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Adopting Energy-Efficient Technologies for Street Lighting: Overcoming Challenges for Utilities

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Many utilities and state and local governments are exploring energy-efficient street lights to help meet energy efficiency goals, curb carbon emissions, decrease operation and maintenance needs, and reduce energy costs. Street lighting can account for up to 40-45% of total municipal energy costs.[1]

In order for municipalities across the United States to take advantage of cost savings associated with light-emitting diode (LED) street lighting, cities either need to own their street lights or be serviced by a utility that offers an attractive LED tariff and is willing to convert to LED technology. Therefore, cities are requesting that investor-owned utilities (IOUs) develop LED tariffs and convert street lights to LED technology, or sell the street light assets (through "buyback programs") so the cities can invest in upgrades themselves.

Beyond requests by customers for utility investments in energy efficiency technologies to reduce energy bills, other utility motivations to upgrade street lights include improved relations with municipalities who are requesting LED lighting upgrades,[2] improved lighting quality for public safety,[3] and meeting climate, environmental and efficiency goals. Even where not called out as a specific measure for achieving these public policy goals, street lighting conversions are often a low cost way for utilities to help achieve them.

This brief discusses energy-efficient street lighting technologies and conversions from the utility's perspective and identifies various business cases for undertaking street lighting upgrades. Section 1 of the brief reviews the costs and benefits of utility investment in energy efficiency technologies and smart infrastructure for utility-owned streetlights. Section 2 presents lessons learned and best practices for LED conversions for utility-owned street lights. Section 3 discusses street light buyback options from the utility's perspective. Section 4 reviews success factors for LED conversions. The resources listed at the end of the brief provide more information.

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[1] See http://aceee.org/partnerships-reduce-energy-use-public-outdoor#_ftn2 and http://www.navigantresearch.com/blog/smart-street-lights-face-financial-hurdles#pq=xfjXDG. In at least one region (the Delaware Valley), street lighting can account for up to 70% of municipal energy Costs. Source: Elizabeth Compitello, personal communication, January 2017.

[2] See http://energy.gov/eere/ssl/gateway-demonstration-outdoor-projects for a number of case studies that include user surveys; users invariably rate the new lighting as superior to the conventional lighting it replaces.

[3] See http://www.leotek.com/education/documents/Leotek.LED.Streetlight.Guide.V7-101613.pdf

1. Economics of Utility Investment in Energy Efficiency Technologies and Smart Infrastructure for Utility-Owned Street Lights

Many jurisdictions around the country have implemented LED street light upgrade projects, providing energy savings, improving lighting quality, and saving money for the municipal governments that pay the energy bills.

From the utility's perspective, LED upgrades may mean reduced revenue (more efficient technologies reduce energy usage and, therefore, retail energy sales) and, in the case of customer buyback programs, sale of capital assets. There is little incentive to invest in a new technology that will likely reduce retail energy sales and revenues when the existing street lights are still functional and provide revenues without requiring additional expenditures. On the other hand, LED upgrades can boost customer satisfaction, may help utilities fulfill regulatory mandates (and in some cases earn shareholder incentives from doing so), and offer a variety of non-traditional earnings opportunities.

Figure 1 summarizes the costs, benefits, and compensation options for utilities[4] and customer and community benefits from LED conversion projects for utility-owned street lights.

Figure 1. Costs and benefits of utility investments in street lighting conversions

Costs to the Utility

- Upfront capital costs for LED technologies and controls
- Installation costs
- Program administration costs
- Regulatory filing and compliance costs
- Stranded asset costs if working lamps are replaced

Utility Benefits

- Improved customer service and satisfaction
- Reduced O&M requirements
- Compliance with applicable regulatory mandates

Utility Compensation Options

- On-bill financing of amortized costs
- Specialty tariffs
- Municipals pay some or all upfront capital costs
- Charges that recover stranded costs

Customer and Community Benefits

- Monthly energy bill savings
- Reduced carbon footprint
- Improved lighting quality
- Achieved energy effiency goals
- O&M savings
- Enabling compatibility with lighting controls

[4] Ultimately, utility customers — typically, the individual municipal customers requesting the upgrades — pay for prudently incurred costs through approved street lighting tariff rates.

