COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

ELECTRONIC APPLICATION OF KENTUCKY UTILITIES COMPANY FOR AN ADJUSTMENT OF ITS ELECTRIC RATES	)))	**CASE NO. 2018-00294**

RESPONSE OF
KENTUCKY UTILITIES COMPANY
TO
LEXINGTON-FAYETTE URBAN COUNTY
GOVERNMENT'S SECOND REQUEST FOR INFORMATION
DATED DECEMBER 13, 2018

FILED: JANUARY 2, 2019

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **Daniel K. Arbough**, being duly sworn, deposes and says that he is Treasurer for Kentucky Utilities Company and Louisville Gas and Electric Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Daniel K. Arbough

Daniel K. Arbough

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:

Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **Lonnie E. Bellar**, being duly sworn, deposes and says that he is Chief Operating Officer for Louisville Gas and Electric Company and Kentucky Utilities Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Lonnie E. Bellar

Lonnie E. Bellar

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:
Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **Robert M. Conroy**, being duly sworn, deposes and says that he is Vice President, State Regulation and Rates, for Kentucky Utilities Company and Louisville Gas and Electric Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Robert M. Conroy

Robert M. Conroy

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:
Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **Christopher M. Garrett**, being duly sworn, deposes and says that he is Controller for Kentucky Utilities Company and Louisville Gas and Electric Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Christopher M. Garrett

Christopher M. Garrett

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:
Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **Elizabeth J. McFarland**, being duly sworn, deposes and says that she is Vice President, Customer Services for Louisville Gas and Electric Company and Kentucky Utilities Company and an employee of LG&E and KU Services Company, and that she has personal knowledge of the matters set forth in the responses for which she is identified as the witness, and the answers contained therein are true and correct to the best of her information, knowledge and belief.

Elizabeth J. McFarland

Elizabeth J. McFarland

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:

Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

STATE OF NORTH CAROLINA)

COUNTY OF BUNCOMBE)

The undersigned, **William Steven Seelye**, being duly sworn, deposes and states that he is a Principal of The Prime Group, LLC, that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

W. Seelye

William Steven Seelye

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 21 day of December 2018.

Ryan Ridenour (SEAL)
Notary Public

My Commission Expires:

7-29-23

Ryan Ridenour
NOTARY PUBLIC
BUNCOMBE COUNTY, NC
MY COMMISSION EXPIRES 7/29/23

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **David S. Sinclair**, being duly sworn, deposes and says that he is Vice President, Energy Supply and Analysis for Kentucky Utilities Company and Louisville Gas and Electric Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Dal S Sinla

David S. Sinclair

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:

Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

VERIFICATION

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF JEFFERSON)

The undersigned, **John K. Wolfe**, being duly sworn, deposes and says that he is Vice President, Electric Distribution for Kentucky Utilities Company and Louisville Gas and Electric Company and an employee of LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

John K. Wolfe

John K. Wolfe

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 28th day of December 2018.

Judy Schooler

Notary Public

My Commission Expires:

Judy Schooler
Notary Public, ID No. 603967
State at Large, Kentucky
Commission Expires 7/11/2022

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 1

Responding Witness: William Steven Seelye

Q-1. Please refer to response to LFUCG 1-1(a), which requested the Company identify and explain all assumptions used in the analysis contained in Exhibit WSS-3.

a. Identify all rate components and corresponding numerical values for the analysis to compare each customer served under TOD-S calculating the change in annual billings with and without the ratchet change implemented in the Company's last rate case. Your response should include (1) the Basic Service Charge per month or day, (2) an Energy Charge per kWh, and (3) a Maximum Load Charge per kW or kVA for Peak Demand Period, Intermediate Demand Period, and Base Demand Period.

b. Identify all other assumptions, components, and values used in the analysis in Exhibit WSS-3 that were not provided in response to LFUCG 1-1(a).

c. Exhibit WSS-3 identifies customers with annual bills of less than $5,000. Explain how a TODS customer could have an annual bill of less than $5,000 if the minimum base demand for the rate classification is 250 kW and the Maximum Load Charge per kW for Base Demand Period is $3.03 per kW (250 kW x $3.03 x 12 months = $9,090).

A-1.

a. See attachment being provided in Excel format.

b. See the response to part a.

c. The analysis included TODS customers that either started or ended service at any point in time in the 12-months ending June 2018. For example, if a customer started service in June 2018, which was the last month of the data set, the corresponding total bill could be less than $5,000. The change in the ratchet would have impacted customers with less than 12 months of usage the same as customers that had usage in every month of the data set.

The attachment is being provided in a separate file in Excel format.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 2

Responding Witness: John K. Wolfe

Q-2. Please refer to response to LFUCG 1-3. In spreadsheet <2018_LFUCG_DR1_KU_Attach_to_Q3.xlsx>, what is the significance of the column "Date Change"? For example, does it relate to the time of last O&M, capital replacement or capital new installation?

A-2. The "Date Change" column can signify either when a light has undergone a change in the fixture type or a clerical correction regarding the location of the fixture.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 3

Responding Witness: John K. Wolfe

Q-3. Please refer to Attachment to response to LFUCG-1-5(a) Page 58 of 66. Please provide a copy of the referenced publication entitled, "Regulatory Issues and Approaches to Municipal LED Street Lighting Conversions."

A-3. See attached.

