Streetlights Report

College of Engineering

The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

www.iisc.uiowa.edu/

Independent study led by Dr. Craig Just

Cecilia Wolf

In partnership with the City of Iowa City

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The University of Iowa Iowa Initiative for Sustainable Communities

City of Iowa City

The University of Iowa College of Engineering

This project was supported by the Iowa Initiative for Sustainable Communities (IISC), a program of the Provost's Office of Outreach and Engagement at the University of Iowa that partners with rural and urban communities across the state to develop projects that university students and faculty complete through research and coursework. Through supporting these projects, the IISC pursues a dual mission of enhancing quality of life in Iowa while transforming teaching and learning at the University of Iowa.

This publication may be available in alternative formats upon request.

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Shedding Light on Savings:
Iowa City's Street Light Conversion Project

Cecilia Wolf
The University of Iowa
December 2015

This project was instigated and primarily overseen by Brenda Nations, the Sustainability Coordinator of the City of Iowa City. Other advisors include Craig Just from the University of Iowa Civil and Environmental Engineering Department and Sarah SanGiovanni from the Provost's Office of Outreach & Engagement at the University of Iowa. Additionally, MidAmerican Energy Company provided much information, answers, and support throughout the process.

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1. Purpose

The purpose of this document is to describe Iowa City's streetlight conversion initiative, and to estimate expected monetary and energy savings that will result from transition of existing high-pressure sodium street light bulbs to LED fixtures. It was prepared by Cecilia Wolf, a student of the University of Iowa, using information provided by Brenda Nations and the MidAmerican Energy Company.

2. Project Background

The City of Iowa City (the City) constantly strives to provide its citizens with the best environment for living, working, and playing. The City is committed to sustainability and uses metrics to show trends and improvements for sustainability initiatives in publications such as the 2013 Sustainability Assessment and annual updates. One important aspect of these metrics is greenhouse gas emissions reduction. The light conversion project is one of many projects the City has undertaken to reduce energy usage and the resulting greenhouse gas emissions.

Since completion of community-wide greenhouse gas inventory and emissions baseline data in 2000, the City has tracked emissions annually to monitor progress toward its goal of overall reduction. This report aims to estimate the energy, emissions, and monetary savings that can be expected from conversion of street lighting to LED fixtures, as well as its contribution to the reduction goal. Other resultant safety and social benefits will also be discussed.

3. Project Summary

In December of 2013, a lighting audit for the City revealed nearly 10 years of overcharging by MidAmerican Energy Company, its primary energy provider. The source of the problem was a simple input mistake in 2004 when the City added two 150-watt high-pressure sodium light bulbs. Rather than adding two light bulbs to the account, an accidental 420 were added, nearly doubling the total number of lights for this particular account. Since the rate structure for the account involved charges per light bulb, the bill doubled leading to $531,405 in wrongful charges. Although not required to reimburse the entire amount, MidAmerican paid the City back in full, without interest.

Before the billing error was discovered, the City was looking into converting all streetlights to LEDs. So, when the City was reimbursed it was decided that the money would be used for the conversion, therefore eliminating future need to find funding. MidAmerican later announced a statewide plan to switch all company-owned bulbs to LEDs within the next ten years. The City then signed an agreement with MidAmerican to have all customer-owned lights also converted.

4. Technology Information

Light emitting diode (LED) technology has been overwhelmingly proven to be more energy efficient, cost-effective, and safer than traditional light bulbs, making it the front-runner in sustainable lighting options. The high powered LEDs used in street lighting can exceed 50,000 hours of usage, which is equivalent to about 12 years – assuming the lights are on for 12 hours each day. This is over four times the life span of a high pressure sodium (HPS) light, the most common type of light currently used in Iowa City's street and security lighting. LEDs also have minimal costs associated with maintenance and replacement compared to HPS lights. Consider an LED bulb and an HPS bulb both installed at the same time; by the time the LED must be replaced, the HPS has already been replaced at least four times, each of these replacements having a cost of $25-$100 not including labor. ("Street Lighting Technology Comparison," n.d.)

Traditional bulbs are replaced with LED equivalents that will offer the necessary illumination of a given area. Due to the high efficacy (ability to convert electricity into visible light), optical efficiency (how much light actually reaches target areas compared to how much light is produced by the fixture), and more versatile range of color temperatures, the LED equivalents of current bulbs require less energy (Table 1).

Table 1. Common equivalencies used in converting traditional light fixtures to LEDs. (The MidAmerican Energy Company)

HPS/MV/MH Wattage	LED Equivalent Wattage
100	37
150	73
250	143
400	215

Numerous studies have even shown that LED lights achieve the same or better visibility as HPS bulbs with less Lumens per square foot on the ground ("Illuminating the Benefits of LED Street Lights," 2015). This is thought to be a result of the type of light they produce. LEDs have Color Rendering Index ratings between 70 and 80, while HPS lights have ratings between 20 and 30. The scale is from 1 to 100, where 100 represents the highest ability of light to discern colors. This means the human eye is able to recognize colors more clearly, therefore causing higher visibility. The light produced is whiter and cooler than that produced by HPS and other traditional lights, which has also been shown by numerous studies to improve nighttime visibility due to its compatibility with the human eye.

Increased visibility offers extremely important safety benefits for drivers and pedestrians. An engineering firm in San Jose, California, Clanton & Associates, found that LED light increased visibility distance by 18%, which means drivers will be able to see what lies ahead more clearly, but also sooner than they would under HPS light. The Los Angeles Police Department even announced a possible correlation between LED lighting and decreased crime after the city of Los Angeles switched some 140,000 HPS lights to LED fixtures, stating that they unexpectedly saw up to a 13% decrease in criminal activity in areas where the lights had been converted. (City of Las Vegas, 2013)

Figure 1. Comparison of LED lighting (left) to traditional lighting (right).
(City of Las Vegas, 2013)

Another benefit of the versatility of LEDs is the ability to better control where light is targeted. This topic tends to be a bit more controversial than the others, as it is more dependent on citizens' opinions than the others. However, there are still many studies that suggest LED lights decrease light pollution – both sky glow and light trespass. While undergoing a similar conversion process, the City of Las Vegas conducted an extensive study on light pollution. The study determined that LED light patterns were more controllable, and once light was directed where it needed to be, there was much less spillage, both onto adjacent properties and into the sky. There was also a decrease in requests by citizens for the City of Las Vegas to shield unwanted light from their property once lights were switched. (City of Las Vegas, 2013)

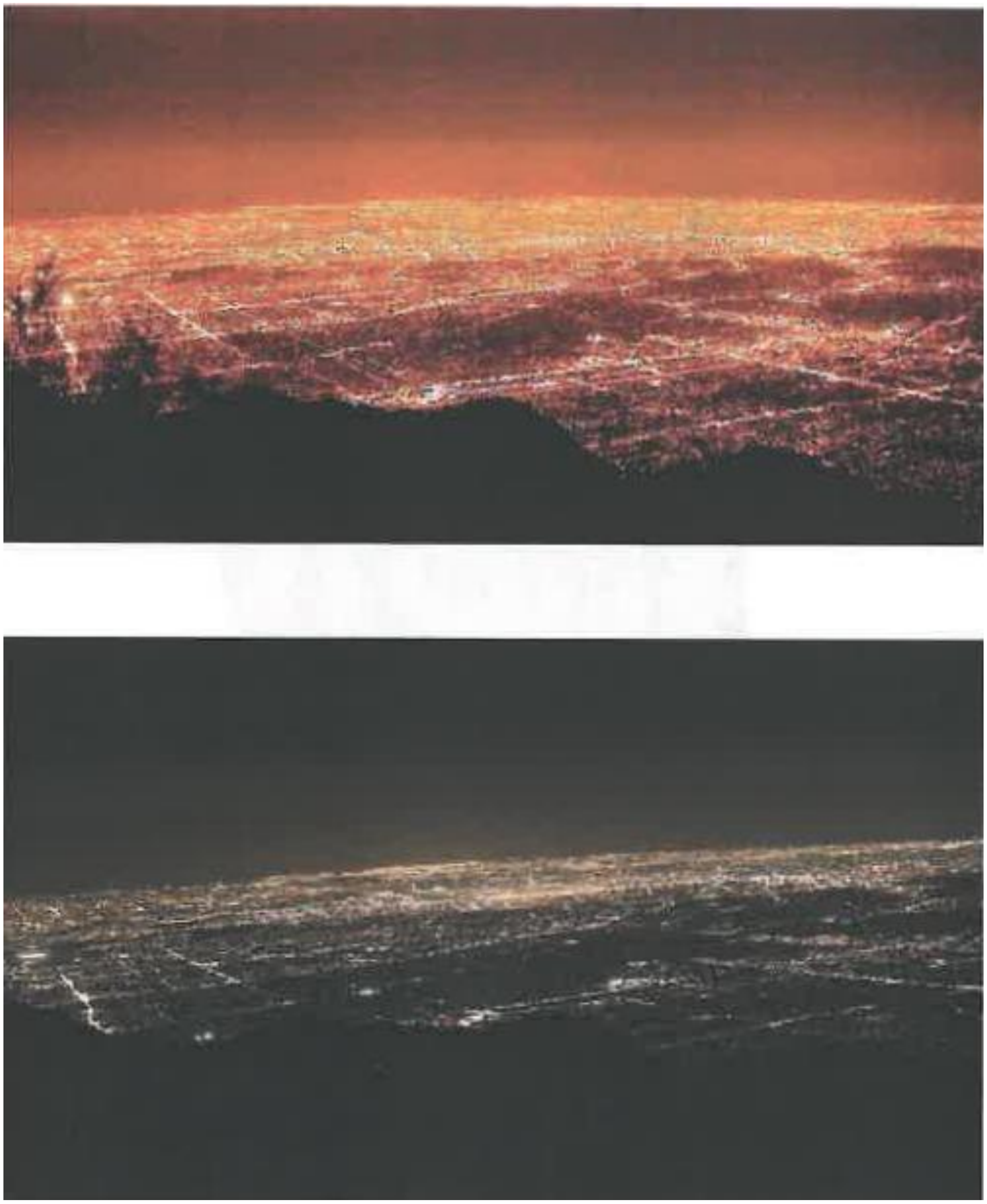

Figure 2. A photo taken at Mount Wilson, outside of Los Angeles. In their extensive study, the City of Las Vegas found that LED lightbulbs have less spillage, reducing light pollution. This is evident in the above photos: the first was taken in 2002, prior to conversion to LEDs, and the second in 2012, post conversion. (City of Las Vegas, 2013)

Aside from efficiency and visibility benefits, LEDs are also completely recyclable and contain no known toxic materials such as mercury or lead contained by conventional bulbs. This means safer disposal, and (due to long life-span) landfill waste reduction ("Illuminating the Benefits of LED Street Lights," 2015).

Although there are many benefits in switching to LEDs, there are some concerns and potential disadvantages. In her article from the *Earth Island Journal*, "LED Streetlights Save Energy, but Could Have Some Serious Side Effects," Zoe Loftus-Farren voices concern that "exposure to blue-rich LED lights can disrupt natural circadian rhythms in humans and wildlife." This is the same reasoning behind suggestions to avoid using devices with a screen, such as cell-phones and computers, right before bed in order to sleep more soundly. Lionel Shriver also mentions this principle in her *New York Times* article, "Ruining That Moody Urban Glow," but her concern is less scientific, and much more opinionated. Shriver simply loathes the light produced by LEDs installed in her neighborhood, writing "in all honesty my biggest beef with LEDs has nothing to do with health issues. These lights are ugly. They're invasive. They're depressing. New York deserves better."

The other primary concern, mentioned previously in the report, is that citizens have reported increased light pollution after LED conversion. As seen in both figures above, studies show light pollution reduction with LED bulbs compared to traditional bulbs. It is possible that what these citizens are noticing is the difference in light color, rather than change in light pollution, and, similar to Shriver, they dislike the change.