1.1. Earnings impacts of LED conversions

The regulatory environment in each state affects the earnings impacts on utilities resulting from LED conversions of street lights. For example, about a dozen states currently have a decoupling mechanism in place for electric utilities[5] — a ratemaking mechanism that mitigates the impact on utilities from revenue erosion between rate cases and encourages them to run effective energy efficiency programs.

Decoupling dissociates the utility's profits from its sales of the energy commodity. Instead, rates are adjusted up or down to meet the revenue target at the end of the adjustment period. This mechanism is intended to motivate utilities to consider all options when planning and making resource decisions on how to meet their customers' needs.[6] States that have enacted decoupling have removed a barrier to utility street lighting upgrades, as reductions in customer electricity usage no longer lower utility revenues between rate cases. However, efficient lighting decreases energy sales, and even with decoupling, reduces both the need for future capital investments in grid infrastructure (and, for vertically integrated utilities, supply-side investments) and the opportunity for utilities to earn a return on those investments.

About half of U.S. states use another regulatory tool to encourage energy efficiency — shareholder performance incentives for utilities that meet or exceed their annual energy efficiency goals.[7] Such incentives help align utility business models with the state's public policy goals.[8] In some cases, utilities may have an opportunity to *increase* revenues through street lighting conversions. (See Section 2 of this brief.)

Some states such as Maryland explicitly permit utilities to include energy savings from LED street lighting to meet energy efficiency goals set by legislation.[9] This regulatory framework is also in place in California and Colorado, where utilities can offer rebates and other financial incentives from energy efficiency program budgets to help buy down the costs of street lights for their municipal customers and take credit for meeting state energy efficiency goals. In turn, utilities can move closer to earning shareholder incentive payments. Legislative or regulatory efficiency targets that recognize street lighting upgrades, combined with energy efficiency program funding for the upgrades, provide opportunities for municipalities and utilities to work together.

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[5] Lowry, M.N., M. Makos, and G. Waschbusch (2015), *Alternative Regulation for Emerging Utility Challenges: 2015 Update.* http://pacificeconomicsgroup.com/mnl/EEI%20Altreg%20Survey%202015%20Advanced%20Copy.pdf.

[6] http://www.raponline.org/wp-content/uploads/2016/05/rap-revenueregulationanddecoupling-2011-04.pdf

[7] For electric utilities, natural gas utilities, or both.

[8] See Seth Nowak, Brendon Baatz, Annie Gilleo, Martin Kushler, Maggie Molina and Dan York, "Beyond Carrots for Utilities: A National Review of Performance Incentives for Energy Efficiency," American Council for an Energy-Efficient Economy, May 2015, http://aceee.org/sites/default/files/publications/researchreports/u1504.pdf.

[9] http://energy.maryland.gov/Pages/Facts/empowerPlanning.aspx. It is worth noting that this policy is not necessarily providing a large incentive to Maryland utilities to lower LED tariffs; see, for example, the city of Takoma Park's conversion, which was priced at $1200 per light: https://documents.takomaparkmd.gov/government/city-council/agendas/2016/council-20160921-3.pdf.

