4	
CASTLE HILL	5				5	
CHERRY	7				7	
CHERRY HILL	7				7	
CHRISTIAN HIL	3	1			4	Pole 1 100w intersection
CHURCH	9				9	
CLARK	1				1	
EAST	8			1	9	Pole 1 250w intersection
EAST MAIN	6			1	7	Pole 1 250w intersection
ELM	0	4			4	
FURNACE	4				4	
GLENDALE INTE	28	2		1	31	Pole 194 250w Pole 203 100w
GLENDALE MIDD	8			1	9	Pole 31 250w intersection & rr crossing
GOODRICH	11				11	
HAWTHORNE	2				2	
HILL	5				5	
ICE GLEN	5				5	
INTERLAKEN CR	1				1	
LAUREL	2				2	
LEE	1				1	
LINCOLN	2				2	
LUKEMAN	3				3	

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Street Name	50w	100W	150w	250W	Grand Total	
MAHKEENAC	3				3	
MAIN			21		21	
MOHAWK LAKE	2				2	
OLD STAGE	1				1	
PARK	5				5	these are set back
PINE	4				4	
QUIETKNOLL	1				1	
RIVER	5				5	
SERGEANT	2				2	
SHAMROCK	2				2	
SOUTH			5		5	
TRAIN HILL	0				0	
VINE	3				3	
W STOCKBRIDGE		6		1	7	pole 20 250w
WALLACE	1				1	
WILLIAMSVILLE	1				1	
WILLOW	1				1	
YALE HILL	4				4	
Grand Total	157	13	26	5	201	

Acquisition Economics

Streetlight utility billing is based on a mathematical formula, not metering. The energy usage is calculated based on an assigned number of hours in each month and the total wattage of each fixture. As an example, the 50w HPS fixture is rated at 59 watts (lamp plus ballast load) and the utility assumes 4175 operating hours per year. The monthly operating hours assigned reflect the varying dusk to dawn times so December has more operating hours than June. Based on 4175 operating hours the 50w HPS lamp consumes 255 kWh per year. This is used to calculate the supply energy costs and the delivery energy costs. In addition, the utility charges a fixture fee that covers their cost of maintenance, depreciation expense and overall approved profit levels. The current 50w HPS fixture charge is $91.32 per year. This charge disappears when the Town purchases the light from the utility. The total cost for this fixture is $91.32 + 255 x $.09850 energy supply) + 255 x $.05191 (distribution delivery) = $129.67 annually. If the Town owned this light this cost drops by $91.32 but the distribution rate goes up to $.09729 and the Town is responsible for maintenance. Maintenance is typically less than $20 per light per year on average for a HPS system. If this light is changed to an LED equivalent it will have a ten year warranty and the annual cost will be $26.70 per year (incl maintenance) verses the utility owned cost for the 50w light of $129.67.

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Conversion to LED technology carries with it two major benefits. The first and most obvious is the reduction in energy usage. To achieve the same perceived lighting level, the 70w (84 total billed watts) HPS lamp can be replaced by a 17-22w LED. The second benefit is the HPS lamp has a mean time to failure of 24,000 hours or 6 years while the LED has a ten-year warranty and an expected life of over 100,000 hours or 23 years. This significantly reduces the maintenance costs. The current lighting system consumes 106,100 kWh per year based on the billed counts and wattages. Conversion of the system to LED technology would reduce the energy usage by approximately 87,070 kWh per year saving $11,009.00 for the energy portion and $33,892 on the fixture charges and qualify for a $21,525 incentive from NGRID to make these energy efficiency improvements. A total savings of $44,901 before deducting maintenance which is discussed below.