Luckily for these citizens, Shriver, and Loftus-Farren, advances in LED technology allow for a solution: variability in light temperatures. Not all LED lights are created equal, and not all lighting needs are the same. While citizens may want public spaces, such as parking lots and garages, intensely lit, this desire does not necessarily apply to neighborhood sidewalks paralleled by homes. The solution is altering light warmth with security and lighting needs. Warmer hues will offer almost all of the same benefits as their cooler counterparts, but they are more favorable to the eye – perfect for a quiet neighborhood. In the event that light color cannot be varied, it is suggested that the public be educated on the invaluable energy and monetary savings related to LED usage so that they at least know the reasoning behind the switch.

5. Findings

In Iowa City there are 3,605 total lights of various types and wattages. The City owns 1,246, and MidAmerican owns 2,349. Of all the lights, 286 are metered and billed based on usage, while 3,319 are unmetered and billed per fixture. By analyzing the different rate structures and equivalent wattages, it was found that the City can expect an estimated $116,064 and 1,276,900 kWh in annual savings once all lights have been converted to LEDs.

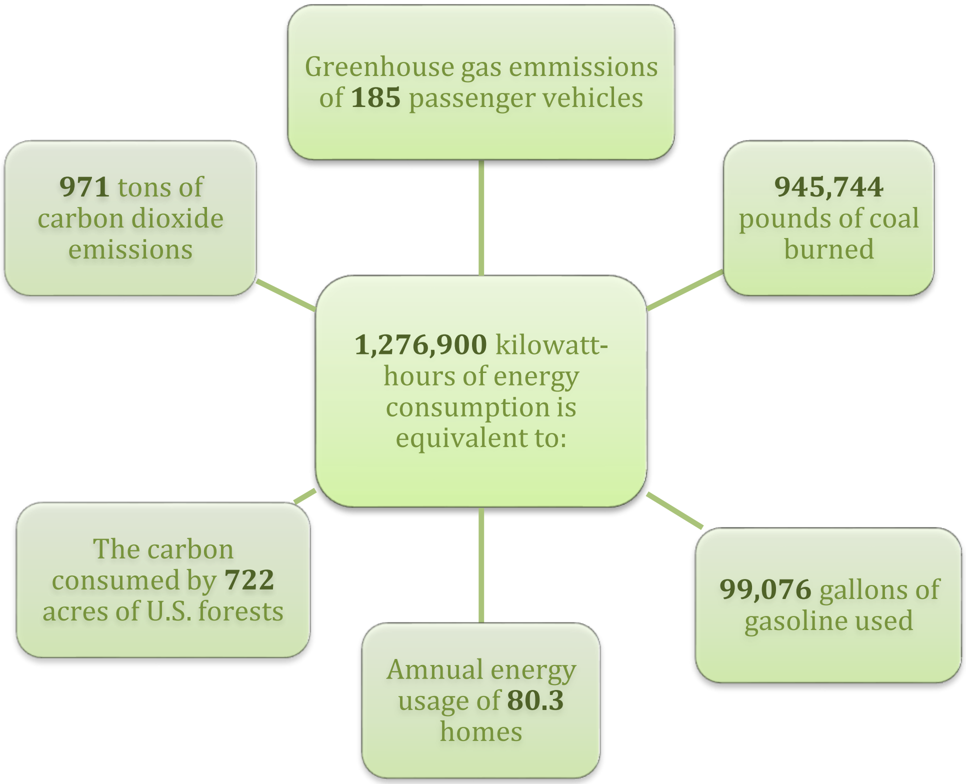

Figure 3. Various equivalencies in energy savings corresponding to the projected energy savings realized by converting all public lighting to LED fixtures. (Equivalencies provided by the EPA's Greenhouse Gas Equivalencies Calculator)

This is only a rough estimation as it does not account for certain factors such as inflation, changing energy costs, and is based on an average yearly operation of 4,200 hours. Figure 3 contains more understandable savings values comparable to the kilo-watt-hour savings stated above, such as 99,076 gallons of gasoline. The City has budgeted $500,00 to covert the 1,246 City-owned lights. This gives a return on investment of about four years. Based on the analysis, it is recommended that the metered lights be switched to LEDs first, as the decreased energy requirement will amount to the greatest cost reduction since these lights are billed based on usage.

In conclusion, this conversion project will have a large, lasting impact on Iowa City's environmental footprint, and will be a great factor in reaching the emissions reduction goal. As one of the first cities in Iowa to convert street lighting to LED fixtures, it is clear that Iowa City is committed to creating a healthier, greener community for its citizens to live, work, and play. This is further exhibited through the City's plan to use the money saved in converting the lights toward future sustainability projects. To learn more about the City's current sustainability goals and initiatives please visit www.icgov.org and click on "Sustainability Services."

Appendix A. Data Analysis and Calculations

METERED COST SAVINGS

ACCT	WATTAGE BERFORE	LED EQUIV. WATT	TOT #LIGHTS	YEARLY USAGE BEFORE	YEARLY USAGE AFTER	ANNUAL COST BEFORE	ANNUAL COST AFTER
04711-35003	35	18	2	294.00	151.20	$29.76	$15.31
09271-55056	250	143	2	2,100.00	1,201.20	$212.60	$121.61
	175	89	12	8,820.00	4,485.60	$892.94	$454.12
13830-99003	70	18	6	1,764.00	453.60	$178.59	$45.92
33511-20018	100	37	4	1,680.00	621.60	$170.08	$62.93
36781-29008	175	89	58	42,630.00	21,680.40	$4,315.86	$2,194.92
52221-07005	100	37	16	6,720.00	2,486.40	$680.33	$251.72
53880-89010	100	37	8	3,360.00	1,243.20	$340.17	$125.86
	175	89	29	21,315.00	10,840.20	$2,157.93	$1,097.46
	250	143	9	9,450.00	5,405.40	$956.72	$547.24
54090-89018	100	37	28	11,760.00	4,351.20	$1,190.58	$440.52
	175	89	48	35,280.00	17,942.40	$3,571.75	$1,816.49
59460-31006	175	89	54	39,690.00	20,185.20	$4,018.22	$2,043.55
72991-02006	100	37	2	840.00	310.80	$85.04	$31.47
04071-18003	100	37	8	3,360.00	1,243.20	$340.17	$125.86
		TOTALS	286	189,063.00	92,601.60	$19,140.74	$9,374.99
				SAVINGS	96,461.40	KWH	
					$9,765.75		

City of Iowa City Metered Street Light Accounts

	Acct #	Metered?	Meter #	Guy's list?	MidAm Name	# tot Lts	#LEDs	Lt Type	Watt	kWh	Rate	BSC*	Rate
1	04711-35003	Y	S98425808	Y-SYS	20 W BENTON ST LIGHT	7	5	HPS	35	750	GES	Y	0.10124
2	09271-55056	Y	S71113971	Y-LOT	603 S DUBUQUE ST	14	0			121	GES	Y	0.10124
						2		MH	250				
						12		MH	175				
3	13830-99003	Y	S66866634	Y-SYS	815 S SUMMIT STREET LIGHTS	6	0	MH	70	253	GES	Y	0.10124
4	21870-91226	Y	S64171246	Y-SYS	492 S GILBERT ST LIGHTING	24	24			687	GES	Y	0.10124
5	33511-20018	Y	S66866900	Y-SYS	1452 CROMWELL PL STL 0	4	0	HPS	100	134	GES	Y	0.10124
6	36781-29008	Y	S64076361	Y-SYS	305 IOWA AVENUE LIGHT	58	0	MH	175	2621	GDS	Y	[redacted]
										2000			0.074
										621			0.06372
7	52031-36004	Y	S98429234	Y-LOT	969 MANITOU TRL	6	6			248	GES	Y	0.10124
8	52221-07005	Y	S64126927	Y-SYS	408 MCCOLLISTER BLVD	16	0	HPS	100	482	GES	Y	0.10124
9	52620-89017	Y	S98458208	Y-LOT	106 E BURLINGTON ST LIGHT/MILL PARK LOT	2	2			72	GES	Y	0.10124
10	53880-89010	Y	S64076049	Y-SYS	227 E WASHINGTON ST SCAPE STREET LIGHT	62	16			3223	GDS	Y	[redacted]
						8		MH	100	2000			0.074
						29		MH	175	1223			0.06372
						9		MH	250				
11	54090-89018	Y	L81957387	Y-LOT	211 E WASHINGTON ST LIGHT	91	15				GDT	Y	[redacted]
						28		MH	100	79	on pk		0.15269
						48		MH	175	2361	off pk		0.03684
										1023	other		0.05804
12	56610-89023	Y	L81957387	Y-LOT	420 E BURLINGTON ST REC CTR LOT LTS	12	12			383	GES	Y	0.10124
13	59460-31006	Y	S64076004	Y-SYS	316 1/2 E MARKET ST	54	0	MH	175	2496	GDS	Y	[redacted]
										2000			0.074
										496			0.06372
14	72991-02006	Y	S98422805	Y-LOT	1324-1/2 LOWER MUSCATINE RD, TUNNEL	5	3	HPS	2	170	GES	Y	0.10124
	(two meters)					**497**	**83**						

480 Total Metered lights plus below

With traffic lights

15	05341-23008	Y	S98458921	Y-SIG	3003 MELROSE AVE TRAFFIC LIGHT	?	?			166	GES	Y	0.10124
16	04071-18003	Y	S64080606	Y-SIG	100 IOWA AVE, TRAFFIC LIGHT	8	0	HPS	100	2258	GD	Y	[redacted]
										2000			0.074
										258			0.06372

MIDAMERICAN OWNED UNMETERED

41820-95010	type	wattage	#lights	rate before	RT AFTER	ANNUAL COST BEFORE	ANNUAL COST AFTER
	HPS	100	1739	$10.80	$7.28	$225,374.40	$151,919.04
	HPS	150	437	$11.73	$8.81	$61,512.12	$46,199.64
	HPS	250	160	$13.43	$10.02	$25,785.60	$19,238.40
	MV	250	12	$3.67	$10.02	$528.48	$1,442.88
	HPS	400	1	$16.05	$11.56	$192.60	$138.72
			2349		TOTAL	$313,393.20	$218,938.68
						SAVINGS	$94,454.52

City Owned Unmetered

41820-95010	type	wattage	#lights	MO. rate before	MO. RT AFTER	ANNUAL COST BEFORE	ANNUAL COST AFTER
	LED	100	25	$7.28	$7.28	$2,184.00	$2,184.00
	HAL	100	8	$1.75	$0.44	$168.00	$42.24
	HPS	100	2	$1.75	$0.44	$42.00	$10.56
	MV	100	6	$1.57	$0.44	$113.04	$31.68
	HPS	150	30	$2.56	$1.53	$921.60	$550.80
	LED	150	4	$8.81	$8.81	$422.88	$422.88
	HAL	175	12	$5.41	$2.07	$779.04	$298.08
	HPS	175	245	$2.93	$2.07	$8,614.20	$6,085.80
	MV	175	27	$2.66	$2.07	$861.84	$670.68
	LED	250	2	$10.02	$10.02	$240.48	$240.48
	HAL	250	42	$3.77	$2.61	$1,900.08	$1,315.44
	HPS	250	477	$3.77	$2.61	$21,579.48	$14,939.64
42450-95010	HPS	150	28	$2.56	$1.53	$860.16	$514.08
55350-89012	HPS	250	58	$10.63	$10.02	$7,398.48	$6,973.92
14110-94000	HPS	100	1	$8.09	$7.28	$97.08	$87.36
52830-89018	HPS	100	1	$8.09	$7.28	$97.08	$87.36
62910-89014	HPS	100	1	$8.09	$7.28	$97.08	$87.36
87480-89013	HPS	100	1	$8.09	$7.28	$97.08	$87.36
			970		TOTAL	$46,473.60	$34,629.72
						ANNUAL SAVINGS	$11,843.88

ACCT #	WATTAGE	TOT #LIGHTS	LED EQUIV. WATT	YEARLY USAGE BEFORE	YEARLY USAGE AFTER
41820-95010	100	1780	37	747,600.00	276,612.00
	150	471	73	296,730.00	144,408.60
	175	284	89	208,740.00	
	250	693	143	727,650.00	416,215.80
	400	1	215	1,680.00	903.00
42450-95010	150	28	73	17,640.00	8,584.80
55350-89012	250	58	143	60,900.00	34,834.80
14110-94000	100	1	37	420.00	155.40
52830-89018	100	1	37	420.00	155.40
62910-89014	100	1	37	420.00	155.40
87480-89013	100	1	37	420.00	155.40
		3319	TOTALS	2,062,620.00	882,180.60
				SAVINGS (KWH)	1,180,439.40

Appendix B. Referenced Documents

IOWA CITY – The city of Iowa City paid $531,405 more than it should have on its electricity bill for streetlights since 2004 because of a data-entry error.