Better Buildings®
U.S. DEPARTMENT OF ENERGY

Regulatory Issues and Approaches to Municipal LED Street Lighting Conversions

FEBRUARY 2017

U.S. DEPARTMENT OF ENERGY

Regulatory Issues and Approaches to Municipal LED Street Lighting Conversions*

Municipalities considering energy-efficient light-emitting diode (LED) street lights for their jurisdiction face a variety of regulatory issues. This brief describes how cities can successfully address these challenges to achieve multiple advantages:

- *Lower energy costs.* Today's LED technology can offer equal or superior lighting performance while lowering street lighting electricity consumption by 50% or more.[1] Given that street lights can constitute as much as 40% of municipal energy bills,[2] these savings are significant for local budgets.
- *Lower maintenance costs.* Because LEDs have a much longer lifetime than other lighting technologies, they require replacement less often. Dollar savings from reduced maintenance can be twice as large as dollar savings from reduced energy consumption.[3]
- *Better street light tracking.* Street lighting replacement efforts often identify unnecessary street lights that can be removed entirely, or even "phantom" street lights that do not exist or belong to another municipality but for which customers are being erroneously charged. For example, some municipalities in Vermont have eliminated 30-40% of their street lights during LED replacement projects.[4]
- *Better street light management.* Advanced lighting controls, with which LED technologies are compatible, can further reduce energy use through automated dimming.[5]
- *Better lighting quality*. LEDs improve visibility, reduce nighttime light pollution significantly, and may create public safety benefits.[6]
- *Reduced greenhouse gas emissions.* LEDs lower electricity usage and associated emissions, which creates worldwide benefit and helps municipalities attain smart or green city status.

Despite all of these benefits, LED street lighting replacement projects have proven difficult to implement for many municipalities. The U.S. Department of Energy's Outdoor Lighting Accelerator, developed to "accelerate the adoption of high-efficiency outdoor lighting and improve system-wide replacement processes at the municipal level,"[7] has

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* By Jeff Deason, Lisa Schwartz, Natalie Mims and Jennifer Potter, Lawrence Berkeley National Laboratory

[1] See http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf. Also, the city of Los Angeles saved about 63% relative to its existing high-pressure sodium lights. See http://www.forbes.com/sites/justingerdes/2013/07/31/los-angeles-completes-worlds-largest-led-street-light-retrofit/#3882870e4b54. Other cities have saved 70-75%.

[2] http://www.navigantresearch.com/blog/smart-street-lights-face-financial-hurdles#pq=xfjXDG

[3] http://www.neep.org/sites/default/files/resources/DOE_LED%20Street%20Lighting%20Assessment%20and%20Strategies%20for%20the%20Northeast%20and%20Mid-Atlantic_1-27-15.pdf

[4] http://aceee.org/files/proceedings/2012/data/papers/0193-000144.pdf

[5] For more on LED street lighting controls, see https://betterbuildingssolutioncenter.energy.gov/webinars/lessons-learned-outdoor-connected-lighting-system-installations

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

[7] http://betterbuildingssolutioncenter.energy.gov/accelerators/outdoor-lighting

identified a number of barriers that confront such projects. These barriers fall into three categories: technical, financial, and regulatory.

This brief focuses on regulatory barriers, which have proven to be widespread in the experience of Accelerator participants. In particular, these barriers are centered around how the utility charges for the LED service:

- *No LED tariff*: The majority of street lights are owned by utility companies, not municipalities.[8] In these cases, municipalities can only elect services for which the utility company has established a tariff. Many utilities do not offer a tariff that allows LED lighting,[9] taking this option off the table. Other utilities control the pace of LED conversions, requiring individual municipalities to wait years for a conversion.
- *High LED tariff*: Where LED tariffs exist (for either utility-owned or municipally-owned lights), the rates specified by these tariffs are sometimes higher than equivalent tariffs for traditional lighting technologies, meaning that municipalities may not see cost savings from adopting LEDs. Where LED tariffs are lower than those for traditional technologies, in some cases the difference may not be enough to pay back upfront costs of conversions that municipalities often need to pay. The first section of this brief discusses LED tariffs and addresses this issue.
- *Ownership alternative*: Where utility LED tariffs are not available or not attractive, municipalities can attempt to purchase utility-owned street lights and retrofit them themselves. However, few utilities offer a formal buyback option, thus complicating these transactions. Without such buyback options (and even in some cases in the presence of them), some municipalities have found utilities unwilling to offer their street lights for purchase.

Further complicating these issues, many municipalities must confront multiple ownership situations – for example, where the municipality owns some lights and one or more utilities also own some of the lights in the jurisdiction. When served by multiple utilities, a municipality may find that those utilities have widely differing tariffs and levels of interest in facilitating LED conversion.

This brief first reviews the structure of street lighting tariffs and the costs and cost assumptions that underlie them. It then lays out pathways that municipalities can take to consider street lighting retrofits if faced by these regulatory barriers. The brief references cases of municipalities' successes and challenges in pursuing these pathways. For more information, see the resources listed at the end of the brief.

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[8] Utilities own approximately 60% of street lights in the U.S. according to a recent survey by the Municipal Solid-State Street Lighting Consortium, with investor-owned utilities owning the vast majority of the utility-owned lights. See https://www1.eere.energy.gov/buildings/ssl/pdfs/msslc_inventory-phase1.pdf.

[9] Only 13 of 40 utilities in states tracked by the Northeast Energy Efficiency Partnerships (11 states plus District of Columbia) offered LED rates in 2013 (see http://www.neep.org/led-street-lighting-assessment-and-strategies-northeast-and-mid-atlantic); only one New York utility offered LED rates as of early 2014 (see https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Energy-Efficiency-Services-Reports, "Street Lighting in New York State"). Of the 10 largest investor-owned utilities we reviewed for this brief, two do not include any mechanism for charging customers for utility-owned LED street lights, and four allow for LEDs only under emerging technology tariffs that do not specify a certain charge.