1.2. Utility investment in smart infrastructure

In the long run, utility revenue opportunities in LED technologies for street lights go well beyond light fixtures. Utilities can use street light infrastructure to improve on distribution system controls or help build out infrastructure for “smart cities.”[10] These broader investment opportunities offer utilities potential sources of revenue as well as reduced operations and maintenance costs and other benefits of grid modernization, by:

- Extending equipment lifetime through dimming
- Anticipating and avoiding faults through distribution automation that provides real-time monitoring of grid conditions
    - Providing accurate malfunction information (detailed problem information, exact location to the utility)
    - Eliminating street lighting night inspections and reassigning resources to more productive tasks
    - Reducing energy consumption via advanced controls that detect motion, as well as daylight sensors that allow for dimming and demand response controls

Local governments also recognize that street lights represent digital real estate that serves as a platform for new technologies and can help them evolve into smart cities. Utilities have an opportunity to invest in this infrastructure by offering upgrades and installation of communication technologies that can control, monitor and provide services on behalf of the cities. These services would provide a new revenue stream from franchise or service fees. Dispersed throughout the city, street lights are ideal data command posts that can potentially gather and convey city data, such as air quality, traffic and noise levels. Utilities could offer the infrastructure for these services, in addition to offering upgrades to LED lighting, thus improving their revenue streams by offering new services, even as revenues from energy sales for street lighting decreased.

Examples of potential revenue streams include:

- Electric vehicle charging infrastructure dispersed throughout the city
- Wireless communication devices
- Public safety monitoring sensor platforms[11] (e.g., gunfire detection[12] and lighting controls as a crime deterrent[13]) and real-time video for monitoring traffic and weather
- Advertising on back-lit panels on the poles

[10] https://www.cacities.org/Resources-Documents/Education-and-Events-Section/Public-Works-Officers-Institute/2016-Handouts/Learn-How-to-Save-$$$-Through-LED-Conversion,-(1)
[11] Utilities could provide the digital real estate and platforms as a service, partnering with a security service provider or municipality that is responsible for the actual monitoring.
[12] http://www.govtech.com/public-safety/Chattanooga-Tenn-Expanding-Streetlight-of-the-Future-Installation.html
[13] http://datasmart.ash.harvard.edu/news/article/using-streetlights-to-strengthen-cities-895

2. Lessons Learned and Best Practices for LED Conversions of Utility-Owned Street Lights

Our companion brief, "Regulatory Barriers and Solution Pathways for Municipal LED Street Lighting Conversions,"[14] discusses street lighting tariff design in detail. This section describes other lessons learned and best practices that have allowed utilities and their customers to move forward with LED projects.

Utility initiatives

- In 2016, Xcel Energy began a LED street light conversion project on all 300,000 utility owned streetlights across its service territory, including the areas in Colorado, New Mexico, Texas, Minnesota, North Dakota, South Dakota, Wisconsin, and Michigan. [15] The costs of the replacements are built into Xcel's proposed rates, so cities do not have to pay up-front for the installations. The utility estimates that it will see energy and maintenance savings of approximately 3.6-6.6% on the LED upgrades, or $3,000 to $5,000 per month for an average-sized city. [16] The utility also offers a reduced tariff rate specific to LED street lighting. Municipalities have a higher monthly fixed charge for the fixtures, but the average energy bill savings is approximately 4-7%.[17]

State initiatives

- In California, under Assembly Bill (AB) 719, utilities are required to offer a special tariff for street light upgrades on utility-owned poles. These tariffs allow municipalities to pay for the upgrades through payments on their electric bills over a period of time, amortized at zero percent interest over a period of years.[18] The utility retains ownership of the street lights, and taking service under the tariff is at the discretion of local governments.

Local government debt for LED technology and installation

- Local government borrowing is another finance mechanism for LED conversions.[19] For example, Florida Power and Light struck a deal where the city of West Palm Beach issued government bonds to purchase the LED technology and paid for the installation cost for utility-owned streetlights, in addition to tackling their municipal-owned streetlights. FPL completed the installations for both utility and local government streetlights and offered a LED tariff to support savings for the city.[20]

Energy efficiency program funding

- A few utilities offer rebates for upgrading customer-owned street lights to LEDs. For example, PG&E's rebates range from $40 to $200 per LED fixture depending on