Buy this photo

(The Gazette)

MidAmerican Energy, the city's electric utility, reimbursed the amount in full last month when the discrepancy was discovered during a light audit, City Manager Tom Markus said.

"I think they settled it as equitably as they could," he said.

The overbilling was for a certain wattage of the city's more than 3,000 streetlights.

Markus said his understanding was that in 2004, the city added two 150-watt high-pressure sodium streetlights, giving it 420 in all. Instead of creating a new total of 420, MidAmerican added 420, doubling its count of that type of light.

The city pays per light, broken down by wattage, rather than for actual electricity usage, which Markus said is common practice.

MidAmerican spokeswoman Julie White said the company has implemented new internal procedures to prevent the mistake from occurring again. She declined to elaborate on what those are.

The city is reviewing its procedures, Markus said. Ultimately, catching such an error comes down to human detection by someone noticing a large increase in the bill, he said. He started with city in 2010 and did not want to speculate on why the mistake was not caught in 2004.

White said what happened with Iowa City was an isolated incident and she is not aware of other cities being overcharged.

Markus said the utility company is only required to go back five years with the reimbursement but chose to pay the full amount. By law, the city cannot collect interest on the sum.

The city must put the $531,405 in its road-use tax fund, where the money originally came from. City officials have been studying converting streetlights to light-emitting diode, or LED, lights, and will use the money to fund that project.

It will cost up to $350,000 to make the switch, and Markus said that amount will be made up in a little more than three years from the 30 percent cost savings in the more efficient LED lights.

The city will start with a pilot project to see what the lights look like and get feedback from the public.

Jan. 3, 2014

Earlier this year, MidAmerican Energy Company began the process of converting our existing streetlight system to more efficient light-emitting diode streetlight equipment. With more than 100,000 company-owned streetlights in Iowa, we are phasing in a full conversion of high-pressure sodium streetlights between 70 and 400 watts during the next 10 years.

MidAmerican Energy is continuing to review LED technology to provide the best service to our communities. The initial 100W equivalent LED light purchased is experiencing a few malfunctions, which are occurring in approximately 2 percent of the lights purchased. Therefore, MidAmerican Energy is in the process of changing to a new light fixture, which will look slightly different, but will have the same light performance and performance specifications.

PREVIOUS 100W EQUIVALENT LED

NEW 100W EQUIVALENT LED

This streetlight fixture change only affects the 100W equivalent LED streetlight fixtures. The 150W, 250W and 400W equivalent LED streetlight fixtures being installed are not affected.

MidAmerican Energy will continually update the website www.midamericanenergy.com\cityLED with manufacturer's specification sheets of the LED streetlight fixture offerings. We encourage lighting designers to routinely monitor this webpage prior to establishing any new designs, as lighting specifications and offerings may change at any time.

Please be assured MidAmerican Energy is working to resolve this issue as quickly as possible. Thank you for your patience and understanding as we work together in the transition to LED streetlights.

Sincerely,

Kathryn M. Kunert
Vice President
Business and Community Development

MIDAMERICAN ENERGY COMPANY – LIGHT EMITTING DIODE (LED) STREET LIGHTING INSTALLATION AGREEMENT

This is a Light Emitting Diode Street Lighting Installation Agreement between

(Please Print Municipality, Government Body and/or City, State of Customer below)

City of Iowa City

(Customer) and MidAmerican Energy Company **(MEC).** Customer and MEC may be referenced as "Parties" collectively.

This Light Emitting Diode (LED) Street Lighting Installation Agreement (Agreement) is entered into by and between MEC and Customer and effective upon signature of both Parties.

Whereas, MEC and the Customer agree that LED street lighting provides many benefits;

Whereas, MEC notified the Customer of the MEC LED street lighting standards selected are comparable to the High Pressure Sodium (HPS) lights they will replace;

Whereas, the Customer is aware that differences do exist in the performance between HPS street lights and LED street lights.

Whereas, the Customer consents and approves of MEC converting existing HPS street lighting to LED street lighting at the Customer's locations including the installation of future street light installation locations requested by the Customer;

Whereas, Service hereunder is subject to the Rules and Regulations of the Company and Applicable Riders included in the (MEC) Electric Tariff.

Now wherefore MEC and the Customer agree as follows:

Customer Responsibilities:

The Customer is responsible for ensuring the street lighting systems meet any applicable lighting standards and requirements of the Illuminating Engineering Society (IES) and/or Department of Transportation (DOT) adopted by the Customer and/or the Customer's own lighting standards.

Customer shall independently evaluate the adjustment of LED street light illumination levels to the road surface to determine the quality of a roadway lighting design.

Customer agrees to the terms and conditions and street lighting pricing out lined in MEC's Rate SL – Street Lighting.

MIDAMERICAN ENERGY COMPANY – LIGHT EMITTING DIODE (LED) STREET LIGHTING INSTALLATION AGREEMENT

MidAmerican Responsibilities:

MEC will replace existing HPS street lights with new LED lights according to the Customer's election below.

At the Customer's request, MEC will provide the performance specifications of the LED lights placed into service for the Customer to review.

MEC will provide street lighting service in accordance with its Rate SL – Street Lighting.

Please Select an Option

1) X **Standard Conversion** - The Customer elects to allow MEC to convert existing HPS lights by planned project areas at MEC's discretion and pace and will allow MEC to install LED lights through the normal streetlight maintenance process as the existing HPS lights fail at no cost to the Customer (estimated 10 year conversion).

2) ____ **Custom Option** - The Customer elects to convert lights on a faster pace and timeline at locations the Customer chooses for a charge of $100/light. A MidAmerican representative will contact the person identified on this Agreement to begin working on the process to identify and change the lights.

The signee of this Agreement confirms they are the Municipality/Government Body/City (Customer) Official, Authority or Representative having legal privileges and rights to sign this agreement on behalf of the Municipality/Government Body/City (Customer).

[signature] Date 5-28-15

Agreement Signature of Customer (Official, Authority or Representative)

Tom Markus Date 5/28/15

Please print name of Customer (Official, Authority or Representative)

Title: City Manager

Phone#: (319) 356-5012

Email: tom-markus@iowa-city.org

***Please keep one signed copy of this Agreement for your records and return one signed copy of this Agreement in the enclosed self-addressed envelope. ***

MIDAMERICAN ENERGY COMPANY – LIGHT EMITTING DIODE (LED) STREET LIGHTING INSTALLATION AGREEMENT

Additional Customer Lighting Project Primary Points of Contact

(Please Print)

Name: Darian Nagle-Gamm **Phone #:** 319 356-5254
Title: Traffic Engineering Planner **Email:** darian-nagle-Gamm@iowa-city.org

Name: Brenda Nations **Phone #:** 319 887-6161
Title: Sustainability Coordinator **Email:** brenda-nations@iowa-city.org

Name: Jon Resler **Phone #:** 319 356 5982
Title: Streets Superintendent **Email:** jon-resler@iowa-city.org

Appendix C. Referenced Reports

BRIGHT LIGHTS, BRIGHT FUTURES:

LED Street Lights for Southeast Michigan Communities

Framework with Tools for a Regional Approach to Energy Efficient Street Lights
Product of the Southeast Michigan LED Street Light Convening November 12-13, 2013

Sponsor: Urban Sustainability Directors Network, A Global Philanthropy Project
Host: The Southeast Michigan Regional Energy Office
Location: Dearborn, Michigan
Report: Susanna Sutherland

Executive Summary

This report is a product of the Southeast Michigan LED Streetlight Convening, funded by the Urban Sustainability Directors Network (USDN) and hosted by the Southeast Michigan Regional Energy Office and the City of Dearborn in Dearborn, MI on November 12 - 13, 2013. The point of the convening was to bring together southeast Michigan communities who share a desire to update their street lighting infrastructure and a common Utility provider (DTE Energy) to discuss financing obstacles and options for phased conversion. The point of this report is to make the Michigan approach replicable to other cities in shared regions or service territories, and to establish a common language for cities and utilities to use when negotiating these types of arrangements. Report findings include:

- A consortium approach can send a powerful customer message to a utility provider and allow them to plan for a broader conversion than on a section-by-section basis.
- Multiple cities in a service territory seeking conversion can allow a utility or energy service performance contractor to leverage group purchasing rates and can allow the utility to plan for standardization of an LED rate across multiple jurisdictions.
- Regulatory agencies, such as a State Energy Board or Utilities Commission can be powerful allies on items like technical assistance and rate setting, but they are not necessary to getting the job done if the conversation between the municipalities and utilities are frequent and productive.
- While LED conversion is a multifaceted project – especially when the utility owns the streetlights - the options for structuring and financing it are many and there is room for creativity, innovation, and national leadership in the solutions.

It is intended that the reader will gain insight into the challenges facing cities and utilities as they seek energy reduction through technology upgrades, and into the solutions available as projects are planned, structured, and executed.

Partner Organization Descriptions

The Urban Sustainability Directors Network is a peer-to-peer network of local government professionals from cities across the United States and Canada dedicated to creating a healthier environment, economic prosperity, and increased social equity. Our dynamic network enables sustainability directors and staff to share best practices and accelerate the application of good ideas across North America.
http://usdn.org/home.html?returnUrl=%2findex.html

The Southeast Michigan Regional Energy Office is a unique collaboration of nonprofits and local governments that offers tools for cities to become more energy efficient and reduce their global warming impact, transforming the region's image from "Rust Belt" to "Green Belt." http://regionalenergyoffice.org

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Section 1. Introduction and Overview

Section Overview

The purpose of this section is to explore the point of the Southeast Michigan LED Street Light convening and explain how the Southeast Michigan approach can be replicated in other communities across the nation. It contains:

- Convening Intent
- Convening Purpose
- Convening Design
- Convening Outcomes

Convening Intent

In July 2013, the Urban Sustainability Directors Network (USDN) issued four awards in response to a Request for Proposals (RFP) to host a Breakthrough Convening. That RFP noted that convening the right people at the right time can lead to important breakthroughs and provide new momentum for innovations. The awards were split into two categories: giving early adopters a chance to improve their efforts by identifying barriers and developing new ways to address them, or to provide opportunities for new alliances to form around advancing a proven innovation.

In this case, the breakthrough convening focused on scaling a proven innovation - Light-Emitting Diode (LED) technology - to other cities. It allowed USDN members, stakeholders, experts, utilities, regulators, and fiscal agents to meet face-to-face to address important barriers and opportunities for this particular innovative practice in urban sustainability. Because street lighting can account for up to 40% of a city's electricity bill[1], new technology retrofits and how to implement them well are of chief concern to city governments. Seeing successfully implemented LED street lighting programs that significantly cut annual utility bills and energy emissions increases the attractiveness and accessibility of streetlight retrofits, regardless of region or utility structure.

The work accomplished at the convening would not have happened without bringing people together for concentrated focus on this topic. It gave a very real sense of purpose to participants, showing solidarity in goals and the possibilities before them if they advanced together as a cohesive group. Though a convening by nature has no guarantee of success, its design was based on seeking a specific outcome and designing a specific process for achieving that outcome. To that end, pre-meeting research was conducted and materials gathered for an effective meeting design and facilitation process.