1. Overview of Street Lighting Tariffs

Utilities charge their customers for most street lighting-related services through electric tariffs. An electric tariff is a document that provides "the approved conditions, terms, and prices of utility services."[10]

In order to provide an overview of utility tariff structures, this brief in part reviews street lighting tariffs of the 10 investor-owned utilities with the largest number of customers.[11] Combined, the 10 utilities we reviewed account for nearly 8% of retail electricity sales (in kilowatt-hours or kWh) in the U.S. Given their size, the utilities serve diverse customer bases and in general tend to have tariff offerings that address a wider range of customer options than other utilities. As such, their street lighting offerings as a group are likely more well-developed than the average investor-owned utility, although considerable variation remains. Table 1 lists the 10 utilities and the states they serve.[12]

Table 1. Ten Largest Investor-Owned Utilities by Number of Customers

Utility	2014 Total Customers	2014 Sales (MWh)	State Served
Pacific Gas & Electric (PG&E)	5,188,308	75,114,523	California
Southern California Edison (SCE)	4,963,983	75,828,585	California
Florida Power & Light Co. (FPL)	4,708,793	104,431,096	Florida
Consolidated Edison (ConEd)	2,478,248	19,756,921	New York
Georgia Power Co.	2,410,042	83,740,365	Georgia
Virginia Electric & Power (doing business as Dominion Virginia Power)	2,381,312	75,562,974	Virginia
DTE Electric Company (DTE)	2,142,829	41,923,906	Michigan
Public Service Electricity & Gas (PSE&G)	1,900,444	19,571,938	New Jersey
Duke Energy Carolinas	1,896,136	56,750,616	North Carolina[13]
Consumers Energy	1,791,366	33,253,922	Michigan

The format for street lighting tariffs is not standardized across utilities. For most of the utilities reviewed for this brief, street lighting-related rates are spread across multiple tariffs. Some utilities have separate tariffs for utility-owned and customer-owned lights; some have separate tariffs for metered lights. In other cases, the utility offers a tariff only for conventional street lighting technology[14] — not including LED rates — with or without

[10] Lazar, 2016, 40.
[11] Customer counts are from 2014 EIA data, Form 861, from the "Sales to Ultimate Customers" data file. We reviewed the ten largest bundled (Part A) utilities. See https://www.eia.gov/electricity/data/eia861/
[12] Some of these utilities serve more than one state; the state listed is the state whose tariff we reviewed.
[13] Duke Energy Carolinas serves both North Carolina and South Carolina. The data here are only for North Carolina, which is the larger customer base. For this brief, we reviewed only the North Carolina tariff.
[14] In this brief, we use the terms "conventional" and "traditional" to refer to several street lighting technologies that predate LEDs, including high- and low-pressure sodium vapor, mercury vapor, and metal halide lights. Often, a single utility has more than one of these lighting technologies in place across its territory.

a separate tariff for emerging technologies (typically without pre-established pricing) that can be used for LED replacement.

Street lighting charges are generally composed of three major components (see Figure 1):[15]

1. An "energy charge" for electricity-related services;
2. A "facilities charge" or "service charge" for maintenance-related services; and
3. Where applicable, a charge to recoup capital costs incurred by a utility if it replaces its own street lights with LEDs.[16] Such charges go by different names in different tariffs, such as "incremental facilities charges" or "capital recovery fees." At times they are listed as supplements to facilities or service charges for some amount of time; other times they are assessed upfront (see section 1.3).

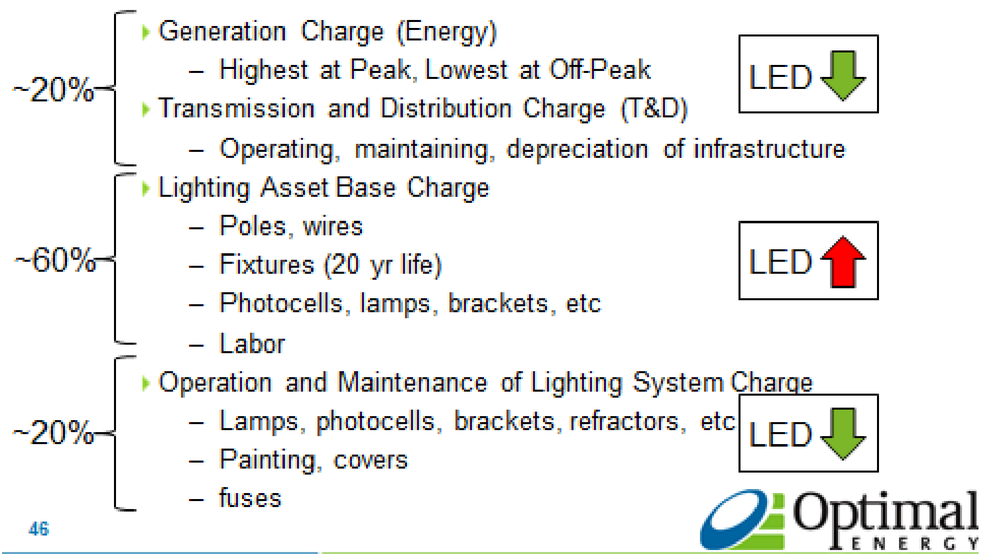

Figure 1. Composition of a typical street lighting tariff.
Arrows indicate relative cost differences between LEDs and conventional technologies. Source: "Street Lighting in New York State: Opportunities and Challenges," NYSERDA 2014.

[15] In some cases one or more of these components are rolled together into a single charge.
[16] Capital recovery costs may include those for light arms, poles, and wiring as well as luminaires.

1.1 Energy charges

Most street lights are not metered. In the absence of data on actual usage, most street lights are charged a flat rate per lamp per billing period for electricity-related services. These rates are based on assumptions about hours of usage, coupled with the wattage used by the lamp and ballast or driver and the electricity rate per kWh approved by the state regulator:

(Assumed hours of usage) x (wattage) x ($/kWh) / 1000

The cost-effectiveness of energy charges for LEDs hinge on three critical issues.

- *Defining LED replacements:* The LED replacement chosen for an existing street light can be consequential. As technology improves, lower wattage lamps can be used to provide comparable lighting performance to incumbent technology. [17] Utility companies, which generally have authority to define LED replacements, should choose luminaires that reflect the most effective street lighting design in order for their customers to fully benefit from LED energy savings. This choice can have important rate and cost ramifications.

- *Pricing for LED wattages*: LED rates may be defined for a range of LED wattages or restricted to only specified wattages. Any luminaire with wattage within a defined range is charged at the midpoint wattage for that range. The width of these ranges can have important consequences, as wide ranges[18] can result in less accurate charges for customers whose LED wattages fall near the boundaries of the ranges. Some utilities[19] define LED charges in 5-watt bands, significantly reducing the potential for less accurate charges. (Others provide a formula for calculating the charges based on actual luminaire wattage, like the one shown at the top of this section, which avoids this issue but requires an additional calculation.)