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[14] [add link when posted]
[15] http://www.startribune.com/xcel-rolls-out-led-fixtures-in-city-lights-in-minn-this-week-then-twin-cities-in-nov/392446741/
[16] http://www.energycentral.com/organization/energybiz/xcel-plans-100-million-led-upgrades
[17]http://www.electricenergyonline.com/detail_news.php?ID=595386&titre=Xcel+Energy+begins+switch+to+more+efficient+LED+streetlights+in+Minnesota&cat=;82
[18] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB719
[19] See the companion brief for further information, including Figure 2, *Regulatory Barriers and Solution Pathways for Municipal LED Street Lighting Conversions*, [add link when posted]
[20]http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf

wattage.[21] However, of the 10 large utilities we surveyed,[22] PG&E is the only one to offer such an incentive. PG&E is also the only one of these utilities that is proactively changing out utility-owned street lights with LEDs.

- In Pennsylvania, PECO offers a rebate ranging from $25 to $75 per fixture depending on wattage reduction.[23]
- Street lighting customers typically contribute toward funding of energy efficiency programs. As is a common practice in ratemaking, some of the money collected from these customers may go toward energy efficiency programs to upgrade street lighting. Utilities can embed in LED rates discounts from the collection of these funds, or these funds can otherwise be used for the benefit of street lighting customers specifically.

Shareholder performance incentives

- Many state regulatory agencies use shareholder performance incentives to encourage IOU investments in energy efficiency. IOUs that upgrade street lights have the opportunity to earn a return on their LED conversion investments. Regulators can offer *additional* financial rewards for utilities through explicit shareholder performance incentives for these investments. In the absence of such incentives, utilities may prefer to invest in other assets — particularly those that do not reduce retail energy sales.
- States that provide shareholder performance incentives for electric utilities can apply them to LED street light conversions, as they do for other cost-effective energy efficiency measures.

[21] https://www.pge.com/en_US/business/save-energy-money/business-solutions-and-rebates/lighting/led-street-lighting/led-streetlight-rebates.page
[22] *Regulatory Barriers and Solution Pathways for Municipal LED Street Lighting Conversions*, [add link when posted]; see Table 1 for utilities reviewed.
[23] https://www.peco.com/WaysToSave/ForYourBusiness/Pages/LightingEquipment.aspx

3. Street Lighting Buyback Options

3.1 State Requirements for a Buyback Option

Most utilities that offer formal buyback options or processes for municipal customers to acquire utility-owned street lights have been required to do so through legislation, including the following states:

- Massachusetts[24]
- Maine[25]
- Vermont [26]
- Rhode Island[27]
- Maryland [28]

In other states, a potential street lighting buyback is generally handled on a case-by-case basis as a direct negotiation between a customer and its utility. Individual utilities may set up their own buyback programs, but this is not common. For example, Southern California Edison (SCE) ran a buyback program for a short time, but in August 2015 discontinued new enrollments. Substantial interest in the program remains among municipalities.

Buybacks have been substantially more widespread where there are legislative requirements for these programs and that explicitly specify pricing. For example, in Massachusetts, where a 1997 law (M.G.L. Chapter 164 Section 34A) requires a buyback option, more than 75 municipalities have bought back street lights and over half of these municipalities have converted street lights to LEDs. For municipalities in the state that purchase street lights under the law, energy charges for street lighting tariffs equal the cost of delivered energy. No other charges may be included. [29] Vermont and Rhode Island have also enacted laws that require IOUs to offer an LED street lighting tariff option for municipalities that purchase utility owned streetlights. In Maryland, which has a legislative requirement to allow buybacks but specifies few details on the terms (e.g., no requirement for dedicated LED tariffs), buybacks have been much less common.[30]