In the case of the "Bright Lights, Bright Futures" convening in Dearborn, MI, it was successful due in part to a consistent schedule set months ahead for event planning, and in part to the overwhelming response of participants the day of the event to commit to a course of action for the coming year.[2]

Convening Purpose

This convening was requested because momentum is building for LED street lights in Southeast Michigan. The Southeast Michigan Regional Energy Office had already coordinated energy efficiency (EE) and renewable energy (RE) efforts with twenty four member cities and one county in Southeast Michigan, who are part of a regional collaborative effort showing leadership in promoting EE and RE technologies in their communities, thus demonstrating that saving energy and money is good for the taxpayer. Among these, six cities have already conducted partial conversion of their cities' streetlights to LEDs. A core city, Detroit, just launched a new lighting authority, making the timing especially good for this conversation.

Assessment prior to the convening estimated around 70,000 streetlights operated in these twenty-five cities that have the potential to be converted to LEDs. Street lighting retrofits could boost the local economy while having positive environmental impacts as well. Cities are looking for ways to continue to decrease consumption for a host of economic, environmental, and social reasons; therefore, finding ways to work with utilities to make energy efficient lighting mainstream is pertinent to cities all across the nation.

Convening Design

The focus of the Southeast Michigan Breakthrough Convening on LED street lighting had two parts:

1. Convening Outcome: Design of a regional lighting consortium along with the information, resources and tools to support conducting phased regional LED street light upgrades; and
2. Long-Term Outcome: Implementation of the lighting consortium's plan.

The meeting Agenda (Appendix 4) was crafted to achieve the above-stated outcomes and to allow southeast Michigan to model how a consortium focused around a street lighting upgrades can be successfully replicated in other regions of the country. The following is a step-by-step process for creating a lighting consortium that works with local utilities to identify cost savings opportunities, including consolidated purchasing from suppliers.

Step 1 - Who to Invite: Cities linked by a common region or utility provider, the public and private utilities who service them, State Energy Office(s), and regional non-profit(s) operating in the EE and RE efficiency space (preferably ones that aren't politically polarizing, so they can advance rather than stall the conversation).

Step 2 - What to Focus On: A common goal of reaching a mutually beneficial solution to replacing inefficient lighting with LED technology, so the cities can reduce their energy consumption and monthly operating expenditures and the utilities still have an attractive bottom line.

Step 3 - When to Host: Timing of the convening and consortium work should take into account the fiscal constraints and cycles of all involved entities, especially the utilities, so projects can be financed, realistically designed, phased, and completed smoothly.

Step 4 - Where to Host: A central location. Also, keep in mind cities and utilities from across a region may find travel difficult on a consistent basis, so after the initial convening, it's important to have a call-in offering as well as in-person meetings, when necessary, to accommodate everyone's needs and keep the conversation well-rounded and moving.

Step 5 - How to Moderate and Oversee the Process: Having a non-profit, non-politicized third party coordinate cities and their utilities is helpful, as it removes the burden of coordination, and keeps the focus on overall project progress. If none is to be had, a strong city partner with an Energy Coordinator who can devote consistent time to this effort could serve this role.

Convening Outcomes

From the November 13, 2013 convening, Southeast Michigan cities and utilities left with the following:

- Cities left understanding the benefit of converting to LED street lights
- Cities were presented with an opportunity to participate with other cities in a regional energy collaborative and lighting consortium;
- Utilities were able to see and hear the interest from the cities they serve in a compelling new way, and the ongoing conversation developed greater depth and intent;
- Cities indicated interest to pursue upgrading their street lights to LED by completing a form (Appendix 5);
- Participants were provided with a one-page overview of the benefits of LED street lights for presenting information to elected officials (Appendix 3).

Anticipated long-term outcomes overview:

- Through USDN, cities in other regions are provided with the general framework for creating a local lighting consortium to upgrade to LED street lights;
- Southeast Michigan cities commit to pursuing financial analysis/cost-structure research of LED streetlight conversion through the Southeast Michigan Regional Energy Office or their own analysis;
- Cities are provided with an opportunity to become members of a regional collaborative, the Southeast Michigan Regional Energy Office, and participate in additional sustainability projects;
- Southeast Michigan communities develop the project design/implementation plan for LED street light upgrades;
- A portion of the utility rebate program is potentially dedicated to service this large-scale program;
- A multi-year project emerges, allowing utilities and cities to plan work loads around phased LED upgrades;
- A portion of the energy cost savings from LED street light upgrades are captured to fund future municipal sustainability projects.

The plan to achieve these long term outcomes is detailed in Section 4 of this document, and includes foundational outcomes, metrics, timeline, staffing, funding, and key challenges.

Section 2. LED Technology and its Penetration into Street Lighting

Section Overview

The purpose of this section is to explore LED technology and explain how its implementation can reduce monthly utility expenditure and carbon emissions in other communities across the nation. It contains:

- Conducting LED streetlight upgrades:
  - Convening Participants Thoughts
  - Five case studies detailing conversion costs and maintenance expectations:
    - Case 1: Ann Arbor, MI
    - Case 2: Lake Nona, FL
    - Case 3: Asheville, NC
    - Case 4: Las Vegas, NV
    - Case 5: Los Angeles, CA

Conducting LED Street Light Upgrades

Though this section explores the details of five cities street lighting retrofit projects, there are many cities that have done this. Here are some reasons why:

- Portland General Electric: "We are installing LED street and area lights because they are more cost-effective, sustainable, and provide better quality light". [3]
- The City of Napa, CA: "The goal is to reduce energy consumption and maintenance costs, and provide better light quality on streets and roadways". [4]
- Berkley, CA: "Conversion will save money, improve lighting quality and reduce greenhouse gas emissions". [5]

The reoccurring themes for a desired conversion come down to three specific areas of good governance:

- Economic – lower operating and maintenance costs to offset purchase and installation costs;
- Environmental – less energy consumed means less carbon into the atmosphere, resulting in improved environmental health; and
- Social – better light quality for increased community pride and safety.

Table 1 contains responses from Bright Lights, Bright Futures participants on top reasons to convert to LED technology, barriers to conversion, and ideas they would like to explore further:

Questions	Attendee Responses
Top Reasons for LED Conversion by Frequency / Priority	Reduced Energy Consumption / Energy Cost Savings Maintenance savings Increased Safety Increased Light Quality Better Light Output Political Pressure (to promote innovation / get positive public opinion) Significant Step towards Climate goals (25% by 2025)

Barriers to LED Conversion	Lack of Resources / Attractive Financing Options
	Uncertainty on LED Rate Setting (how the rates are set and why they typically don't pass on any energy savings)
	Limited Annul Utility Installs (8,500 / year with DTE)
	Project Scheduling and Planning (need a bigger program)
	Replacing Street Lights - competes with cops and firefighters (4,000,000 lights)
	Unknown Lifespan / Maintenance Costs (hard to calculate the true payback rate)
	Paying to Upgrade Assets Cities Don't Own (makes capital tricky)
	Communication and Outreach (to abate any community upset at install or increased light levels)
	Lack of Knowledge / Comfort with LED Technology (makes HPS the default)
Solutions of Interest	Explore Collaboration to Obtain Attractive Financing
	Communication/Making the case
	Host Regular Lighting / Funding Workshops
	Transferring Light Ownership from Utility to City bill or new rate structure
	Examine the Role of the Utility as a Performance Contractor to Cities in Street Light Upgrades
	Better Understand the need for LED Rates (and how they are set)
	Look to larger financing statewide - State legislators may need to be involved - MI Bond Bank
	Explore Consolidated Purchase Agreements
	Explore LED Lighting Controls Options Prior to Install
	Explore Incentives as Part of the Solutions (for both cities and utilities)
	Explore Options for Project management / Financing (i.e., performance contracting)
	Explore Lighting Transfer of Ownership Until Financing Term is Up (project is paid for)

Table 1: Responses from the Southeast Michigan LED Breakthrough Convening on LED Street Lights.

Because LED technology has had a notably fast developmental trajectory in the outdoor lighting world the past six years, case studies abound that explore the conversion costs and maintenance expectations of LED street lights.

The case studies below were selected to reflect small, medium, and large project sizes in a variety of regional and legislative environments, East Coast to West Coast, and the point of including them is to examine different ways to get the job done in any type of setting and circumstance. The same information was not offered for all of the case studies, so they are ordered as closely as possible to each other, but are not mirror images. As with any city and utility project, there's no "one size fits all," so funding and implementation plans will vary by utility service territory and political environment. It is also important to note that these are individual cities, not cases of cities in collaboration with each other. The power of collaboration is addressed in Section 3.

Case Study 1 – Ann Arbor, MI [6,7]

Who - Streetlight Ownership and Utility Structure:

- City owned streetlights
- Investor Owned Utility (DTE) owns remaining streetlights
- Vendor / Product used: Relume R-series street lamps (test installation) and decorative post top luminaries

What – Project Logistics:

- Piloted LED replacement for their downtown decorative "globe" lights
- Retrofitted 1,400 downtown cobra-head lights

Timeframes – Warranties, Installations, Payback Periods:

- 10-15 year lifespan of new LED light engines vs. 2-year lifespan of traditional fixtures
- In 2014 -2015, finish replacing all public lighting with LEDs.

- Estimated 3.3-year payback

Where – Project Structure and Phasing:

- Downtown first, then the rest
- Wattages vary from 50 to 80-watts for fixtures that replace 250-watt fixtures
- The "instant-on" and dimming abilities of LEDs offer additional energy savings through control strategies that can brighten and dim based on time of day, ambient light, or any other control parameters desired
- Motion sensors turn LEDs on or off instantly, allowing lighting to be used only when needed

Why – Fiscal and Energy Savings, Other Benefits:

- $100,000 annual savings
- Half the energy use of prior High Pressure Sodium (HPS) lighting
- 267 tons annual reduction in carbon emissions
- Less light trespass (when light falls where it's not intended to be)
- Improved light output and color rendition for enhanced business district safety
- Full implementation will cut public lighting energy use in half and reduce greenhouse gas emissions by 2,200 tons of carbon annually

How – Funding / Policy / Community Engagement:

- A portion of the savings from the retrofits is paid back to a city fund to pay for future retrofits (Matt Naud, Environmental Coordinator notes that long term replacement needs to be budgeted for outside the operating fund somehow – right now there's no savings mechanism for this in the current operating budget)
- The second phase of the project is a test installation consisting of cobra-head street lighting in a residential neighborhood.
- These fixtures are on loan from Relume Technologies
- Installations have signs requesting public input, and the response from the community has been overwhelmingly positive (81 positive of 83 total received responses). The positive responses emphasized dramatically improved light trespass, the lack of light spilling out onto yards and house faces.