  A similar issue can arise when a utility offers only a few predefined LED wattages in its tariff, as this may effectively require a customer to choose a luminaire that is more powerful (and consumes more electricity) than necessary.[20] Utilities prefer to carry fewer types of LED bulbs, as costs go up when maintaining many different styles. Models with adjustable drive settings or dimming capacity can help reduce the number of different types the utility stocks.

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[17] Lighting performance is generally measured by lumens of lighting output. However, LEDs also deliver those lumens to a specific area more efficiently, so LED replacement lights can provide comparable performance at lower lumen levels than conventional lights. In addition, standard electricity rates typically account for peak loads as a percentage of the total peaks (see NARUC Cost Electricity Cost Allocation Manual). Conversion to LED significantly reduces peak loads from street lighting and their contribution to total system peaks, which should result in an additional corresponding reduction in their share of those costs.
[18] For example, National Grid's LED tariff has 50-watt bands. See http://www.mass.gov/eea/docs/doer/green-communities/pubs-reports/led-streetlights-qa.pdf.
[19] For example, PG&E (http://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_LS-1.pdf) and SCE (https://www.sce.com/NR/sc3/tm2/pdf/ce36-12.pdf)
[20] The bulk of the cost impact of an oversized LED is generally found in higher capital costs, not higher energy charges, as the former is a much larger portion of an LED tariff.

- *Accounting for lighting controls*: Many LED street lights have the capacity to operate at less than full capacity through dimming, either prescheduled or controlled by sensors.[21] This can further reduce LED electricity usage relative to existing lighting technologies that are simply on or off. LED dimming technology is distinct from photocells, which can be used on any street lighting technology to automatically turn the lights on or off. While many tariffs charge lower rates for photocell-equipped lights or for lights that operate for fewer hours, none of the 10 reviewed tariffs include pre-established, non-metered rates that reflect electricity savings from dimmable or networked LEDs.[22] The only ways to receive credit for dimmers under the reviewed tariffs are through (1) metered tariffs, for utilities that offer them or (2) pursuing emerging technology provisions in tariffs. Instead, PECO (a Pennsylvania investor-owned utility) promotes dimming controls in two ways:[23]
  - For wireless controls, PECO takes the average percentage dimmed and reduces the total wattage charged by that percentage.
  - For pre-installed or field adjustable dimmers, PECO simply charges based on the dimmed wattage. The customer provides PECO the dimmed wattage rate to include and copies of the dimmer spec sheets.

1.2 Facilities or service charges

Facilities or service charges cover maintenance of street light lamps and other hardware, including repairing or replacing the lamps themselves as well as ballasts and wiring. Tariffs for utility-owned lights typically offer comprehensive maintenance services. Tariffs for customer-owned lights generally have a lower facilities or service charge than tariffs for utility-owned lights, because the customer performs some maintenance — either the vast majority of maintenance or only routine maintenance. For example, customer-owned street lighting tariffs may include utility relamping services, where the utility replaces broken lamps and recovers its anticipated cost through the tariff. Other tariffs for customer-owned lights do not include such services, leaving them to the municipality, and include only a minor charge to maintain electric service to the fixture. Some tariffs give a choice between these options.

While the nature of these maintenance services for LED lights is analogous to those for traditional lights, the actual cost of these services is not the same. LED luminaires have a much longer life than traditional street light technologies. As a result, luminaires fail

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[21] For more on advanced control technologies, see http://cltc.ucdavis.edu/sites/default/files/files/publication/2011_NEEA_Network_Outdoor_Controls_Report.pdf

[22] The California Street Lighting Association is intervening in a San Diego Gas and Electric rate case to propose a rate credit for dimmable lights and lighting controls. In addition, Georgia Power is planning to introduce controls to dim utility-owned LED street lights and a tariff that provides rate credits for dimming. Finally, Rhode Island will install both controls and meters in some of its LED street lights, potentially yielding data that might support controls credits in tariffs in the future. For information on these cases, see http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf

[23] Tariff is at https://www.peco.com/SiteCollectionDocuments/6.%20PECO%20EXHIBIT%20RAS-1_001.pdf, rate SL-E

much less often, lowering maintenance costs substantially.[24] The dollar savings from lower LED maintenance costs can be double the dollar savings from electricity use reduction.[25]

In the tariffs reviewed for this brief, utility maintenance charges do not vary in keeping with these large potential cost savings. Some utilities charge the same facilities or service charge per street light for LEDs as they do for other lights. For utilities with differentiated LED facilities or service charges, in most cases those rates are somewhat lower than those for traditional technologies – though in some cases the LED charges are actually slightly higher.

Several factors contribute to the relative maintenance pricing of LED and conventional lights:

- *Utilities' relative lack of experience with LED technologies*. Utilities do not want to risk undercharging for street light maintenance. As utilities gain experience with operating LED street lights, rates may go down if maintenance savings prove to be reliable.
- *Utility revenue incentives*. Street lighting maintenance charges are a major source of utility revenues. They represent a much larger share of street light revenues than do energy charges, and the basis for their calculation is generally less transparent.
- *Outdated rates for conventional lighting*. In some cases, flat charges per conventional street light have been in effect for decades without being updated. LEDs have brought that process gap to light. A new cost-based LED rate should be complemented by updates to rates for conventional lighting.

[24] Typical high-pressure sodium lamps have an average annual failure rate of 18 to 20% while thus far LED systems such as in Los Angeles have experienced failure rates of less than 1% per year. Some LED installations are experiencing "dirt depreciation" — performance degradation over time due to dirt buildup. This may require cleaning each fixture periodically, reducing maintenance savings. See, for example, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/beckwith_depreciation_seattlemsslc2011.pdf.
[25] See http://www.neep.org/sites/default/files/resources/DOE_LED%20Street%20Lighting%20Assessment%20and%20Strategies%20for%20the%20Northeast%20and%20Mid-Atlantic_1-27-15.pdf.