LED Technology

LED technology is not new but the ability to produce white light with good color rendering characteristics is relatively new. The DOE tested some of the earliest LED streetlights in 2007 as part of their CALiPER 7 studies (January 2009). These fixtures showed a wide range of efficiencies 19-33 lumens per watt verses an HPS lamp at 56 effective lumens per watt and were quite expensive. They did exhibit greatly improved color rendering 68-74 CRI (Color Rendering Index-true color is 100) verses the HPS lamp at a CRI of 21. The importance of this is that the human eye perceives a higher color rendering source as brighter on a per lumen basis. So using a high color rendering source you can use less lumens and therefore less watts to achieve the same perceived brightness. In 2010 LightSmart did its first LED project in Berlin PA and the fixtures cost $466 each. That same fixture today that is producing over 150 lumens per watt costs less than $150. The other important LED development has been the ability to produce warmer color temperature light without a significant sacrifice in fixture life or fixture efficacy. Generally the public prefers the warmer color temperatures with less blue content. The first LEDS had a Kelvin temperature of 6000 °K (very blue white) with an option to go to 4300 °K but with a 15% reduction in efficiency and a 20% reduction in life expectancy. Today those differences are less than five percent. Experience has shown the higher blue content lights have greater adverse glare complaints than the warmer colors. Overall studies have shown the optimum color temperature for object recognition and reaction times is the 4000 °K range but the AMA and Dark skies associations have recommended the 3000 or lower Kelvin for other reasons. LightSmart has installed both and find the differences are subtle and if properly designed the differences are barely noticeable. Some communities such as Medfield have chosen to use the 3000 °K in the neighborhoods and the 4000 °K lights on the main thoroughfares.

Networked Systems

The ability to dim LED lights and their instant on off characteristics and the information age has led to streetlight photo controls becoming intelligent controls that the user can communicate with to monitor the lights condition, change its output, measure its energy consumption and potentially connect to other ancillary devices to operate on the same network. These systems have demonstrated the ability to work with weather monitoring, gunshot detection, traffic

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monitoring, license plate and facial recognition, cameras, pedestrian activity level monitoring to mention a few. Utility companies such as Florida Power and Light have used these streetlight intelligent controls on the same frequency as their AMI meters to improve the overall network. Unfortunately, there are no standards in place as of yet to make all of these systems interoperable. So in choosing the company one must take into account many factors to ensure they will be in business to be able to support their systems over the long haul. The City of Cambridge selected the company Lumawave for their networked system and today Lumawave is out of business. Generally, we recommend looking to systems employed by major utility companies and well known companies with a long strong financial history.

These systems work in one of three ways.

1. Mesh network-each device communicates with a nearby device which relays the information. A series of Gateways are installed that gather the information from multiple devices and relays it back to the client vial hard wire or fiber connection or wireless transmission. Each of these control nodes has limited range (1500 feet or less) and do rely on minimum densities or added relays to work. They typically operate on unlicensed frequencies such as 2.4 gHz or the 900 mHz bands.
2. Star and Hub systems-These systems have a central communication tower that communicates individually with each control node. These devices frequently are on licensed frequencies and can have ranges of fifteen miles or more. Their advantage is if a node is down it won't affect the network as would be the case if a single critical node to the path to the gateway failed. The Town would likely require three Towers.
3. Wireless-Recently Verizon has entered the control node space. They are using licensed frequency bands that are no longer used as they shift to 5G communications. The advantage of this system, like the star and hub approach, is that you can install as many or few controls as you desire and not be reliant on a mesh providing greater customization capability. These systems do not require gateways or communication towers, just good cellular signals. In addition, Verizon has the ability to provide up to HD camera capability as well as support a number of other options. Other cell companies are now entering this market

The other consideration in selecting a network provider should be their investment in the added capabilities. The true value of these systems is the ability to use them for multiple community service needs. The current economic benefits of a control network is limited primarily to outage reporting, dimming energy savings and increased energy efficiency incentives for diming. Unfortunately, these do not offset the increased annual operating and maintenance costs associated with ongoing network and software fees. NGRID will provide additional incentives for dimming the lights after hours. Currently some 25-30 communities are dimming their lights by 50% from 11PM until 5 AM daily including for example the City of Providence. To date not a single citizen has called in to ask if the lights are being dimmed. 50% dimming is barely noticeable to the human eye. In fact, the average human cannot detect up to 30% dimming. This results in an added 26% energy savings. What would this mean for Stockbridge. Converting the system to LED technology would reduce the energy consumption by 86,100 kWh from 106,100 kWh to 19,949 per year. Diming would reduce this by another 4987 kWh which, at today's

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energy rates, would save an additional $922 annually and qualify for $1,246.75 in additional incentives. However, the annual network and software fees would be roughly $3,500 per year.

There is another alternative to the control network to provide the dimming savings and that is the Dimulator photo control. These are manufactured by a Massachusetts company, Sunrise Technology, in Raynham Massachusetts. They can be programmed to dim on any desired schedule and thereafter operate autonomously. They cost about $35 more than a conventional long life photocell but have no ongoing costs post installation. LightSmart has employed probably 50,000 of these devices without a single failure. The economics of the Dimulator option are more compelling. The added project costs for the 201 lights would be $7,035 but they would qualify for an added $1,246.75 in incentives lowering the added costs to $5,788.25 and would generate an additional $922 in annual energy savings for an ROI of 6.27 years. This of course improves as energy costs increase.