Case Study 2 - Lake Nona, FL [8]

Who - Streetlight Ownership and Utility Structure:

- City owned streetlights (7,000 acre master-planned community)
- Vendor / Product used: RoHS Products

What – Project Logistics:

- Converted 504 High Intensity Distribution (HID) to LED technology

Timeframes – Warranties, Installations, Payback Periods:

- Five-year warranty
- Payback: immediate due to utility bundling
- Next Steps: complete 5,000 more retrofits

Where – Project Structure and Phasing:

- All over the community – no one test area

Why – Fiscal and Energy Savings, Other Benefits:

- Expected Energy Savings: 40%
- Actual Savings: $45,440 to $18,600 ($26,800 annual savings, $2,200 / mo)
- Actual Load: 120 kilowatts (kW) to 40 kW (71 kW, or 253,000 kWh/yr savings)
- Real Life Equivalencies: 84 tons of coal saved / 34 cars off the road / 49 acres: trees planted
- Reduced 197 tons of carbon dioxide (CO_2), 1 ton of sulfur dioxide (So_2), and 1 ton nitrogen dioxide (NO_2)

How – Funding / Policy / Community Engagement:

- Maintenance Expectations: $336,000 (over 10 years)
- Local utility financing package

Case Study 3: Asheville, NC [9]

Who - Streetlight Ownership and Utility Structure:

- Streetlights were owned and operated by the regional investor-owned utility Duke Energy Progress (DEP).
- Prior to the LED program, the utility billed the City for a flat monthly rate for maintenance, repair and energy consumption for each streetlight
- This rate is regulated by the NC Public Utility Commission

What – Project Logistics:

- Retrofitting of 7,500 lights from HPS to LED
- Rate changes for each individual streetlight were managed to ensure that the new rate was applied (at a pro-rated amount) based on individual fixture installation date

Timeframes – Warranties, Installations, Payback Periods:

- 4.6 year payback
- Eighteen month replacement timeframe

Where – Project Structure and Phasing:

- A geographic schedule was set up to identify which specific lights would get replaced on which street for each year
- The City worked with the utility to set up a purchase and installation schedule that was realistic for the utility to manage
- Procurement: LED rate structure required that the customer purchase utility approved LED fixtures; when the purchases were made the utility had three approved vendors: BetaLED, Leotek and GE, and the City managed the procurement process for the fixtures with the manufacturers' representatives
- Setting the number of lights to be replaced per year: the city worked with the utility to figure out how many fixtures it could replace each year

Why – Fiscal and Energy Savings, Other Benefits:

- 2,294,030 kWh saved annually
- Avoid approximately 1,083 tons of CO_2 per year
- Total carbon savings represents a 6.5% reduction in the city's carbon footprint
- Average savings is 50% of existing costs (energy and maintenance)
- Each retrofitted LED light saves an average of $53 in energy costs per year
- Saving an average of $401,476 per year

How – Funding / Policy / Community Engagement:

- Creation of a new rate structure for street lights that let the City to the LED fixtures installed on the utility-owned arm and pole
- New rate structure reduced per-light cost based on less energy used, as well as the reduced need for maintenance
- Rate structure cut the per-light monthly cost by 50%
- Rate made the utility responsible for the costs of installation of the LED fixtures
- The City issued general obligation bonds of $1,750,000 to finance the program
- City created a Green Capital Improvement Plan (Green CIP), where the savings from each project are deposited in a capital improvements account, whose funds can roll from one year to the next, financing future initiatives
- Streetlight savings are managed like an internal Energy Performance Contract (EPC) relationship, except in this case managed directly by the city
- Annual savings from the LED replacements are captured and used to both pay off the debt incurred for fixture procurement and also fund other energy improvements

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Case Study 4: Las Vegas, NV [10]

Who - Streetlight Ownership and Utility Structure:
- City owns the streetlights
- Streetlights are metered; the city pays a fixed rate of 5.5 cents/kWh
- GE Evolve-Transcore-Crescent proposal selected

What – Project Logistics:
- Bid Process:
    - Open to all light technologies (received LED, Induction, and Plasma proposals)
    - Must meet photopic requirements of IESNA/RP-8
    - 40% minimum energy savings
    - Unit cost for light and labor installation
    - Product capacity >1000 lights per month
    - Remote monitoring capable
    - Fabrication in USA (due to federal funding requirements)
    - Partnership with supplier as primary what?
    - Scoring: Durability-10%, Serviceability-20%, Energy Savings-20%, Illumination Evaluation-25, Cost-15%
- Installation Process: 40,000 lights converted

Timeframes – Warranties, Installations, Payback Periods:
- Payback in four to nine years
- Seven-year product warranty
- Phase I schedule: 2 – two-man crews, 4.5 month installation period (64 lights / night)
- Phase II schedule: 3 – two-man crews (96 lights / day), 15 months total installation period
- Next Steps: traffic signals, decorative roadway lights, city properties, and sport field lighting

Where – Project Structure and Phasing:
- Installed all areas of the city for exposure
- Field Testing:
    - Four-month process with five different products in the same location, measured illumination levels
    - 100W samples installed in residential neighborhood, 250W installed on an arterial street
- Phase 1 - 6,600 in Phase 1 as a "Test": 132W, 80W
    - 4,000 Lights Residential Streets - 80W LED replace 100W HPS

    - 2,600 Lights Commercial Streets – 157W LED replace 250 W HPS
    - City assigned work locations weekly, only worked at night
- Phase 2 - 35,000 with enhanced photometrics: 130W, 82W, 54W, 43W
    - Moved forward only when comfort level was met
    - 36,000 fixtures
    - Night and day work (location dependent), city assigned work locations weekly

Why – Fiscal and Energy Savings, Other Benefits:

- Energy Savings: 20,000,000 fewer kWh used annually
- Actual Savings: $ 1,700,000 annually
- Maintenance Savings: $400,000 annually
- Annual Savings: $2,200,000/yr in energy and maintenance
- Environmental Impacts: 12,000 tons of CO_2 eliminated
- Real Life Equivalencies: 3,200 acres of trees planted, 2,300 cars removed from the road

How – Funding / Policy / Community Engagement:

- Requested feedback from customers
- Funding: bonds, ARRA, Nevada Energy Rebates
    - $3,000,000 budget Phase I
    - $17,400,000 budget Phase II

Case Study 5: Los Angeles, CA [11]

Who - Streetlight Ownership and Utility Structure:

- City owns and operates the nation's second-largest street lighting system: 210,000 streetlights (including 70,000 decorative street lamps that will be retrofitted in a second phase) along 4,500 miles of illuminated streets.
- Cree's XSP series and LEDway series, Hadco's RX series (Hadco is a Philips PHG +0.11% company), and Leotek's GC series
- A portion of the streetlights feature the Roam® streetlight monitoring system to collect and report data such as energy usage and equipment performance for each fixture

What – Project Logistics:

- 209,000 streetlights or 5,000 miles of lighted streets
- Phase I was 141,089 street lights

Timeframes – Warranties, Installations, Payback Periods:

- 2009 announcement
- Seven year payback period through electricity and maintenance savings alone

Where – Project Structure and Phasing:

- In 2009, the city installed 8,000 streetlights and replaced a total of 30,000 streetlights each year for the next four years
- The system also has the capability reduce equipment down time due to malfunction

Why – Fiscal and Energy Savings, Other Benefits:

- An estimated $10,000,000 annually starting in year 8 (end of year 7)
- $7,000,000 in electricity savings annually
- $2,500,000 in avoided maintenance costs annually

- 70,000 in street light repair and maintenance events fell to 46,300 from 2008 to 2012
- Consume about 63% less electricity and last much longer than the HPS they replaced

How – Funding / Policy / Community Engagement:

- Streetlights represented 29% of the City's total operating budget prior to the retrofit
- $57,000,000 project, funded through a combination of energy rebates, the Street Lighting Assessment Fund, and a $40,000,000 loan

Cost and Maintenance Summary

As seen from the case studies above and the prevailing research to date, LED technology for streetlights results in lower annual energy and maintenance costs. While specific numbers and finance mechanisms vary in each case, these two numbers seem to consistently offset the initial capitol investment typically within the warranty period.

Another item to note is that it's obviously easier to upgrade an asset owned than one owned by another entity. In the situation of Asheville, NC, the city purchased the lights from the utility prior to the upgrades, and in the other four case studies, the lights were owned outright by the cities. However, we'll explore options for the many municipalities that don't own their streetlights in the next section, as this is the case in so many North American cities.

Section 3. Tools for Approaching LED Conversion

Section Overview

The focus of this section is on improving streetlight communications between cities and municipal/investor-owned utilities; it looks for commonalities in organizational goals and works to create a common language from a broader understanding of the pressures and challenges facing both parties.

- When Streetlights Belong to the City
- When Streetlights Belong to the Utility
- Checklist for Starting the Conversation

When the City Owns the Street Lights

If a city owns the lights, it's easy to make the budgetary case to administrations for conversion. Key talking points include the following:

1.) Show the cost of doing nothing:

In a garage and parking lighting conversion study for Grand Rapids, MI, it was calculated that the cost of waiting to retrofit was $14,000 per month.[5] Information like this can be a compelling message to city administrators, who constantly look for ways to cut operational costs. The cost of doing nothing is an important part of any project assessment when doing a return on investment (ROI) study. Many vendors will offer an ROI to show the effects of their product if there is no in-house analyst to conduct the work; this scenario should be part of any bid package the city receives to budget and perform the work.

***2.) Explain the payback period if conversion were to happen*:**

Also a basic of any bid package – the "do-nothing" scenario should be followed by the payback period of the work, which can range from immediate (Lake Nona, FL) to 8 years (Los Angeles, CA), and is heavily dependent on the finance mechanism offered.

***3.) Outline the finance mechanisms to fund the project*:**

As seen in all five case studies, project financing can be bundled into a portfolio of grants, bonds, utility rebates, and vendor offerings (an ESCO-type situation where the payback is guaranteed and the savings can be diverted into several different streams – one to pay off any debt incurred, and another to become an energy revolving loan for future projects, for example).

***4.) Estimate the timeframe of the undertaking*:**

Installation can range from months to years depending on the phasing selected; the timeframe of the debt will be heavily dependent on what financing arrangement is the most attractive in a given situation. The timeframe needs to be forgiving and be based on project structure.

5.) Develop an implementation plan with the local utility:

For a city that owns the lights, this is still a key relationship, as sometimes maintenance can fall within the power and service agreements of a local utility, and it's essential they are at the table from the very beginning, even if they aren't responsible for any part of the financing or project execution. The city and the utility need to be comfortable with the product selected as well as it's lifespan, warranty offerings, and light components. These conversations can take time, but they are the foundation of a successful conversion.

6.) Communicate with the local governing body (mayor; council; city administrator):

Districts may be selected for testing, but as seen in many of the case studies, when rollout occurs, it's essential that there are no "favorites," and that all areas of the community are treated equally with the same care taken to explain, in layman's terms, the cost, carbon, and social benefits.

7.) Communicate with the community:

People need to know what is going on and why – the case studies indicate that public opposition is minimal, as the human eye is attracted to the spectrum of LED, but, as with any public project, planning for the worst and being pleasantly surprised is better than hoping for acceptance without doing the leg work first. Explaining the monetary, health, and safety benefits are important for buy-in and support.

8.) Plan for procurement:

As seen in the Las Vegas conversion project, the bid package should be very explicit with city expectations. This will ensure the vendor is very aware of their responsibility to the city and minimize negotiation time and any future change orders. Warranty and replacement expectations for failed lights due to manufacturing deficiencies are a key part of this outline, as are energy savings expectations and what happens if those aren't met, as that can significantly impact the payback period.

9.) Plan for disposal of old fixtures:

This isn't a subject that is talked about much, but it's an important one just the same - resources abound online, but as it's a very localized topic (due to cost and product lifespan carbon footprint), regional options should be checked to fit a municipality's individual circumstance. Chattanooga, TN[12] did a quick scan of how other cities dealt with HPS disposal. The response from Antioch, CA was very detailed:

- Disposed of the lamps in the usual manner, having them taken away by a certified mercury recycler
- Recycled the ballasts by bringing them to a metal recycler
- Found a plastics recycler that would take the lenses
- If fixtures were being replaced, they were brought to a metal recycler
- In most cases, metal recyclers will take mixed metals and metals mixed with ceramic (socket) for free and do the separation themselves, or will pay for the metal when separated

When the Utility Owns the Street Lights

Now more than ever, this is the emerging conversation: how do cities and utilities work together to craft a streetlight conversion project that does not negatively impact the utility's bottom line, but allows the city to also capture some of the energy savings on their monthly utility bill? Bloomington, Indiana participated in the Michigan convening for just this reason – to figure out how to translate the consortium model to the Duke Energy service territory, and start a conversation that results in action on this issue.[13] The power of a consortium is an emerging concept: as seen with the recent North Carolina utilities commission ruling, the voice of many cities can be more powerful together, and can allow for better long term planning and more transparency for both the cities and the utilities. [18, 20]

It's a more complicated project than a city with ownership must deal with, as there are many moving parts and two very different bottom lines to consider. However, there are items both entities have in common, and these should be the crux of the conversation, so keep everyone on the same page and as open with each other as possible. Key talking points include the following:

1.) Find common ground in energy consumption reduction:

Utilities are under pressure due to growth projections and increased energy consumption even in the face of more efficient technologies to plan for a future load that can meet projected demands. Selling more power is good for the bottom line only to a point, and then the cost of building new power generation and distribution facilities comes into play with long term investment projections.