1.3 The Role of Capital Cost

As Figure 1 shows, LED technology generally has lower energy and other operations and maintenance expenses than traditional technologies. However, the capital cost – the cost of the luminaires and associated equipment – is higher for LEDs.

Where utilities own LED street lights, they generally make the capital investment to procure them.[26] These capital investments may be rolled together with other charges (as is done with traditional street lights) or may be charged to customers separately. In circumstances where these investments are partially or fully rolled into a maintenance-related charge, that may explain what might otherwise appear to be a lack of accounting for maintenance-related savings from LEDs.

Even with research, it can be difficult to unpack the role of capital costs in utility tariffs. A utility typically must submit work papers in support of the rates it requests the state regulator to approve. The work papers detail the assumptions about costs that support the rate. However, the level of detail and accessibility of these work papers vary. To the extent that the supporting assumptions are available to municipalities, review of them may help explain the charges or may reveal inaccurate assumptions that might be contested in a rate proceeding.

The utility tariffs reviewed take a wide variety of approaches for handling capital costs of utility-owned LED street light conversions.

- *Contributions in aid of construction*. Some utilities require municipalities to pay the full capital cost of an LED conversion upfront (e.g., Florida Power & Light, Consumers Energy), or may require or allow at least a partial payment upfront (e.g., Georgia Power, DTE Energy, PSE&G). These payments may be referred to as "contributions in aid of construction." Such financing structures may benefit some municipalities. This approach should provide for a lower tariff cost because the utility does not have to capture the depreciation of the capital cost of equipment. Further, municipalities may be able to raise money at more favorable rates than investor-owned utilities. On the other hand, some municipalities – especially smaller towns – may not be able to raise the capital needed for this financing structure.

- *Upfront fee per light*. Some utilities (e.g., Duke Energy Carolinas) do not charge a contribution in aid of construction but instead charge a flat fee upfront per LED conversion – again requiring at least a portion of the capital upfront.

- *Incremental facilities charges*. Other utilities include incremental facilities charges for a fixed time period[27] to finance utility-owned LED lighting, either paid by the

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[26] One interesting exception is Eversource New Hampshire, which has a "customer contributed" tariff that allows a customer to procure lights and lighting upgrade services from a third party rather than the utility itself. See http://www.neep.org/blog/street-lighting-high-low-hanging-fruit.

[27] This time period varies across utilities. For example, SCE's tariff includes a small incremental charge for 20 years. PG&E's includes a larger incremental charge for an unspecified time period; however, PG&E has indicated that it may discontinue the incremental charge in its 2017 general rate case, which would mean the charge was in

individual customer (e.g., Southern California Edison, PSE&G) or spread across all customers in the rate class (e.g., Pacific Gas & Electric, which is converting all its street lights to LEDs).

- *No provision*. Some tariffs are entirely silent on LEDs, and therefore have no explicit provisions for treatment of capital cost recovery (e.g., Dominion Virginia Power, ConEd).

For more on financing options and solutions, see the Better Buildings Solutions Pathways document.[28]

Typically, utilities recover the cost of conventional street lights over time through tariffs. If conventional lights are removed before their costs have been fully recovered, the utility may seek to recover this cost through other means, creating an additional cost for LED conversion. For example, MidAmerican Energy charges its customers a flat $100 fee at time of upgrade for lights that have not reached the end of their assumed useful lives. Alternatively, PG&E is replacing all its street lights over a multi-year period and is charging all customers of its utility-owned street lights an incremental charge to (in part) recover remaining costs for replaced street lights. Other utilities may forecast their cost shortfall due to this issue and roll these costs into their LED tariffs.

Another factor for upgrading utility-owned street lights is that the utility's stated cost to perform the upgrades may be considerably higher than those quoted by other providers such as energy service companies (ESCOs).[29] Utilities are not required to compete with outside providers on cost for street light upgrades; if the utility's regulator is satisfied with the proposed rates, they can be approved.

Most utilities do not provide financing to convert customer-owned street lights to LEDs, though a few do offer financing options — as part of electric tariffs or as a separate service.[30]

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place for three years at most (see https://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4488-E.pdf). Shorter incremental cost periods mean that the utility is charging a rate of return for fewer years. On the other hand, shorter time periods also mean higher payments in those years as the amortization period is shorter.

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

[29] For example, see http://www.mypalmbeachpost.com/news/business/boynton-beach-seniors-outraged-over-proposed-fpl-l/nq849/

[30] An example is PG&E's LED Streetlight Turnkey Replacement Service. See https://www.pge.com/en_US/business/save-energy-money/business-solutions-and-rebates/lighting/led-street-lighting/led-street-light-turnkey.page

1.4 LED Tariff Best Practices

Based on experience to date with LED conversions, following are several best practices for LED tariffs:

- *Explicit LED Option*. Include LEDs as an explicit option, rather than relying on general emerging technology tariffs that lack pricing specificity.
- *Flexible Energy Charges*. Specify LED energy charges through either (1) a set of narrow wattage bands or (2) a simple and transparent method for calculating charges based on wattage.
- *Metered Provision*. Include provisions for a metered tariff using meter data supplied by the control system.
- *Wide Range of LED Options*. Provide a broad range of LED wattage options to allow a more precise tariff and to recognize continually improving technology without the need to modify the tariff.
- *Appropriate Maintenance Charges*. Set maintenance charges that reflect growing utility experience with the actual cost of maintaining LED lighting, compared to conventional lighting technology.
- *Tariff-Based Financing*. For utility-owned lights, offer a means of financing the lights through the tariff, rolled into the maintenance charge (as with conventional technologies), through a short-lived incremental charge, or by allowing third-party services.[31]
- *Controls Provision*. Include emerging technology provisions to allow credit for lighting controls based on experience with their performance.
- *Ancillary Equipment Provision*. The evolution of the control systems for LED lights will lead to many applications that take advantage of street lighting communication networks to provide other information and services. Tariffs should allow communities to use their network for more than just lighting.

