Measure: Residential Solar Street Lights (E22)

Install solar-powered LED streetlights whenever new streetlights are added to Tucson residential areas. The initial installment of 1,000 solar streetlights will be evaluated as to energy savings and used to benchmark additional solar streetlight deployment in future years.

Note: The potential savings from this measure are uncertain enough that the GHG emissions savings are not counted towards achievement of the City's 2012 and 2020 goals. The reasons are (1) solar streetlights appear to be cost-effective already in 2011, so the measure would not make a difference in whether they were purchased or not; and (2) the additional of streetlights in residential streets is optional for the City, so numbers of installations to 2020 could range from zero to thousands.

Emission reduction potential by 2020:	176 tCO_2e/yr.
Percentage of goal (2012):	0.00009%
Percentage of goal (2020):	0.008%
Total annual average implementation costs:	$0 – Solar is less expensive than alternatives in 2011
Entity that bears the costs of implementation:	City of Tucson (new residential street lights are optional)
Cost/Savings per tCO_2e in 2020 and over lifetime of solar streetlights:	Savings: $96 / tCO_2e
Net annual savings in 2020:	$16,768 / year
Entity that realizes the financial return:	City of Tucson
Equitability (progressive/regressive, income/revenue neutral, etc):	Neutral
Potential unintended consequences:	Insignificant

Note:

Net savings 2011-2020 is projected at: $84,680. Net savings over lifetime of the solar streetlights is projected at: $381,000.

Background information:

In residential areas where conventional, grid-connected electric streetlights have yet to be installed, neighborhoods in the U.S. and overseas are beginning to adopt stand-alone solar or hybrid, solar-wind powered streetlights.

These lights have first-cost, energy savings, and greenhouse gas reduction benefits apart from benefits in the way of security and better night and low-light visibility for traffic.

In a solar streetlight, a solar panel absorbs sunlight and converts it to electricity to generally to power a 60W LED pole-mounted street light. The overall streetlight system consists of a small solar panel, a 60W LED street light fixture, a battery, controller, and a pole 18-24 feet high. Exact system specifications will depend on average local solar insolation, desired working hours per day of the streetlight, and backup days of storage desired for periods of low/no sun.

One Tucson neighborhood is included among the early adopters nationwide.[1] It is currently in the design phase of a project featuring 40-50 pole-wrapped solar collectors, and a Ni-CD battery with an 11-year life span.

Status Quo / Business as Usual:

The City of Tucson currently maintains some 9,000 residential, grid-connected streetlights, some (850) with LED fixtures and the remaining 8,150 use high-pressure sodium lamps. There are more neighborhoods in the City without streetlights than there are with streetlights and the number of potential solar street lighting opportunities is in the “thousands.”[2]

The Business As Usual scenario in the short-run includes City of Tucson difficulty obtained the capital investment funds for new streetlights – making the ability to use energy-efficiency or solar-energy grants more important.

Description of Measure and Implementation Scenario:

This measure proposes the installation of solar-powered LED streetlights whenever <u>new</u> streetlights are being planned for installation in Tucson neighborhoods.

An initial analysis is provided here for 1,000 such streetlights, although the total number of potential new solar streetlights is much higher. We do not forecast when the solar lamps might be installed over the decade, but set a target of 1,000 lamps in place by 2020. We suggest this as an opportunity for funding sources such as grants, additional federal or state transportation/community development or energy programs, or utility partnerships.

Has the Measure been implemented elsewhere and with what results:

Using a combination of solar, wind and battery power, the Prentiss Creek Subdivision in Downers Grove, Illinois (a Chicago suburb) is the first residential subdivision in the United States with hybrid streetlights.[3]

The Prentiss Creek Hybrid Street Light Project includes 25 energy-efficient streetlights comprised of wind turbines, solar panels and LED lights. The system uses no electricity from the grid. The super-quiet vertical-axis turbines work in both low and high winds. The sealed batteries located at the base of the pole store up to three days worth of electricity and are good for about 10 years. A special coating on the traditional-style concrete post is graffiti-proof.