The Tennessee Valley Authority's website has the following to say about LED streetlights:

> *"Costs for street and area lighting continue to go up as energy and labor costs rise. Government regulations are forcing utilities to develop a replacement strategy for older mercury vapor lighting and probe start metal halide lighting. While these fixtures have long lamp life, they are not energy efficient. New light-emitting-diode technology may offer a way to save energy and reduce service visits to change bulbs. LED lighting is expensive, but has shown the potential to lower energy use 67% and lower maintenance costs as well."*[14]

In light of avoiding new infrastructure investments, unities agree[15] that energy efficiency makes more sense than building new infrastructure, and lighting is an area that has room for great improvement in all sectors. It is a conceptually simple improvement that has the largest cost and carbon savings of any energy efficiency retrofit.[16]

2.) Clearly identify roles of the customer and the provider:

Often, the legal roles of City and Utility aren't well defined, and exist in old charter or in a memorandum-style project-by-project basis. It's important to have a frank conversation that on this particular undertaking, everyone understands roles and jurisdiction. It needs to be clear that in spite of any historical differences between customer and provider, that on a project of this magnitude, both parties move ahead with a clear foundation of minimized grey area.

3.) Agree on a clear set of shared goals:

It may the city's intent to reduce carbon by 20% by 2020, but that may not be on the utility's radar. It may be a goal of the utility to have a certain profit margin that is maintained by old arrangements and maintenance agreements, which may not necessarily matter to the city. Identifying these differences on the front end and determining a course of action that allows both entities to reach their own goals is the key to success in this case. Good negotiation, by definition, means a little initial discomfort for both parties but a solution both can live with long-term.

4.) Assign like-minded staff from the utility and the city to work together:

Once mutual goals are agreed upon, make sure assigned staff can work together effectively. This may mean strategically rearranging assignments, but having two points of contact with report and a level of trust will make the project run smoothly.

5.) Determine a rate structure that is understandable to both parties:

Some utilities don't set a separate rate for LED streetlights.[15] Most say setting an LED rate is the first step. However, when setting a separate LED rate, that rate can, for example, show a confusing increase in maintenance, or no visible reduction in energy costs, which is cited to the capitol cost of the investment. As rates are the purview of the utility, and the spreadsheet from which they are developed isn't freely shared, it's important for utilities to explain to their customers the general premise of how the numbers are arrived at, therefore clarifying the overall cost of the project to the consumer, and the impact to the utility's bottom line. A sample rate is shown in Appendix 6. Utilities should show for instance, if maintenance savings are not there, why that is, or if the energy savings are negated, how that happened. They should show why their rate is competitive and how it was derived.

Likewise, cities should show that they have done the legwork to understanding exactly how many lights they are billed for, how much they pay monthly, what savings the technology should garner, and where these lights are to be located. This involves a considerable amount of homework from both parties, but the fact checking leads both parties to the same page. This is also where cities collectively can be more effective communicating with a shared utility, as there are savings in economies of scale, and conversion in one city will inevitably lead to requests of conversion in other cities. So, it's in the best interest of both parties to recognize that this is a long term, wide scale, game changing conversation that's occurring.

6.) Outline Costs and Benefits to Both Parties:

The trickiest subject by far is cost sharing. When a utility owns the lights, cities often question why they should pay to upgrade someone else's assets. In EE efforts of all kinds, this is echoed again and again – a renter who pays the utility bills and a landlord who has no incentive to weatherize, for instance. But when public assets are involved, it becomes a matter of good stewardship and good policy, which leads to good public relations – and these are all items that both a city and a utility want.

The conversation ultimately comes down to the ratepayer, who has a customer's expectation that a portion of the rate is reserved for upgrades to infrastructure to keep operational costs as low as possible. The utility must understand that the city cannot bond for an asset they don't own, and the city must understand that the technology needs to fit into existing infrastructure as much as possible to minimize costs of retrofitting. There are several interesting ideas here:

- Could the utility serve as an ESCO to the city, for instance?
- Retrofitting and diverting savings to their own debt payoff and retrofit phasing plan?
- Could a private ESCO work with the utility to craft a financial model that works a portion of the energy savings back to the city after payback for infrastructure has been achieved?
- Could the utility deed the lights to the city until the investment is repaid?

The point here isn't to explore all the packaging options, but to note that where there is a shared goal, there are additional finance mechanisms to consider, whether it be third party or otherwise. Because of this, both parties should be prepared to share in both the upfront expense and the long-term savings.

7.) Understand and Agree on the Timeline:

Here, it's important that cities, especially when they have convened and agreed on a shared goal, understand that a utility can't convert all existing lights to LEDs at the same time; prioritization must occur. There is so much to consider: circuit capacity, potential transformer upgrades, pole spacing per road classification, improving technologies, etc. Besides the engineering details, cities must understand that getting to a comfort level with the technology, choosing the finance mechanism, securing the financing, procuring the vendor, setting the retrofit schedule, etc. can take years in some cases.

This is where a consistent meeting schedule can keep the project on the front burner and keep the details going and avoid the feeling that the same conversation has been had before. Stay with it; don't let months pass before the next meeting.

8.) Develop a support system with other key stakeholders:

This is especially important if there is an external power distributor that services the utility. In the TVA 7-state service territory, for example, power is generated or purchased and then sold to the utility, so rates are set (in part) from that overarching structure. Structures like these make it necessary to have the distributor on board as well. In a recent sustainability award from TVA that the City of Knoxville received (Platinum, TVA Green Communities Program), one of the recommendations was for city conversion of streetlights to LED[17], and the distributor for the first time has started to incentivize streetlights. This is a conversation changer in the Tennessee Valley, as local utilities often take cues of interest from TVA.

Another key stakeholder to engage (if available) is the State Energy Office and Utility Regulatory Commission. In an October 2013 order spurred by a North Carolina Municipal League collaboration on street lighting, the North Carolina Utilities Commission mandated a utility rate for LED streetlights.[18] In the case of the Southeast Michigan Lighting Consortium, the Michigan Energy Office offered help and support to the cities by way of technical support and a voice at the table. [19] Approaching the State Energy Office may be new territory for a city or utility, but it starts like any conversation, according to Michigan State Energy Office's Jan Patrick, by stating intentions and letting the Energy Office express what role they can play in supporting those intentions. To be very clear, there is a role for regulators – they can advance a stuck conversation, as in the NC example, or support an ongoing conversation, as in the MI example. They are resources to enhance the existing relationship between municipalities and their utilities.

It is worth noting that while the Public Service Commission is regulatory, the State Energy Office is not. Many states have these entities in different forms, and many are funded through the federal State Energy Program (SEP), although where they are housed and what their priorities are vary tremendously from state to state. Typically, there is some form of EE / RE implementers and energy supporters within the state administration, and it is worth reaching out to the State to ask about this kind of technical assistance or funding capacity and how it could relate to municipal street lighting.

9.) Execute with project management meetings to minimize surprises:

Meet often, with a set schedule, a timeframe, and an agenda. It sounds simple, but if this is done well the project can be smooth for all involved parties. Accountability also minimizes unplanned costs.

10.) Revisit finances on a regular basis:

Conversion isn't the end of the conversation. There's a monthly monitoring that should jointly occur: the utility from a maintenance standpoint (how many failures, outages, replacements, etc.) and the city from a utility bill perspective (street light bills monitored for savings, any debt incurred monitored for timely payback, any funding for new project from the savings being planned for and implemented). As with most EE work, details-post project form the justification for the front-end expense.

Checklist for Starting the Conversation Between a City and its Utility

Take the Temperature on Political Will of Both the City and the Utility:

- Is there a city commitment to reducing local carbon emissions, outlined publically in a climate action, local sustainability, or comprehensive city plan? Is there a city commitment to operating government facilities in the most energy efficient way that is fiscally possible?
  - If yes, is the utility aware of these goals and are they supportive?
  - If no, start the meeting explaining these goals.
- Is there a utility mandate or goal to control energy demand through consumption reduction?
- Are there utility incentives available for energy efficiency, and do they reflect EE or RE goals?
  - If yes, does streetlight conversion help with these long-term goals?
  - If no, what does the utility's long term planning look like? Start the conversation here.

Understand the Decision Making Process:

- What is the city/utility business model for city streetlights?
  - Know who owns the lights, how many are there and where they are.
  - Understand the rate structure, the current monthly expenditure, how the city is billed, and what percent of that represents maintenance costs.
- Is there a rate structure that allows effective capture of at least a portion of the energy savings from LED replacements after the payback period has been met?

Understand the Historical and Current City and Utility Relationship:

- Understand the staff: are there any people who shouldn't be working together at this juncture and who are the people who *can* work together?
- What have been the points of tension and have they ever been openly addressed? Set about clearing the air between organizational administrations if possible. If not, evaluate available third parties (Non-profit(s), State Energy Office, State Utilities Regulatory Commission, etc.) for outside help.

Develop Options for the Financial Model:

- Is the administration of either or both organizations comfortable with an ESCO model or an internal Energy Savings Revolving program?
- If so, will that administration allow retention of energy and maintenance savings in excess of the capitol investment and implementation costs?
- What kind of financing packages and payback terms are they willing to consider?
- Is the owning party willing to explore bonding or new debt for the capital for front-end implementation? Check if this could be a Program-related Investment (PRI) opportunity for the local Community Foundation.
- Is there anyone local who has the skill to pull financial scenarios together? If not, consider outside technical assistance through a State Energy Office, Regulatory Commission, or implementation case studies that may work in your utility territory.

Plan for Program Management:

- Do you have the staff to plan and manage a technically complicated implementation process? If not, consider hiring an outside third party to finance and manage the project.
- Are there measurable performance metrics that create an incentive for demonstrating progress? If not, these should be developed prior to implementation.

Section 4. Collaboration to Implementation

Section Overview

This section wraps up the convening report by bringing attention back to the Southeast Michigan model, and how they plan to move ahead in 2014. It contains:

- Long Term Goals and Desired Outcomes
- Metrics to Measure Success
- Timeline of 2014 Implementation
- Staffing
- Funding
- Key Challenges
- Conclusion

Consortium Long-term Goals and Desired Outcomes

The Southeast Michigan Regional Energy Office hopes to create a replicable model that can be applied in other metropolitan areas across the country, a goal supported by the USDN and many city officials in attendance at Bright Lights, Bright Futures convening. Those in attendance were excited to be part of a project that demonstrates to the nation our commitment to helping each other save money and energy, working together toward a more sustainable future for metro Detroit.

The Consortium's goal is to coordinate a large-scale, regional effort to replace existing municipal streetlights with LED technology throughout metro Detroit over the next five years so:

1. The region's communities have a better, more affordable lighting system;
2. The region has the greenest street lighting system in the country;
3. Metro Detroit has a well-funded vehicle for collaborative action; and
4. Importance and results of effort are well publicized throughout the region and nation.

In addition to these foundational outcomes, the Southeast Regional Energy Office will also consider opportunities for the following possible outcomes:

- Building a history of collaboration among local governments that leads to other collaborative projects;
- Leveraging regional scale aggregate purchasing power to convert other lighting systems to LED (e.g. parking lot lighting);
- Securing a commitment from new City of Detroit Public Lighting Authority to be a green-tech leader; and
- Piloting streetlight integration of smart transportation and vehicle-to-vehicle communication controls.

Metrics to Measure Success of the Intended Outcomes

1.) Better, more affordable lighting system
    a.) Funds saved by cities
    b.) Aesthetic consistency across region (percent of lights in similar technology)

2.) Greenest street lighting system in the country:
    a.) Reduced CO_2 emissions
    b.) Percent of street lighting system upgraded

3.) Vehicle for collaborative action:
    a.) 40-60 communities participating
    b.) Formally shared strategy is in place
    c.) Size of endowment for lighting improvements

4.) Publicized efforts:
    a.) Press coverage in metro Detroit
    b.) Press coverage nationally

Timeline for 2014 Consortium Implementation

Table 2 offers a basic timeline for major activities of the strategy. While these strategies operate roughly in the order shown below, some portions run simultaneously – and some may require earlier portions to be adjusted as future activities proceed.