Table 2 lists several tariffs for utility-owned lighting that have many of these features and may serve as potential models for further refinement. However, none of these tariffs include provisions for LED-specific controls to improve operational efficiency. In Rhode Island, Docket 4513 directed the utility to conduct a pilot to explore this issue.[32]

[31] For an example of potential third-party ESCO services, see http://www.mypalmbeachpost.com/news/business/boynton-beach-seniors-outraged-over-proposed-fpl-l/nq849/.
[32] See http://www.ripuc.org/eventsactions/docket/4513page.html

Table 2. Tariffs for Utility-Owned Street Lights With Features Favorable for LED Upgrades

Tariff	Explicit LED Option	Flexible Energy Charges	Tariff-Based Financing	Controls Provision
Pacific Gas & Electric	✓	✓	✓	—
Georgia Power	✓	✓	✓	—
Mid-American	✓	✓	✓	—
Duke Energy Progress	✓	✓	✓	—
Portland General Electric	✓	✓	✓	—

2. Solution Pathways for LED Street Lighting Upgrades

Broadly, LED street lighting upgrades can occur two ways. One, a utility can replace lights that it owns with LEDs, recovering the cost using any of the various mechanisms discussed above. Two, a municipality that owns the lights (or purchases them from the utility) can replace them itself.

Figure 2 outlines the potential pathways that municipalities can pursue.

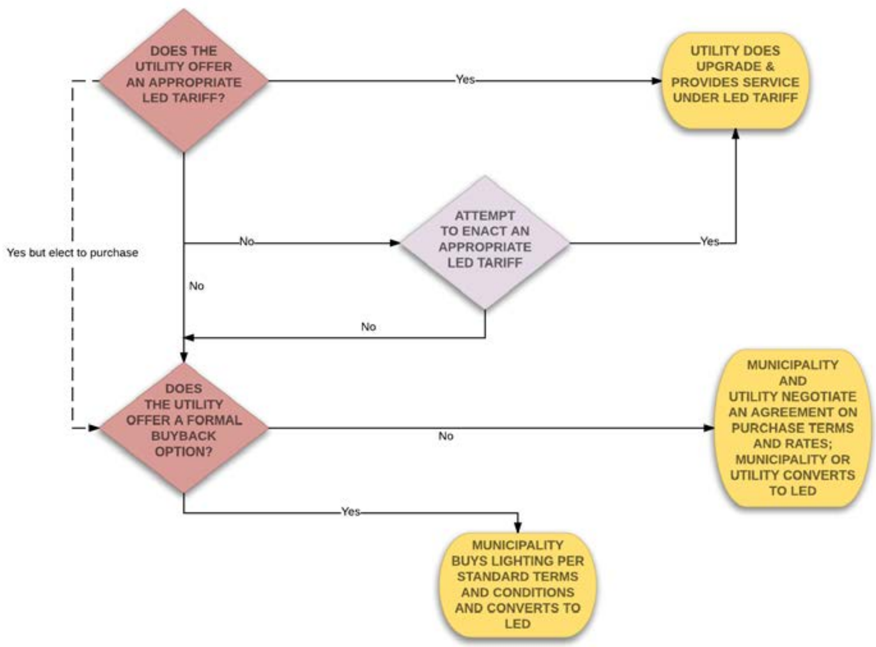

Figure 2. Regulatory Pathways for LED Street Lighting Upgrades

2.1 Implementing Upgrades to Utility-Owned Street Lights Via Tariffs

2.1.1 Establishing or Revising LED Tariffs: The Regulatory Process

To offer utility-owned LED street lights to its customers, a utility must have a tariff establishing this service. Many utilities do not have such a tariff. Further, the total cost for LED retrofits under some established LED tariffs is higher than for conventional products, frustrating municipalities who feel that these rates do not reflect the cost savings LEDs afford.[33] Therefore, municipalities interested in achieving the benefits of energy-efficient street lights may need to take action to bring about new tariffs or changes to existing tariffs. This section of the brief provides an overview of the regulatory process for tariff setting and revision in the context of street lighting services.

The utility submits proposed new or revised retail electric tariffs to its state regulatory commission for approval, most often through a general rate case, a proceeding involving all of the rates and policies of a utility.[34] The commission also may consider new or revised tariff filings in a stand-alone proceeding.

Regulatory practices vary from state to state. However, in almost all states, an electric utility can request a general rate case at any time, as long as it can demonstrate that its existing tariffs do not offer the utility the opportunity to earn its allowed rate of return.[35] Some states also have a mandatory schedule for rate cases, but most do not.[36]

A general rate case offers the opportunity for the municipality to negotiate a proposed settlement with the utility on tariff changes. Municipalities may wish to monitor when general rate case proceedings occur, but it is challenging and potentially expensive to engage in them. The most effective way to initiate potential changes to the tariff is to make a direct request to the utility. Municipalities also can bring the issue to the attention of the state regulatory commission.

It can be challenging to demonstrate that a utility's current or proposed street lighting tariff is not fair and reasonable. Ultimately, the commission must determine if the utility's tariffs are fair and reasonable.

After a utility files a rate case application or a tariff revision, a regulatory proceeding ensues. Table 1 shows a typical schedule for a major rate case. Some state commissions provide information online about their rate case process, including how the public can participate.[37]

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[33] For example, see http://midwestenergynews.com/2015/07/13/michigan-cities-gearing-up-for-fight-with-utilities-over-led-streetlights/.
[34] For example, in March 2016, Southern California Edison revised its LED street lighting tariff as part of its rate case. "Lighting- Street and Highway," SCE, accessed July 12, 2016. https://www.sce.com/NR/sc3/tm2/pdf/ce36-12.pdf
[35] Lazar, 2016, 40.
[36] Lazar, 2016, 40.
[37] For example, see http://www.psc.state.fl.us/Files/PDF/publications/consumer/brochure/ratemaking.pdf

Table 1. Typical Schedule for a Major Rate Case[38]

Typical Schedule for a Major Rate Case

Activity	Calendar Date	Months From Filing Date
Notice of intent to file	Jan 15	-2
Initial filing of tariffs and evidence	Mar 15	0
Discovery period ends	Jun 15	3
Staff and intervenor evidence due	Jul 1	3.5
Rebuttal evidence due	Aug 1	4.5
Rebuttal discovery period ends	Aug 15	5
Expert witness hearings	Sep 1-20	6
Public witness hearings	Sep 25-27	6.5
Briefs due	Nov 1	7.5
Commission decision	Dec 15	9

The utility relies on multiple analyses to calculate the proposed rates and allocate costs to its customers. The utility must first determine its revenue requirement, a complex process that considers all costs and revenues and comprises the majority of the rate case. After determining the total revenue requirement, the utility can use a Cost of Service Study to determine how to allocate the revenue requirement across customer classes. These two components are used to determine the proposed tariffs.