3.2 Utility Buyback Process

In order to enable municipal purchase of street lights, the utility needs to make available staff or a third-party consultant to determine which street lighting assets within the footprint of the municipality can be sold and their value. The street light poles may have additional infrastructure mounted on the pole — for example, transformers or switchgear. In these instances, the utility likely will want to maintain possession of the poles that host this infrastructure. Other negotiations may also be necessary. For example, the parties must determine who will pay for any necessary upgrades to light poles. Relatedly, municipalities are

[24] "Municipal Street Lighting Service." Massachusetts General Laws, Chapter 164, Section 34A. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXXII/Chapter164/Section34A

[25] An Act To Reduce Energy Costs, Increase Energy Efficiency, Promote Electric System Reliability and Protect the Environment [PART E, Sec. E-1. 35-A MRSA §2523]. http://www.mainelegislature.org/legis/bills/bills_126th/billtexts/HP112801.asp

[26] For more on Vermont, see http://aceee.org/files/proceedings/2012/data/papers/0193-000144.pdf

[27] http://webserver.rilin.state.ri.us/Statutes/title39/39-30/INDEX.HTM

[28] The EmPOWER Maryland Energy Efficiency Act Standard Report of 2014.

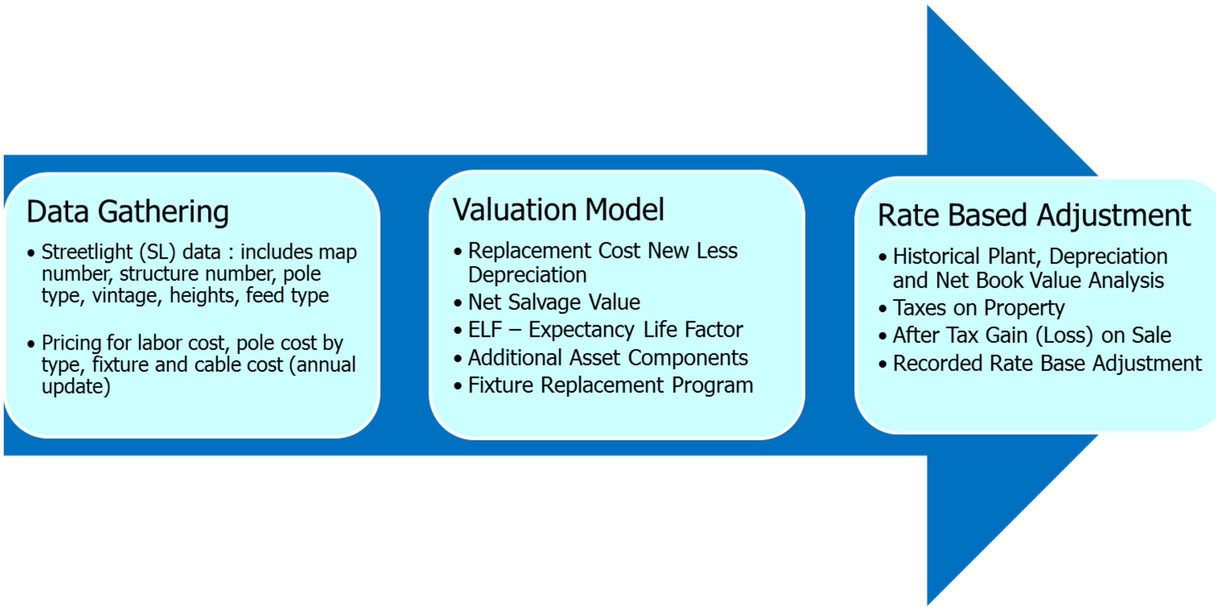
[29] http://www.mapc.org/system/files/bids/Buy%20Back%20Streetlights%20from%20Utility.pdf

[30] See http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf.

subject to a different electrical code than utilities (National Electrical Code vs. National Electrical Safety Code).[31]

Figure 2 outlines the process that SCE implements in order to determine the value of streetlights and infrastructure for each municipal government during its buyback program. The process includes data gathering, economic valuation, and determination of the rate based adjustment for the sale of the assets.[32] It can take up to a year to complete all of these steps.[33]

