Measure: Enhanced LED Street Lighting Initiative (G3, E21, E21b)

Commit to a systematic replacement of all 8,222 residential streetlights that currently use low and high-pressure sodium (HPS) lamps with LED fixtures, providing equal or improved illumination at an attractive net savings over the estimated 15-year life of an LED fixture (vs. 5 years for an HPS lamp and 3 years for an LPS lamp).

Accomplish this by replacing 240 per year 2012-2020, and implementing a financial accounting system wherein the City uses the monies saved from these initial LED re-lampings for continued LED relampings of all existing streetlights.

The analysis below concerns only the replacement of 240 lamps per year 2012-2020, a total of 2,160.

COT Summary:

Emission reduction potential:	520 tCO_2e
Percentage of goal (2020):	.02%
Total annual average implementation costs:	$113,000
Entity that bears the costs of implementation:	City of Tucson
Cost/Savings per tCO_2e in 2020:	$306
Net annual savings in 2020:	$150,000
Entity that realizes the financial return:	City of Tucson
Equitability (progressive/regressive, income/revenue neutral, etc):	Life cycle savings will ultimately result in lower lighting expenditures in the COT budget
Potential unintended consequences:	Technology advances even more energy efficient than LEDs prior to the end of the LED design life

Note:

Over the 20-year lifetime of the 2,160 lamp replacements from 2012-2020 recommended by this measure, the City is projected to realize:

Savings of ~11,000 tCO_2e.
Savings to the City of ~$2.16 million.

Background information:

The City of Tucson currently maintains over 9,000 residential, grid-connected streetlights, some 850 now featuring LED fixtures. These streetlights use a mix of 4,447 high-pressure sodium lamps and 3,775 low-pressure sodium lamps. In 2008, City of Tucson streetlights were responsible for 5% of total City government greenhouse gas emissions.[1]

Light emitting diodes, or LEDs, are semiconductor diodes that emit light when conducting a current. LED fixtures consume less energy than traditional sources for the same amount of illumination. The design life of LEDs is generally many times that of traditional incandescent lamps.

By replacing City street lights (low and high pressure sodium vapor) with LED fixtures, the City could save a significant amount of money and reduce both energy consumption and greenhouse gas emissions. LED street lighting is a very popular energy efficiency, cost savings, and climate mitigation measure being taken by governments and industries across the country.

Compared to 2009, the City saved $2,848.42 in energy costs in November 2010 for the initial 850 lamps installed with ARRA funding. Over a year, the savings for these 850 streetlights should amount to $34,176. Through the 2020 period, energy savings from the 850 replaced lamps should total $341,760. The 850 lights represent about 10% of the inventory of streetlights still awaiting relamping.

Theoretical savings for all remaining 8,222 streetlights would be 10 times the $34,176 amount, or $341,176/year at 2010 electricity rates.

Description of Measure and Implementation Scenario:

The City should continue to invest in a streetlight lamp conversion initiative, with the goal of using savings from the initial 850 LED streetlight conversions funded under the 2009 Energy Efficiency and Conservation Block Grant to help finance the conversion.

Energy performance contracting services may also be needed if deployment of LED lamps is to occur within the 2020 time frame (see below).

As energy cost savings accrue month by month, the City could begin pooling these savings so that subsequent stages of LED relamping could be financed in part out of savings from previous relampings. The design of such a financing system would need to be worked out by the City, but in practice this should not be difficult.

Has the Measure been implemented elsewhere and with what result:

As of the beginning of 2010, 90 percent of the nation's lighting was in the form of high-pressure sodium, vapor lamps, while only 1 percent of the nation's streetlights employed LED lighting.[2] However, new municipal projects are beginning to come on line and significant inroads in LED re-lamping are being made.

In 2010, **Seattle City Light** installed 5,000 LED streetlights in residential neighborhoods and plans a total of 40,000 LED conversions during the next five years. City Light expects the LED streetlights to save $294,000 in the first year and $2.4 million per year once all 40,000 have been installed.[3]

The **City of Los Angeles**, CA is embarking on a major LED streetlight re-lamping project expected to take five years and replace 140,000 existing lamps with LED fixtures.[4] Projected annual energy and maintenance savings, post-retrofit, are projected at $10 million with annual energy savings of 68,640,000 kWh/year. Total project costs of $57 million give an expected payback of 7 years.[5]

Energy/Emission analysis:

Of the City's 8,222 residential streetlights eligible for conversion to LED, 4,447 are HPS lamps and 3,775 are LPS. 3306 are rated at 120W and 1,141 are rated at 175. (Actual lamp ratings are 100W and 150W before ballast power draw is added.)

Each high-pressure sodium lamp targeted for replacement is rated at either 110W or 150W. Factoring in added ballast power draw, actual power consumed per hour of use is 120W and 175W.

The HPS lamps (4,447) currently operate 10 hours/day. The 1141 175W HPS lamps thus consume 728,814 kWh/year. The 3306 120W HPS lamps consume 1,448,028 kWh/year. Combined, the HPS street lamps consume 2,176,842 kWh/yr

The remaining 3,775 LPS lamps for conversion to LED are rated at 110W. They consume 1,512,662 kWh/year.

Total energy consumption by the remaining HPS and LPS City street lights is 3,692,504 kWh/year.

At 53W/fixture, 8,222 LED lamps would consume 1,590,545 kWh/year.

Thus, total energy savings from relamping all 8,222 HPS and LPS street lights with 53W LED fixtures is 3,692,504 – 1,590,545 = 2,182,959 kWh/year, or 265.5 kWh/year per lamp.

Upon conversion of all remaining 8,222 non-LED street lights to LED fixtures, the greenhouse gas emissions reduced through the savings of 2,182,959 kWh/year amount to 1,980 tCO_2e/year.