As a municipality considers participation in a rate case, it must first determine if it should officially intervene in the proceeding. Active intervention can be a time-consuming process,[39] including review of the utility's application, "discovery" (including data requests to the utility and interveners, including the municipality), rounds of testimony, a hearing with cross-examination and briefs. The interested party submits an application for party status with requisite information to the state utility regulator.[40] The commission reviews the application and determines if it will grant intervener status. Some common criteria that an intervener must prove are that it is affected by the proposed change, and its interests are unique and not represented by the parties called out by law to participate (e.g., consumer advocates, utilities).

When determining whether to seek intervention in a proceeding, the municipality should consider its ultimate goal. It will likely be judicious to have informal discussions with the electric utility regarding street lighting tariff concerns prior to intervening in a proceeding. Similarly, informal conversations with regulatory commission staff may help the interested party determine if intervention is the best solution. Another potential solution

[38] RAP 2016
[39] An alternative is to intervene in order to track a proceeding and receive documents, rather than filing testimony and the like. This is not as difficult or time-consuming, though some proceedings generate a formidable volume of documents.
[40] There are a variety of names for state electric utility regulators. The public utility commission is common, as is the public service commission.

may be to work with commission staff, national experts, or entities that provide technical assistance to conduct a workshop or develop a focused work group to allow for informal, collaborative, and open dialogue.

If a municipality determines that intervention is the best course, it is useful to consult commission staff regarding the requirements for intervention, as the rules vary significantly by state. For example, some states require an attorney to represent an intervener, and other states do not; most states allow for electronic filings, though some require a designated number of paper copies be provided to the commission and parties. The specific requirements for how to intervene in a docket are listed on most state public utility commission websites.

In testimony in the rate case, an interested party can suggest changes to the utility's application. It is most effective to provide a clear request and articulate why the proposed change is superior to the utility's application, based on expert opinion. Commissioners may be interested in hearing about other utilities that have a similar street lighting tariff to what the municipality is proposing. Strong documentation of research and clear analysis that can be easily understood by commission staff and commissioners are powerful components of any request for change.

2.1.2 Examples of Municipal Actions to Revise Tariffs

Negotiation with Utility[41]

A municipality can approach its utility directly to negotiate new or revised tariffs, and the utility can file the resulting proposal with the regulatory commission for approval. For example:

- The city of West Palm Beach, Florida, successfully negotiated with Florida Power & Light to reduce its LED rate while simultaneously reaching terms on a street light buyback (discussed in Section 2.2).
- The city of Asheville, North Carolina, successfully negotiated with Progress Energy (which has since merged with Duke Energy) for a lower LED rate.
- Through its general rate case, Georgia Power recently began offering an LED rate, in part based on prior requests from its municipal customers — although the tariff is no lower, and perhaps slightly higher, than for conventional lighting.[42]
- The city of Portland purchased lights from Portland General Electric, addressing a range of issues along the way.[43]

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[41] See pages 17-18 at http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf
[42] See http://www.ajc.com/news/business/revolutionary-street-lights-save-bundles-but-not-f/nrHm6/
[43] http://energy.gov/sites/prod/files/2015/09/f26/2015_gateway-msslc_portland_0.pdf

Regulatory Interventions

Alternatively, or if direct discussions with the utility are unsuccessful, the municipality can intervene in regulatory proceedings to establish new or improved tariffs for LED street lights. Examples include the following:

- A collection of Michigan municipalities, with support from the Southeast Michigan Regional Energy Office, has formed the Michigan Street Lighting Coalition and intervened in two DTE Electric general rate cases in pursuit of lower LED tariff rates.[44]
- The North Carolina League of Municipalities intervened in a Duke Energy Carolina rate case in part to recommend an LED rate for utility-owned street lights. This intervention was successful, as the regulatory commission required Duke to include this rate.[45]
- The city of Manchester, New Hampshire, intervened when the Public Service Company of New Hampshire (now part of Eversource) proposed a new LED rate the city found unfavorable. The city reached a settlement that produced a substantially different and more acceptable rate.[46]
- In Southern California, the Coalition for Affordable Streetlights (a group of local governments) and the California Street Lighting Association (representing municipalities served by investor-owned utilities statewide) intervened in a Southern California Edison rate case to contest an LED rate increase.

2.1.3 Legislation to Implement Tariffs

The legislative pathway is an option if utilities are resistant to offering LED rates and municipalities are not achieving changes through the regulatory process. However, pursuing legislation can be a time-and resource-intensive process. Following are two examples of successful legislative initiatives:

- California passed legislation[47] requiring its investor-owned utilities to offer LED street lighting tariffs for utility-owned fixtures and a means for municipalities to finance conversion projects.
- Rhode Island enacted legislation[48] directing its distribution companies to offer LED rates that give credit for dimmable controls. (This legislation also required investor-owned utilities to offer a buyback provision for its street lights, which is discussed in the next section.)