The self-contained hybrid system is designed to last for up to 100,000 hours, compared to conventional lighting systems that need to be replaced after 10,000 hours. When compared to traditional streetlights, it is estimated the hybrid system will save 500,000 kilowatts of electricity and reduce carbon dioxide emissions by nearly 350 tons over a 30-year period. Nearly half of the $282,500 project was funded by Community Development Block Grant (CDBG) Agreement from the DuPage County Neighborhood Investment Program.

The Prentiss Creek Hybrid Street Light Project took about six months to complete, requires little maintenance, saves money and reduces carbon emissions while providing much needed light to the neighborhood.

Energy/Emission analysis:

If solar LED street lights are assumed to substitute for grid-connected LED streetlights, then the energy savings per light is the 53 W of the lamp times 10 hours of daily usage incurred by an LED fixture, or 193 kWh/year. For 1,000 solar streetlights this amounts to an annual energy savings of 193,000 kWh.

If solar LED streetlights are assumed to substitute for grid-connected high-pressure sodium lamps, then the energy savings per light will be the 1.3 kWh/day usage incurred by a high-pressure sodium fixture, or 475 kWh/yr. For 1,000 solar streetlights, this amounts to an annual energy savings of 474,500 kWh/year.

Greenhouse gas emissions reductions for this example total 175 tCO_2e (193,450 kWh x 2.0 pounds CO_2/kWh divided by 2205 pounds/metric ton) for the avoidance of grid-connected LED electricity use.

Solar streetlamps in lieu of grid-connected HPS lamps save 475 kWh/year each. One thousand solar streetlights on-line in 2020 would thus save the City 475,000 kWh of electricity.

Greenhouse gas emissions reductions for this example total 431 tCO_2e (475,000 kWh x 2.0 divided by 2205 pounds/metric ton = 431 tCO2e. There is a range of savings, from 175 – 431 tCO_2e depending on the type of gird-connected fixture to be avoided.

Climate Change Impact Summary in tCO_2e:

COT 1990 Citywide GHG emissions (baseline):	5,461,020
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):	2,264,392
Contribution of this Measure in 2020:	176

Economic analysis:

Measure Costs

This involves comparing the complete installed cost of a conventional street light and annual electricity consumption with the complete installed cost of a solar streetlight.

Based on information from the City Department of Transportation, the installed first cost of a new, conventional pole mounted LED or high-pressure sodium lamp is $6,000 in addition to site-specific excavation, trenching, foundation and conduit costs.[4]

Based on information from one company with a commercially available solar street lamp product, the following data are available. The company, Solar Illuminations, offers the following product:[5]

> A SL01 Solar “High Lux” Street solar-powered streetlight uses the latest LED and SMD technology. Illumination time is generally from dusk to dawn and is fully automated via a photocell (light sensor). The lamp head attaches to the support arm that, in turn, fixes to the pole. The pole has an integral base that can be bolted directly to a level, solid surface. A ground anchor kit and templates are included. A battery box is supplied to facilitate the rechargeable batteries. The 140w or 180w solar panel attaches direct to the pole and is rated for use in most applications.
>
> This system stores reserve power to allow for up to several days of cloudy weather. The light head is fitted with either 744 Cree® LED's, 552 Cree® SMD's,

> 972 Cree® LED's or 720 Cree® SMDs which have a typical lifespan of approximately 100,000 hours (about 22 years).
>
> Prices for typical systems start at $3,000. The standard, stocked product is the 552 SMD lamp with a 20' pole, which is a popular choice for most customers. Shipping costs will vary and are subject to quantity, size and weight of shipment as well as delivery address. The more powerful 972 LED sells for $4000 and provides almost 6,000 lumens. For a majority of US states, domestic shipping is typically (on average) around $500 for one street light with 20' pole and around $350 for each subsequent street light with 20' pole sent at the same time to the same address. (Retail prices for the 552 and 972 are $3500 and $5500.)

Thus, the cost of a solar streetlight (not including installation or non-retail discounts available) comes to approximately either $3500 or $5500, shipping included. Solar street lights avoid the need for trench excavation and conduits. Only a foundation for the pole is necessary.

From this analysis, the cost of hardware for a complete, pole-mounted solar street light as defined above is <u>cost-neutral or cheaper</u> that the cost and installation of a conventional pole and street lamp assembly, whether LED or HPS illuminated.