As a minimum, we would recommend the fixtures should be control ready so that if at any time in the future the Town wanted to add controls they could. Therefore, they need to have the zero to ten volt dimming drivers and the ANSI 135.41 seven pin photocell receptacle. Second, given the likely increase in energy costs, we believe the investment at this stage in the Dimulator is a good and wise investment. Thirdly, we believe purchasing fixtures with internal adjustability to change their output will provide simpler maintenance and greater flexibility for the Town. LED's can be purchased that provide a range of outputs based on an adjustable internal selector. The same fixture can have multiple applications simplifying repair stocks and maintenance operations and the ability to respond easily to any citizen requests for more or less light. This approach provides the future proofing to be able to later add controls and to maximize their potential benefit. The selection of color temperature and glare reduction is far more subjective. The public tends to prefer the warmer color temperatures but studies show overall visibility is slightly better under the slightly cooler temperatures.

Maintenance Costs

The Town assumes maintenance when they take over the streetlights. Most communities have employed local contractors for this work. These contractors must meet certain qualification standards in accordance to the License Agreement the Town will sign with NGRID. The Town would have number of options for this maintenance. The most obvious and optimum solution would be to partner with Greenfield who has a contractor already in place. Other potential neighbors will include, Gill and Buckland. Secondly, if there is a local qualified electrical contractor, the Town could employ that person. Thirdly they could look to a nearby municipal electric companies. As an example, Paxton Municipal Light Department has provided these services for Spencer. Lastly the Town of Amherst has provided these services for Erving using their in-house electrician and bucket truck.

The amount of work and costs associated with an LED system is small. Typical failure rates are less than one percent. The Town might receive 8-10 outage reports per year. In addition, when the utility replaces a pole the Town will be responsible to relocate their light to the new pole. Thirdly storm damage-once the utility completes their repairs then the Town will need to

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reinstall lights on any replaced poles that previously had a light. The cost of a typical call out is $200 to $375 given the location of Stockbridge relative to a contractor. A replacement mast arm with a new fixture can be $400 to $500 installed. Keep in mind the fixtures and photo controls are warranted so no material costs for failed fixtures or controls aside from the cost to exchange the failed unit for a replacement. As part of the initial procurement we include some spares so that repairs can be timely and used spares replaced through the warranty process. Any of the contingency funds not used can be carried over to the next year and supplemented as necessary. The Town might expect maintenance costs of around $2,000 per year for routine matters and should have an additional contingency of $1000 for emergencies or unanticipated issues. This contingency may need to be increased if as part of the purchase the Town acquires any underground wiring. The Purchase and Sale will include any underground wiring that is solely for the purpose of the lighting. If it is combined with distribution wiring the utility retains ownership.

Cost and Savings Summary

The table on the following page summarizes the discussion above and includes estimated conversion project costs. Please note these are estimates based on recent bids in Eastern Massachusetts and final costs may vary from these. The one unknown is the condition of the system. Given the number of incandescent fixtures which have not been installed since the 1920's it is very likely that the internal wiring will be in poor condition and many of the mast arms may need to be replaced. We would recommend hiring an independent electrician to do a spot examination of the wiring to determine its condition prior to purchase. I believe we should assume at least half of these need new mast arms and all will need rewire. Based on this the costs will assume 50 new mast arms with wiring at $450 each and another 50 rewires at 485 which includes the replacement compression fittings-total add of $26,750. The removal of some fixtures will reduce project costs but may incur a cost of removal. Given that so many lights are not likely working now and have not been for some time the Town may decide they should not be purchased. The terms for this would need to be negotiated with NGRID to determine the optimum solution for the Town. If the Town is contemplating this then there needs to be a public process to develop the list of removals. If the Town determines to remove a light a citizen may choose to take responsibility and pay for it. The Town already has 25 such lights.

The table does not account for the purchase price of the system. The vast majority of the system is fully depreciated. The unknown is the underground fed metal poles as well as that there are three new underground fed aluminum poles with lights on Main Street which are expensive to install that will certainly have value. The hope is that the excess depreciation of the older lights will offset those costs. Depending on the number the Town gets from NGRID, there may be some room for negotiation.