Figure 2. Adapted from SCE's process for street light buybacks[34]



Utilities can standardize processes, terms and conditions for street lighting buyback programs to simplify the transaction with participating local governments. For example, SCE created standard agreement templates, standard evaluation practices, and a standard process for advice or full regulatory filings with the California Public Utilities Commission for approval of the transfer of the street lighting assets and tariff agreements.[35]

Figure 3 outlines the stages of the acquisition process for SCE's street light buyback program. Approximately 60 local governments are in a queue for evaluation of street lighting assets in their jurisdiction.[36]

[31] This issue arose in Portland, OR; see http://energy.gov/eere/ssl/downloads/portland-street-lighting-report-august-2015.

[32] Utility base rates include amortized capital infrastructure costs. Cost recovery for street light assets is embedded within the rate base, including depreciation. When calculating the rate based adjustment for the street lights, the utility determines the amount necessary to recover the capital cost investments that were included in the rate base, the tax implications, and the depreciation values.

[33] Interview with John King, program manager of the street light buy back program at SCE. 8/16/2016

[34] Source: SCE public presentation on street lighting buyback program, August 2016.

[35] SCE is the only utility that had committed to a voluntary program, although the program has been closed to new participants.

[36] Interview with John King and program presentation from 8/16/2016.

Figure 3. SCE's process for municipalities to purchase street lights[37]

6 key stages of the Acquisition Process

Process stage	Description
Stage 1 **Initial Engagement and Education**	• Local Government (LG) reaches out to SCE Account Manager, Region Manager or BCD Street Light Team for acquisition process information • SCE provides valuation process overview and reviews current inventory
Stage 2 **Invoicing and Payment**	• LG reviews Inventory and determines feasibility to pay for valuation services • SCE invoices LG $10,000 for valuation work and places LG into valuation queue upon receiving payment
Stage 3 **Valuation Coordination and Kickoff**	• Kick-off meeting held with LG to review field inventory process • LG participates in ride along with SCE to understand field work and valuation methodology
Stage 4 **Evaluation Field Inventory**	• SCE performs valuation inventory of street lights, over head conductor, wood pole counts, etc… • SCE compiles results and presents LG with an estimated sales price
Stage 5 ***Sales Terms Development and CPUC Filing***	• LG confirms desire to move forward with purchase and enters into Sales Terms development with SCE • SCE and LG submit 851 Application or Advice Letter to CPUC for review and approval of sale
Stage 6 **Asset Transfer**	• Following CPUC approval of sale, SCE and LG enter into transition phase of assets • Broken out by phases agreed upon by SCE and the LG, the street light system is systematically physically transferred over to LG and rate changed from LS-1 to LS-2

4. Utility Success Factors for LED Conversions

For utilities that are responding to legislation or municipal requests for LED conversions, success can be considered as the optimization of meeting state requirements, customer service needs, the utility's revenue requirements and other shareholder interests. To do all that, utilities will make timely adjustments to business protocols, accounting and operations.

Rather than wait for mandates that require utilities to offer buyback options or LED tariffs, utilities can begin planning programs that will enable them to maximize the benefits for themselves as well as their customers. For most utilities, the approval process for buyback programs and LED tariffs require significant lead time. This includes approval of advice filings with state public utility commissions for programs and tariffs. Once implemented, the process takes time. For example, for SCE's buyback program, evaluation and agreement processes are still underway with dozens of local governments even though the program was closed to new participation in 2015. Utilities can learn best practices from such experiences and be proactive in developing buyback programs that can adequately fulfill the demand for them.

[37] Source: SCE public presentation on street lighting buyback program, August 2016.

When SCE began its voluntary buyback program, the utility did so at the direction of senior leadership. The leadership vision for the program emphasized customer service and community stewardship, and SCE allocated resources and made a long-term investment in the program that worked to benefit customers.