TIMING	**OUTPUTS** *(things we create)*	**ACTIVITIES** *(things we do)*
Nov. 2013 – Dec. 2014	Regional streetlight consortium	1. Recruit 40-60 communities
		2. Engage non-gov partners (DTE, industry, etc.)
		3. Engage state and national governmental partners (State of Michigan, DOE, etc.)
		4. Convene participants regularly
		5. Draft formal agreement
Jan. – May, 2014	A financing plan	1. Develop scenarios for overall costs depending on extent of participation, technology, etc.
		2. Identify funding vehicles (e.g. PRI, bonding, general fund contributions) etc.
		3. Secure funding
Jun. – Sep. 2014	Cost savings sharing agreement	1. Design and negotiate the contract (with legal counsel)
		2. Secure governing board approvals
Jun. – Nov. 2014	Technology agreement (policy/ordinance/etc)	1. Investigate/Research available technologies and their appropriate use
		2. Draft a model policy
		3. Negotiate and support adoption among consortium members

July – Dec. 2014	Implementation plan	1. Develop a timeline for full implementation 2. Determine actors and roles (e.g. what does DTE do versus Regional Energy Office versus communities)
Jan. 2015	Streetlights are upgraded	Begin to carry out Implementation Plan

Table 2. Timeframe for 2014 Southeast Michigan Street Lighting Consortium Implementation.

Staffing of the Effort

Staff of the Southeast Michigan Regional Energy Office will coordinate this effort. Municipal staff will also be required for participation in the consortium meetings, as well as integrating the formal agreements and implementation plan into their local jurisdictions. DTE Energy Community Lighting staff will be needed for approval to changes to their assets, and determination of rates, as well as possible maintenance needs and technical consulting.

The Michigan Public Service Commission will most likely be engaged in determining best practices for these upgrades, and have expressed strong interest to be involved in the consortium.

Additional partners will be engaged for technical, financial, and political consulting as needed.

Funding of the Effort

Foundation funding will be sought to cover the time investment anticipated to launch the program. The Southeast Michigan Regional Energy Office intends to provide basic staffing support for this effort, but additional funding will support faster and more robust coordination and program delivery.

The primary funding goal for this effort is to secure the money needed to implement the projects. Funding is a potentially complicated process, but one that shows clear promise for a solid return on investment. This funding will hopefully come from one major source, and the size of that funding may largely determine the scale of the project.

Funding for the project will be leveraged for long-term regional benefit. While the first immediate benefit is the lowering of utility costs for municipalities, those communities will also pay back portions of their savings into an endowment to support future regional energy initiatives, which will further improve economic development.

Funding sources under consideration include but are not limited to:

- Municipal bonding through the Regional Energy Office Community Alliance, an intergovernmental body made up of Regional Energy Office members;
- Program related investments (PRIs) from foundations, public pension funds, or other sources;
- A performance contract through the local utility;
- Direct financing through the local utility; and
- Traditional financing, with non-streetlight collateral provided (since the cities are seeking the funds, but the streetlights are owned by the utilities).

Key Challenges

The success of this project faces several key challenges. While the solutions cannot be entirely anticipated at this time, we enter the process confident that solutions are available as long as stakeholders continue to seek them in good faith. Some of the anticipated key challenges are outlined here:

- Securing financing of a sufficient scale;
- Overcoming ownership/investment challenge based on the fact that the utility owns the streetlights, while the communities pay for use and want the upgrades;
- Proper balancing of the opportunity costs of waiting to make replacements vs. opportunity costs of installing LEDs when the technology is still improving and costs are coming down;
- Coordinating aggregated purchasing and installation across numerous political jurisdictions; and
- Determining and securing appropriate utility rates for LED streetlights, along with any additional changes needed for lighting with controls or other features as relevant.

Conclusion

Conversion to LED technology is possible even if the utility owns the lights. Lessons learned from this particular undertaking include the following:

- Start with funding: the project succeeds here, so a good strong analysis of the situation and the market by both the city and the utility is key.
- Understand your rate structure and know the list of hidden places that impact financial analysis; get outside help with this if it's not forthcoming.
- In the case of ownership, thinking outside the box is a must. Debt is based on collateral, and typically the owner of the collateral pays that debt.
- This is a good time to explore an energy fund - could energy cost savings from LED street light upgrades be captured to fund future municipal sustainability projects?
- Cities and utilities benefit by having the conversation together – and quantities of scale can be achieved with multiple customers at the table.
- The project must be outlined clearly, with openness from both cities and utilities to understanding both sides of the picture.
- There are distinct advantages to working with an existing outside body for project coordination and execution, either regulatory or nonprofit. It can neutralize potentially tense situations and provide unbiased researched advice on rates, maintaining, and improving organizational bottom lines and programming for savings after debt is repaid.

Appendix 1: Glossary of Terms
In Order of Occurrence

Innovation - the development and/or scaling of a new way for local government to solve a problem or take advantage of an opportunity in urban sustainability. An innovation could be a policy, practice, tool, program, performance standard, or organizational model. Innovations proceed through a set of stages divided roughly into two categories:

- Development—which starts with research and conceptualization, then moves to prototyping and launching.
- Scaling—which spreads a proven innovation to other communities.

Breakthrough Convening – assembling to overcome a common key barrier preventing development or scaling of an innovation, or seizing an opportunity to accelerate the development or scaling of an innovation.

Light-Emitting Diode (LED) - a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for general lighting. Appearing as practical electronic components in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

Energy Efficiency (EE) - the goal to reduce the amount of energy required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Improvements in energy efficiency are generally achieved by adopting a more efficient technology or production processes or by application of commonly accepted methods to reduce energy losses.

Renewable Energy (RE) - a socially and politically defined category of energy sources. Renewable energy is generally defined as energy that comes from resources, which are continually replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat.

High Intensity Discharge (HID) - a type of electrical gas-discharge lamp which produces light by means of an electric arc between tungsten electrodes housed inside a translucent or transparent fused quartz or fused alumina arc tube. This tube is filled with both gas and metal salts. The gas facilitates the arc's initial strike.

Sodium Vapor Lamp - a gas-discharge lamp that uses sodium in an excited state to produce light. There are two varieties of such lamps:

- Low-pressure sodium (LPS) lamps - the most efficient electrical light sources, but their yellow light restricts applications to outdoor lighting; and
- High-pressure sodium (HPS) lamps - have a broader spectrum of light than LPS, but still poorer color rendering than other types of lamps.

Mercury Vapor Lamp - a gas discharge lamp that uses an electric arc through vaporized mercury to produce light. The arc discharge is generally confined to a small fused quartz arc tube mounted within a larger borosilicate glass bulb. The outer bulb may be clear or coated with a phosphor; in either case, the outer bulb provides thermal insulation, protection from the ultraviolet radiation the light produces, and a convenient mounting for the fused quartz arc tube.

Watt (W) - a derived unit of power defined as one joule per second that measures the rate of energy conversion or transfer.

Kilowatt (kW) – a unit of power that is equal to 1,000 watts.

Kilowatt Hour (kWh) - a unit of energy equal to 1,000 watt-hours or 3.6 megajoules. For constant power, energy in watt-hours is the product of power in watts and time in hours. The kilowatt-hour is most commonly known as a billing unit for energy delivered to consumers by electric utilities.

Carbon dioxide (CO_2) – a naturally occurring chemical compound composed of two oxygen atoms each covalently double bonded to a single carbon atom. It is a gas at standard temperature and pressure and exists in Earth's atmosphere in this state. Carbon dioxide is an important greenhouse gas, absorbing heat radiation from Earth's surface which otherwise would leave the atmosphere.

Sulfur dioxide (So_2) – a chemical compound that at standard atmosphere it is a toxic gas with a pungent smell. It is released naturally by volcanic activity and is a potent global warming gas.

Nitrogen dioxide (NO_2) – a chemical compound and one of several nitrogen oxides. This reddish-brown toxic gas has a characteristic sharp, biting odor and is a prominent air pollutant.

Enhanced Photometrics - the science of the measurement of light, in terms of its perceived brightness to the human eye. The human eye is not equally sensitive to all wavelengths of visible light. Photometry attempts to account for this by weighing the measured power at each wavelength with a factor that represents how sensitive the eye is at that wavelength.

Induction Lamp - a gas discharge lamp in which the power required to generate light is transferred from outside the lamp envelope to the gas inside via an electric or magnetic field, in contrast with a typical gas discharge lamp that uses internal electrodes connected to the power supply by conductors that pass through the lamp envelope.

Plasma Lamp - a clear glass orb filled with a mixture of various noble gases with a high-voltage electrode in the center of the sphere. Plasma filaments extend from the inner electrode to the outer glass insulator, giving the appearance of multiple constant beams of colored light.

IESNA/RP-8 - American National Standard Practice for Roadway Lighting (copyright 1999 by the Illuminating Engineering Society of North America).

Energy Efficiency and Conservation Block Grants (EECBG) – funded for the first time by the American Recovery and Reinvestment Act (ARRA) of 2009, the EECBG program represents a Presidential priority to deploy the cheapest, cleanest, and most reliable energy technologies in energy efficiency and conservation across the country.

American Recovery and Reinvestment Act (ARRA) - commonly referred to as the Stimulus or The Recovery Act, was an economic stimulus package enacted by the 111th United States Congress in February 2009 and signed into law on February 17, 2009, by President Barack Obama. To respond to the Great Recession, the primary objective for ARRA was to save and create jobs almost immediately. Secondary objectives were to provide temporary relief programs for those most impacted by the recession and invest in infrastructure, education, health, and renewable energy. The approximate cost of the economic stimulus package was estimated to be $787 billion at the time of passage, later revised to $831 billion between 2009 and 2019.

Energy Performance Contract (EPC) - a partnership between a company or agency seeking energy efficiency upgrades to their facilities and an energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the facilities and identifies improvements to save energy. In consultation with the client, the ESCO designs and constructs a project that meets the entity's needs and arranges the necessary financing. The ESCO guarantees that the improvements will generate energy cost savings sufficient to pay for the project over the term of the contract. After the contract ends, all additional cost savings accrue to the entity. The savings must be guaranteed.

Appendix 2: Literature Review

1. Navigant Research: http://www.navigantresearch.com/blog/smart-street-lights-face-financial-hurdles. Accessed December 2013.

2. Interview of Dave Norwood, Sustainability Coordinator, City of Dearborn, MI: Lessons Learned from the Southeast Michigan "Bright Lights, Bright Futures" LED Streetlight Convening. Completed by Susanna Sutherland, December 2013.

3. Portland General Electric website: LED Streetlights Frequently asked Questions: http://www.portlandgeneral.com/safety_outages/safety/outdoor_lighting/led_streetlights_faq.aspx Accessed December 2013.

4. The City of Napa: LED Street Lighting Coversion Frequently Asked Questions: http://www.cityofnapa.org/index.php?option=com_content&id=1714:led-streetlight-conversion-faq&Itemid=121 , Accessed December 2013.

5. The City of Berkeley, CA, Press Release on LED Street Light Conversion: http://www.berkeleyside.com/2013/10/30/berkeley-aims-to-switch-old-streetlights-to-leds/ Accessed December 2013.

6. Interview with Matt Naud, Environmental Coordinator for the City of Ann Arbor: How Ann Arbor Converted their Streetlights to LED Technology. Conducted by Susanna Sutherland, December 2013.

7. Relume Technologies Case Study on Ann Arbor Streetlight Conversion, 2011: http://www.relume.com/docs/corporate/relume_casestudy_annarbor.pdf

8. "Energy-Efficient Lighting: Why a retrofit makes sense now more than ever!" Presentation by Shelli Sedlak, Senior Lighting Specialist GE Lighting Institute, and Niel Rohleder, Traffic Operations Mgr. City of Las Vegas. Hosted by the Sustainable City Network, 2013.