Measure Savings

If solar LED street lights are assumed to substitute for grid-connected LED streetlights, then the energy savings per light is the 0.53 kWh/day usage incurred by an LED fixture, or 193.5 kWh/year.

For 1,000 solar streetlights this amounts to an annual energy savings of 193,500 kWh.

If solar LED streetlights are assumed to substitute for grid-connected high-pressure sodium lamps, then the energy savings per light will be the 1.3 kWh/day usage incurred by a high-pressure sodium fixture, or 474.5 kWh/yr. For 1,000 solar streetlights, this amounts to energy avoided of 474,500 kWh/year.

Avoided electricity cost for street lighting in Tucson is presently $0.07/kWh.[6] We expect electricity rates to increase 2.4% per year to 2020, meaning that street lighting rates would be $0.087/kWh in 2020.

The analysis below assumes that 100 solar streetlights are installed each year 2011-2020 replacing LED streetlights.

> Total savings in 2020: $16,768
> Total savings to 2020: $84,680
> Total savings over 20-year lifetime of streetlights (extending to 2040): ~$381,000

Net Economic Impact

Measure costs are projected at zero since solar street lights are less expensive to install than grid-connected LED lights. Measure net savings are therefore the total savings figures above.

The savings per tCO2e in 2020: $96. Savings per tCO2e from 2012-2020: $89. Savings per per tCO2e over lifetime of the lights: $109.

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

In 2020:	$ 25,000
By 2020:	$127,000
Lifetime of the lights:	$571,000

Co-benefits:

In addition to the economic benefits from elimination of grid-connected electricity costs, there will be savings as well from reduced maintenance on a grid-connected street-lighting project.

Other co-benefits of solar streetlights include:

1) No line voltage, trenching, or metering;
2) No power outages;
3) Able to employ battery backup for cloudy or rainy days (estimated 11-year life for the Tucson solar street light project now in design);
4) Distributed light and power - no single point of failure for enhanced security;
5) Easy to install with quick connect plugs - less than 1 hour;
6) No scheduled maintenance for up to 15 years;
7) No cost of replacing concrete, asphalt or landscaping from trenching;
8) No cost of transformers or meters to be added for electric service;
9) Possible qualification for savings from various state and federal taxes and utility incentives;
10) Controlled charging to prolong battery service life;
11) Reduced emissions of criteria air pollutants from utility electricity production;
12) Self-contained-light on/off controlled by automatic daylight sensing or hour preset, thus no running or maintenance cost; and
13) Safe 12 volt / 24 volt circuit with little to no risk of electric shock.

Equitability:

Equitability would only be impacted if the new residential streetlights were inequitably deployed not in lower income neighborhoods, or if the City's utility savings were inequitably spent. Neither of these outcomes seems likely and the savings are not a significant amount of dollars, so we believe the measure has a neutral equitability effect.

Potential unintended consequences:

Stand-alone solar streetlights will provide illumination in the event of a power failure to the installation area. This could have unintended but very positive benefits in the way of enhanced community security in what would otherwise be a blackout situation due to storm damage, heat wave-triggered grid overload, or other causes.

On the other hand should low-sun conditions persist beyond the storage capacity of the streetlight batteries the lights would no longer be operable. In Tucson, the prospects of three consecutive occluded days are remote.

Vandalism is always a possibility but is not considered unique to solar vs. conventional streetlights. Possible theft of solar panels is also possible, however a 20-foot pole elevation for a solar panel should be a significant deterrent to any but the most determined and resourceful thief.

Endnotes

[1] Conversation with Mr. Bruce Plenk, Solar Energy Manager, City of Tucson. October 15, 2010.

[2] Conversation with Mr. Ernie Encinas, Transportation Department, City of Tucson, 520-791-3154, November 15, 2010.

[3] Energy Boom. "Chicago Subdivision is First Residential Subdivision in U.S. with Hybrid Street Lights." April 7, 2010. http://energyboom.com/wind/chicago-suburb-first-residential-subdivision-us-hybrid-street-lights

[4] Encinas. Op. cit.

[5] Solar Illuminations. 2010. http://www.solarilluminations.com/acatalog/Solar_Street_Lights___Parking_Lot_Lighting.html

[6] Encinas. Op.cit.