This analysis assumes that the City replaces 2,160 lamps from 2012 to 2020 at the rate of 240 per year. Each LED lamp is assumed to save 265.5 kWh/yr.

Assuming an average of six months of savings in the first year of installation for 240 lamps, the GHG emissions savings would be small – 29 tCO_2e. For 2,160 lamps in place in 2020 and each saving 265.5 kWh/year, the GHG savings is projected to be ~520 tCO_2e.

Climate Change Impact Summary in tCO_2e:

COT 1990 Citywide GHG emissions (baseline):	5,461,020 tCO_2e
MCPA 7% reduction target for COT:	5,078,749
2012 BAU GHG emissions projection:	7,000,000
2020 BAU GHG emissions projection:	7,343,141
GHG emissions reduction to meet 7% goal (2012):	1,921,251
GHG emissions reduction to meet 7% goal (2020):	2,264,792
Contribution of this Measure:	520

Economic analysis:

Measure Benefits

The City pays $0.07/kWh in 2011 for street lighting electricity.[6] Assuming rates increase 2.4%/yr. as projected by Westmoreland Associates, savings of this measure in 2021 at full deployment of the 2,160 LED lamps would be ~$51,000. Accumulated savings from 2012-2020 is projected to be ~$125,000. Savings over the 20-year lifetime of the lamps is projected at $1.16 million.

An additional cost savings to the City occurs in avoided/deferred maintenance. An LED lasting 20 years would avoid the costs of replacing LPS lamps every three years. The City reports this savings potential at $150/lamp per replacement, or $450/lamp over a ten-year period.[7]

This analysis assumes that each LED, when installed, is credited for saving 6 replacements during its lifetime at $150 each. Thus, the City's investment of ~$113,000 each year results in maintenance savings of ~$216,000 and electricity savings of 265.5 kWh at between $0.7 and $0.14/kWh.

It is reasonable for the City to invest the annual savings from electricity and maintenance into continual relamping until all 8,222 street lights have been replaced.

Financial analysis of such a program should be performed when considering the source of capital for relamping.

Measure Costs

Estimated labor and materials for each HPS/LPS-LED replacement is $470. Each year for nine years, 240 lamps are replaced at ~$113,000/yr, or $1.015 million.

Net Economic Impact

In the year 2020:

Measure Benefits in 2020:	$263,000 (including lifetime maintenance savings)
Measure Costs in 2020:	$113,000
Net Savings in 2020:	$150,000

The savings per tCO2e in 2020: $306. Savings per tCO2e from 2012-2020: $487. Savings per per tCO2e over lifetime of the LEDs: $198.

By 2020, this measure will have cost the City ~$1.02 million. Lifetime maintenance savings of the LEDs is projected to be $1.94 million, and the City is saving $51,000/yr. in electricity costs. Total net savings: $2.089 million.

Applying an economic impact multiplier of 1.5 to the energy saved, the City economy would benefit:

In 2020:	$225,000
By 2020:	$1.7 million.
Lifetime of the LEDs:	$3.2 million.

Co-benefits:

Co-benefits of LED streetlight conversion include reduced City maintenance costs for periodic re-lamping as LED lamps outlast HPS and other incandescent lamps by a factor of at least 10 –15 years. The current operational life of white LED fixtures is 100,000 hours, which is 11 years of continuous operation (or 22 years of 50% operation.)[8]

Cost savings potential of avoided maintenance is calculated above. Because of their directional output, LEDs are also better at placing their light in a single direction than incandescent or fluorescent bulbs.[9] LED lights are more rugged and damage-resistant than compact fluorescents and incandescent bulbs. LED lights don't flicker.

Equitability:

The measure has a cost benefit to the entire community in that electricity savings from each deployment of LED fixtures will be used to invest in additional LED conversion until the full compliment of 9,072 City-owned/maintained residential streetlights are converted.

Potential unintended consequences:

One unintended consequence might include advances in more cost-effective and energy efficient streetlight technology becoming commercial before the end of the design life of the LED fixtures. There is also the issue of overall life-cycle environmental impacts of Led vs. alternative streetlight technology.

A University of Pittsburgh study on the subject recently concluded that LEDs contain "fewer harmful materials" than other lighting technologies, however it is more energy intensive.[10]

Thus, though LED fixtures are not as difficult a product to manage, do not contain mercury, and are not encased in glass, best practices still call for some form of responsible materials management/solid waste management plan to be in place to recapture as much as possible of the original metal and other materials in the LED fixture before disposal in a regulated disposal site.

Endnotes

[1] Regional Greenhouse Gas Inventory. Pima Association of Governments. October 2010.

[2] Pittsburgh Post-Gazette.com. January 18, 2010. http://www.post-gazette.com/pg/10018/1029038-53.stm.

[3] Powerlines. Seattle City Light. 2010. http://powerlines.seattle.gov/2010/07/07/seattle-city-light-begins-led-streetlight-rollout/.

[4] City of Los Angeles LED Street Lighting Case Study. http://www.mwcog.org/environment/streetlights/downloads/CCI%20Case%20Study%20Los%20Angeles%20LED%20Retrofit.pdf.

[5] Ibid.

[6] Communication with Mr. Ernie Encinas, Transportation Department, City of Tucson, November 15, 2010.

[7] Communication with Mr. Ernie Encinas, City of Tucson. January 2011.

[8] LightComp LED Corp. 2010. http://www.lc-led.com/articles/ledlights.html.

[9] NAHB Research Center. http://www.toolbase.org/Technology-Inventory/Electrical-Electronics/white-LED-lighting.

[10] Pittsburgh Post-Gazette. op. cit.