9. "LED Streetlights Make Dollars and Sense", City of Asheville, NC. Original Prepared by John Cleveland of Innovation Network for Communities, September 2011. Updated by Maggie Ullman, City of Asheville Sustainability Program Manager, March 2013.

10. City of Las Vegas Evaluation of L.E.D. Street Lighting Implementation, prepared by City of Las Vegas Public Works, December 2013.

11. City of Los Angeles Street lighting Project Brief by Cree: http://www.betaled.com/us-en/LEDApplications/municipal/City-of-Los-Angeles-California.aspx, Accessed December 2013.

12. "Streetlight Disposal Research", a white paper by the City of Chattanooga, TN, Office of Sustainability. May 2011.

13. Interview with Jacqui Bauer, Sustainability Coordinator, Economic & Sustainable Development in Bloomington, IN: Indiana involvement in the Michigan convening and what it will mean moving forward. Conducted by Susanna Sutherland, December 2013.

[14] A Utility's Perspective: The Tennessee Valley Authority's Website on LED Street lighting: http://www.tva.com/environment/technology/led.htm

[15] Interview with Pamela Tierney, Energy Systems Program Manager at Wyandotte Utility, MI: A Small Local Utility's Perspective – Challenges and Needs. Completed by Susanna Sutherland December 2013.

[16] Northeast Energy Efficiency Partnerships: An Overview of the Lighting Investment in Energy Efficiency Measures: https://neep.org/efficient-products/high-efficiency-lighting/residential-lighting-strategy/lighting-public-policy/energy-efficiency-as-an-investment, Accessed December 2013.

[17] The Tennessee Valley Authority's Green Communities Program: http://www.tvaed.com/sustainability.htm, Accessed December 2013.

[18] North Carolina Utility Commission Order on LED Streetlight Rates. Duke Rate Case Report. http://www.ncuc.commerce.state.nc.us/?cm_mid=2604030&cm_crmid=%7Bb6533932-1017-e211-85ed-005056a07b49%7D&cm_medium=email&cm_mid=2810008&cm_crmid=%7B9451473b-f917-df11-9fcd-005056a07b49%7D&cm_medium=email. Accessed December 2013.

[19] Interview with Jan Patrick, Conservation Section & EECBG Program Manager, Michigan State Energy Office: A State Energy Office Perspective: Role and how Cities can Approach them for Support. Completed by Susanna Sutherland, December 2013.

[20] LED Rate Comparison_12.20.13.xls, provided by Asheville, NC as an example of Duke Streetlight Rate Setting. December 2013.

Appendix 3: One page overview of LED lighting

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

SOLID-STATE LIGHTING:

National Consortium Supports Cities in Evaluating LED Streetlights

To leverage the efforts of cities pursuing evaluations of LED street lighting products, the U.S. Department of Energy supports the Municipal Solid-State Street Lighting Consortium. The Consortium collects, analyzes, and shares technical information and experiences related to LED street and area lighting demonstrations.

Cities, power providers, and others who invest in street and area lighting participate in the Consortium to share their experiences through national and regional meetings, webcasts, web-based discussion forums, and other means. The goal is to build a repository of valuable field experience, data, and resources that will significantly accelerate the learning curve for buying and implementing high-quality, energy-efficient LED streetlights.

The Consortium provides a forum for entities with similar backgrounds and needs to share questions and answers and enables more informed decisions about LED street lighting purchases. By joining the Consortium, even small municipalities can tap into a larger body of knowledge and experience that will maximize the value of their dollars spent evaluating LED street lighting.

Through the Municipal Solid-State Street Lighting Consortium, cities of all sizes share valuable field experience that informs their investments in LED street lighting. *Photo courtesy of Pacific Northwest National Laboratory.*

Who Can Join?

Membership in the Consortium is open to municipalities, utilities, and energy efficiency organizations, with participation at various levels from interested parties.

- **Primary members** include municipalities, power providers, building owners, and other decision-makers who invest in street and area lighting.
- **Advisory members** are solicited from organizations with a known history of promoting quality lighting and energy efficiency (e.g., educational institutions, environmental monitoring agencies) and are selected to fill specific Consortium needs.
- **Guests** include individual employees of organizations that meet the requirements for membership but whose organizations have chosen not to join.

The Consortium is intended to be a user's group, focused on the needs of participants making investments in street and area lighting. Manufacturers are excluded from membership, although they may be invited to present information on select topics at Consortium meetings and may also be given an opportunity to review and provide comment on draft specifications and other materials prior to their issuance.

How Can I Join?

Simply fill out the membership application on the Consortium website: ssl.energy.gov/consortium.html.

Related Materials

DOE offers a variety of resources to guide municipalities, utilities, and others in their evaluation of LED street lighting products. See ssl.energy.gov/resources.html or ssl.energy.gov/information_resources.html to download any of the following, including the video *Considering LEDs for Street and Area Lighting*.

Appendix 4: Meeting Agenda

SOUTHEAST MICHIGAN REGIONAL ENERGY OFFICE

BRIGHT LIGHTS, BRIGHT FUTURES:

LED Street Lights for Southeast Michigan Communities

Wednesday, November 13th
8:00 a.m. – 4:00 p.m.
Ford Performing Arts Center, Studio A
15801 Michigan Avenue, Dearborn, MI 48126

AGENDA

8:00 a.m. Registration & Breakfast

9:00 a.m. Welcome & Introductions

- Mayor John B. O'Reilly, Jr., City of Dearborn
- David Norwood, Sustainability Coordinator, City of Dearborn
- Jacob Corvidae, Green Programs Manager, EcoWorks

9:30 a.m. Why LED Street Lighting?

Learn about the benefits of upgrading city street lights to LEDs and an approach that one local government took to upgrading 30,000 city street lights.

- Maggie Ullman, Chief Sustainability Officer, City of Asheville, North Carolina

10:30 a.m. Where Are We Today?

DTE Energy's Community Lighting Team will present an overview of LED street lights in southeast Michigan communities.

- Ed Henderson, Manager, Community Lighting Department, DTE Energy

Planning for Your City's LED Street Light Project

Learn how DTE Energy approaches its projects, and the nuts and bolts of how to plan your LED street light project.

- Jeff LeBrun, Principal Supervisor, Community Lighting Marketing & Sales, DTE Energy

11:15 a.m. Peer-to-Peer Panel Discussion

Local governments will hear about the challenges and opportunities faced by southeast Michigan local governments endeavoring to conduct LED street light upgrades, as well as hearing strategies for success from peers.

- Carlo Santia, Director, Planning & Community Development, Clinton Township
- Christopher Rayes, Community Service Director, St. Clair Shores
- Nathan Geisler, Energy Programs Associate, City of Ann Arbor
- Robert Cady, City Controller, City of Roseville
- Steve Duchane, City Manager, City of Eastpointe
- Stan Kirton, DPW Director, City of Ypsilanti

AGENDA, CONT.

12:15 p.m. **Collaborative Working Lunch**

1:15 p.m. **Keynote Address**

Mike Lambert, KCL Engineering
The future of LED lighting, how it works and how it's evolving.

Jim Frazer, Gridaptive Technologies
Current status and future evolution of roadway lighting controls.

2:15 p.m. **Networking break**

2:30 p.m. **Financing Strategies**

Financing LED street light projects in the municipal market presents unique challenges and opportunities. In this session, several options available to city governments will be discussed. The session will highlight bond financing with the Regional Energy Office, Program-Related Investments (foundation funding), street light assessments and millages, and DTE Energy's Energy Optimization program.

- Conan Smith, Board Treasurer, Southeast Michigan Regional Energy Office
- David Massaron, Attorney and Counselor at Law, Miller Canfield
- Ken Randazzo, Manager, Commercial Energy Optimization Programs, DTE Energy
- Todd O'Grady, Commercial Program Coordinator, Michigan Saves

3:15 p.m. **Regional Energy Office Lighting Consortium**

Southeast Michigan local governments are invited to hear about a step-by-step process for planning LED street light upgrades and participating in a regional collaborative lighting consortium.

- Conan Smith, Board Treasurer, Southeast Michigan Regional Energy Office
- Jacob Stevens Corvidae, Board President, Southeast Michigan Regional Energy Office

4:00 p.m. **Conclusion and Sponsor Recognition**

Appendix 5: Bright Lights, Bright Futures Form Indicating City Interest

Bright Lights, Bright Future

LED Streetlights, Nov 13, 2013

ID	
	NAME: TITLE: COMMUNITY:

A	
Top Reasons Why	

B	
Barriers	

SOUTHEAST MICHIGAN REGIONAL ENERGY OFFICE

Bright Lights, Bright Future

LED Streetlights, Nov 13, 2013

C Solutions of Interest	

D Recruit	NAME: TITLE: COMMUNITY:

Please check one of the option below and turn in before leaving. Note that joining the consortium does not commit your city at this time. Rather it is a personal commitment to see this project move forward.

- ❑ I would like to join the lighting consortium and pursue regional street light upgrades
- ❑ I am interested in the lighting consortium but don't know if I want to participate yet
- ❑ I am interested in street light upgrades, but intend to pursue it independently
- ❑ I am not interested in street light upgrades at this time.

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Appendix 6: Sample LED Rate from Duke

Duke Energy Progress (North Carolina)		
Street Lighting Service, SLS-26		
As of December 1, 2013		
Basic Rate (Non-LED Lighting)		
	Monthly	**Monthly**
Fixture Type:	**Cost/Fixture**	**kWh/Fixture**
Sodium Vapor 5,800 lumen	$7.21	29
Sodium Vapor 9,500 lumen	$9.91	46
Sodium Vapor 16,000 lumen	$13.23	59
Sodium Vapor 28,500 lumen	$17.20	109
Sodium Vapor 50,000 lumen	$20.55	152
Metal Halide 9,000 lumen	$12.77	41
Metal Halide 20,000 lumen	$19.02	94
Metal Halide 33,000 lumen	$24.81	133
Metal Halide 110,000 lumen	$51.02	370
7,000 lumen semi-enclosed (mercury vapor)	$9.71	69
7,000 lumen (mercury vapor)	$10.44	69
12,000 lumen (Retrofit Sodium Vapor)	$11.50	59
21,000 lumen (mercury vapor)	$16.61	149
22,000 lumen (Sodium Vapor)	$14.41	86
38,000 lumen (Retrofit Sodium Vapor)	$17.68	135
40,000 lumen (metal halide)	$26.32	160
60,000 lumen (mercury vapor)	$34.88	382
Sources:		
Progress Energy Standard Street Lighting Service (SLS-26)		
Progress Energy Outdoor Lighing Matrix (NC-SLS-24)		

Basic Rate (LED Lighting)						
	Company Owned - Standard Option				**Customer Owned Option**	
	Monthly Per Fixture				**Monthly**	**Monthly**
Fixture Type:	**Basic Rate**	**Monthly Facility Charge (MFC)**	**TOTAL**	**kWh/Fixture**	**Cost/Fixture**	**kWh/Fixture**
LED 75	$6.42	$1.92	$8.34	25	$5.59	25
LED 105	$9.20	$1.13	$10.33	35	$6.07	35
LED 215	$13.54	$2.90	$16.44	73	$7.72	73
LED 205 Site Lighter	$13.59	$8.59	$22.18	69	$7.55	69

Special Street Lighting Poles and Posts	
Type	**Monthly Charge Per Pole/Post**
Wood	$1.60
Metal, Fiberglass, or Post	$2.80
12-Foot Smooth Concrete Post	$9.81
Decorative Square Metal	$11.62
16-Foot Smooth Concrete Post	$10.79
13-Foot Fluted Concrete Post	$14.72
Decorative Aluminum 12-Foot Post	$17.66
Decorative 35- or 39-Foot Tapered Metal Pole	$28.04
System Metal	$0.96

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