The importance of leadership at the utility cannot be underestimated. To be successful, leadership must articulate a clear directive supporting the buyback program and clearly understand the objectives and consequences for the utility. As with the SCE example, utilities may undertake a buyback program for the customer service it provides to the local governments they serve. Alternatively, if leadership views the buyback program primarily as damaging to the utility's bottom line since it is selling capital assets that generate revenue, the program may not be successful.

As was the case with SCE, the business acumen of utility leadership is critical to defining what factors for success are more heavily weighted than others. In most cases, utilities seek to protect revenue and profits as the highest order. However, customer service also plays an important role in defining success and delivering revenues in the long run. When utilities evaluate how to prepare their businesses for LED conversions, it is important to consider both factors in a manner that reflects the long-term goals for the utility.

Some other utilities have taken a different approach to municipality interest in more efficient street lighting. For example, utilities may file LED street lighting tariffs with significantly higher rates than the current tariff for high-pressure sodium fixtures, even though these existing fixtures use far more electricity per lumen. Local governments may turn to buyback options when faced with tariffs that penalize efficient technologies.

To address the reduced revenue streams that typically result from energy-efficient LED technologies, state regulators in Georgia approved Georgia Power's proposal to increase the fee for street lights converted to LED technologies.[38] Georgia Power pays for the LED conversions, and the utility keeps the energy savings itself. While this protects the utility from revenue erosion, municipalities do not see reduced energy bills – though they can benefit from improved lighting.

Ideally, IOUs will begin planning for LED street lighting programs in advance of legislative or regulatory mandates or disputes in general rate cases. As SCE has illustrated with its voluntary buyback program and incentivized rate schedules for LED street lights, laying the foundation with a program that has a limited duration allows utilities to gauge interest from local governments and establish protocols for establishing value of street lighting assets. By investing in adequate resources that are specifically prepared to handle street lighting upgrades, utilities can better position themselves to take advantage of the benefits of these programs, from higher customer satisfaction, to taking credit for achievement of public policy goals, to identifying new revenue streams for services that use street lighting infrastructure.

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[38] http://www.ajc.com/news/business/revolutionary-street-lights-save-bundles-but-not-f/nrHm6/

5. Resources

Other Accelerator Resources

Outdoor Lighting Decision Tree Tool – covers a range of considerations for implementing LED street lighting projects and embeds a number of links to municipal-specific documents with more information. Available at http://betterbuildingssolutioncenter.energy.gov/solutions-at-a-glance/outdoor-lighting-decision-tree-tool-successful-approaches-cities-states-and

O*utdoor Lighting Challenges and Solutions Pathways* – discusses technological, financing, and regulatory barriers to LED street lighting upgrades and presents short case studies of solutions to those barriers. Available at http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf

Regulatory Barriers and Solution Pathways for Municipal LED Street Lighting Conversions, https://betterbuildingsinitiative.energy.gov/sites/default/files/attachments/Regulatory Issues and Approaches to Municipal LED Street Lighting Conversions.docx

Outside Resources

Kenneth Gordon and Wayne Olsen, 2004. *Retail Cost Recovery and Rate Design in a Restructured Environment*- - paper examines the retail and wholesale electric supply market and offers recommendations on appropriate regulatory policy toward retail electricity rate design and cost recovery mechanisms. Available at: http://www.ksg.harvard.edu/hepg/Papers/Gordon.Olson.Retail.Cost.Recovery.pdf

Seth Nowak, Brendon Baatz, Annie Gilleo, Martin Kushler, Maggie Molina and Dan York, "Beyond Carrots for Utilities: A National Review of Performance Incentives for Energy Efficiency," American Council for an Energy-Efficient Economy, May 2015. –qualitative case study analysis of utility energy efficiency performance incentives programs.
Available at:
http://aceee.org/sites/default/files/publications/researchreports/u1504.pdf.

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