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Table 4. Cost and Savings

	Current	Community Owned As Is	LED-Photocell	LED-Dimulator
Fixture Charges	$33,892.36	$0.00	$0.00	$0.00
Delivery/Supply Energy Cost	$14,688.40	$19,530.37	$3,658.42	$2,707.73
Maintenance Cost	$0.00	$15,000.00*	$4,000.00	$4,000.00
Total Operating Costs	$48,560.76	$34,530.37	$7,658.42	$6,707.73
Savings	**$0.00**	**$14,030.39**	**$40,902.34**	**$41,853.30**
Project cost	N/A	Purchase price?	**$52,606.00**	**58,837.00**
System Repairs	N/A	Included above	$26,750.00	$26,750.00
Incentive	N/A	N/A	$21,525.00	$22,447.00
Net Project Cost	N/A	N/A	$57,831.00	$63,140.00
Ten-year savings*		$203,303.90**	$351,192.40	$355,393.00
ROI	N/A		1.41 Yrs	1.51
		*Assumes rewires etc.	Major repairs in project costs	Major repairs in project costs

*Net of Project costs **Assumes three years of higher maintenance costs and then reduced costs for he remaining seven years

As can be seen from Table 2 the highest overall long term savings come from the Dimulator option even though the initial ROI is slightly longer. It is also important to understand the above figures are estimates only. In the column labeled “Community Owned As Is” I have included a significant expense for maintenance. The assumption is that once the Town owned the lights there might be a push to restore all lights to service and during the course of that work some percentage of the lights would require rewire and or mast arm replacement. The license agreement also states that the Town is required to install a fuse assembly when a light is serviced with the objective that over time all lights would have a fuse installed. Absent a detailed inspection of some percentage of the lights to get a sense of the overall condition of the system it is not possible to accurately predict the quantities that may require extensive repair or rewire. During the audit we identified only a very few mast arms that were damaged or not serviceable. Many were rusted but still serviceable.

The illustrated project costs do not include the higher cost low glare fixture option which would add approximately $20-25 per fixture to the project costs. Also not considered is the purchase price of the system as it is currently unknown. Also, keep in mind if the Town were to order the removal of some fixtures where they are not needed the utility may charge for this service and would still collect any unrealized depreciation for those fixtures. Consequently, the purchase price may not change as it represents the unrealized depreciation from the system.

The savings are so significant that even if the Town were to replace the vast majority of the mast arms and wiring The return on investment would still be quite good-under five years.

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Project Financing

These projects can be financed through Bonds or Tax Exempt Municipal Lease financing. Lease financing previously did not require a two thirds vote of the town meeting but several years ago that apparently was changed. Never-the-less tax exempt leases are at very competitive rates with Bonds and have no up front costs nor any early termination penalties. They are paid out of the savings and can be set up to streamline the vendor payment process. They will require approval of the governing body. Consequently, if a tax exempt lease is contemplated, it is important to have the voter approval in advance. To that end Town meeting should approve entering into a lease or borrowing at the discretion of the Town based on the approach that would be most beneficial to the Town for the purpose of this project not to exceed $100,000.

The Town can seek Green Community funds but these have certain restrictions that may not cover the needed repairs. The balance of the costs not covered can be from borrowed monies paid through the savings. There are numerous approaches available including deferring some of the replacement costs over time. As an example GC funds cover the full cost of the project except the repair work. That leaves the grant from NGRID to be applied towards that work. By only doing the absolutely essential work during the project and the balance over a period of time the savings can cover the costs with no up-front capital from the community. The initial savings each year would be reduced until the system is fully repaired. The Town might consider a fund raising.

The details of how the Town would pay for the work would be worked out once we have the purchase price information, the final design and costs and a clear understanding of the various sources of funds and any limitations on those funds.

The acquisition and conversion of utility owned streetlights will provide significant savings. The most frequent comment from community leaders is 'this looks too good to be true-what are you not telling me?' Communities have been taking advantage of the legislation now for over 20 years. The towns of Lexington and Acton acquired their lights in 1999 and numerous others followed. There is a long history now proving the savings and value of this process. The Town can save over 80% of their current costs, improve overall lighting and public safety with an under four year return on their investment even if they have to replace much of the system. These savings continue and grow year over year as energy costs increase. The transition to LED technology and control ready fixtures positions the community to take advantage of the rapidly evolving Internet of Things, i.e. Smart Cities and expanding capabilities of networked streetlights when options become available and are cost effective that would enhance the services of the government to the taxpayers of the community.

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