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[44] This rate case is ongoing. For the coalition's initial filing, see https://efile.mpsc.state.mi.us/efile/docs/17767/0417.pdf. The full docket for the rate case is at https://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=17767. See http://midwestenergynews.com/2015/07/13/michigan-cities-gearing-up-for-fight-with-utilities-over-led-streetlights/ for a news article reviewing the issue involved.
[45] The order approving the LED tariff is at http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=5d96b757-a902-4217-ae76-c23ffca2f303
[46] This docket is at http://www.puc.state.nh.us/regulatory/Docketbk/2013/13-248.html.
[47] See http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB719
[48] http://www.environmentcouncilri.org/content/municipal-streetlight-investment-act

2.2 Implementing Upgrades Via Municipal Buyback of Street Lights

2.2.1 Municipal Buyback Options

Faced with unattractive or no LED rate options, many municipalities have explored buying street lights from their utilities and undertaking LED conversion projects themselves. Experiences with this pathway have varied widely.

In several states in the Northeast and Mid-Atlantic regions, legislation has required utilities to offer a buyback option to municipal customers (see Section 2.2.3). In other states, a potential street lighting buyback is generally[49] handled on a case-by-case basis as a direct negotiation between a customer and its utility. Buybacks have been substantially more widespread where legislatively required buyback options exist and where buyback options explicitly specify pricing.[50]

Utility regulatory commissions can play a role in adjudicating disagreements over street lighting pricing. Municipalities have the right to bring a complaint to the state utility regulator if a utility sets a price they feel is unfair, or if the utility fails to respond to a pricing inquiry. However, this is often a time-consuming process, and the cost of bringing a complaint before a regulatory commission can swamp any gains in lower pricing, particularly when lost cost savings due to delay are factored in.[51]

Legislation requiring buyback options generally governs how pricing is determined. Some components of this calculation — for example, the depreciation schedules for street lights — rely on values approved by the utility regulator in rate cases.[52] Even in states without legislatively governed buyback options, such values are a natural point of reference for determining pricing.

Street lighting buybacks require a number of determinations in addition to the purchase price of the lighting. Notably, utilities and municipalities must agree on the extent of maintenance services the utility will provide and the pricing of those services. These options may be defined by existing tariffs for customer-owned lighting. If a new LED tariff for customer-owned lights is being established, however, or where the existing tariffs are not attractive, the ratemaking discussion in Section 2.1.1 applies. Alternately, customer-specific arrangements can be made that do not involve setting or modifying a tariff, though regulatory approval for such contracts is generally required.

[49] Individual utilities may set up their own buyback programs, but this is not common. Southern California Edison ran a buyback program for a short time, but then discontinued it.
[50] For example, in Massachusetts, where a 1997 law requires a buyback option, more than 75 municipalities have bought back street lights and over half of these have converted them to LEDs. In Maryland, which has a legislative requirement to allow buybacks but does little to specify the terms of buybacks, they have been much less frequent. For more details, see http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf.
[51] See, for example, http://www.mapc.org/sites/default/files/Notes_Streetlight-Buyback-Roundtable_092012.pdf
[52] http://www.mapc.org/sites/default/files/Notes_Streetlight-Buyback-Roundtable_092012.pdf

2.2.2 Municipal Buyback Experiences

The Outdoor Lighting Challenges and Solution Pathways document[53] reviews a number of municipalities' experiences with utility buybacks. These municipalities include:

- West Palm Beach, Florida, negotiated a buyback from Florida Power & Light.
- Asheville, North Carolina, completed a similar process with Progress Energy.
- Over 70 municipalities in Massachusetts, including Somerville, have purchased their lights and more than 30 have converted lights.[54]
- Huntington Beach, California, is in the process of negotiating a street lighting purchase from Southern California Edison, facilitated by the utility's now-discontinued buyback program.
- Richmond, California, negotiated a street light purchase with Pacific Gas and Electric, including a special tariff approved by the regulatory commission.
- In Rhode Island over 30 communities are in the process of acquiring their street lights and the City of Providence is well underway converting its lights.

2.2.3 Legislative Pathway for Buybacks

Legislation requiring buyback options can be a powerful tool for encouraging LED retrofits. Pursuing this pathway, as with legislation requiring LED tariffs discussed earlier in this brief, can be a time- and resource-intensive process. Approaches taken include the following:

- Massachusetts passed legislation requiring utilities to sell their street lighting assets to any community that wished to purchase them for their net book value. Communities were then able to either take advantage of existing tariffs for "other" lights or convince their utility to provide an LED tariff for customer-owned lights.
- The State of New York PSC directed utilities to provide a mechanism for an LED tariff and/or the ability for communities to transition to customer owned lights.
- The State of Maine passed legislation requiring sale of the assets and an LED tariff for customer-owned lights.

Vermont,[55] Rhode Island, and Maryland also have legislation that requires their utilities to offer buyback options. Many state legislative approaches are summarized in the Better Buildings Solutions Center's Outdoor Lighting Challenges and Solution Pathways.[56]

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[53]http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf
[54] For discussion of Somerville, see http://www.mapc.org/system/files/bids/Buy%20Back%20Streetlights%20from%20Utility.pdf
[55] For more on Vermont, see http://aceee.org/files/proceedings/2012/data/papers/0193-000144.pdf
[56]http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Outdoor%20Lighting%20Challenges%20and%20Solutions%20Pathways%20Paper.pdf

3. Additional 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

Outdoor 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

Additional Resources on Regulatory Issues

Electricity Regulation in the U.S.: A Guide – an overview of electricity regulation from the Regulatory Assistance Project. See especially chapter 7. Available at http://www.raponline.org/knowledge-center/electricity-regulation-in-the-us-a-guide-2/

LED Street Lighting Assessment and Strategies for the Northeast and Mid-Atlantic – from the Northeast Energy Efficiency Partnerships, regionally focused but covers many regulatory and other aspects of implementing projects. Available at http://www.neep.org/led-street-lighting-assessment-and-strategies-northeast-and-mid-atlantic

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 4

Responding Witness: John K. Wolfe

Q-4. Please refer to Attachment to response to LFUCG-1-5(a) Page 59 of 66. Please provide a copy of the referenced publication entitled, "Building Technologies Program – Solid-State Lighting Technology Fact Sheet."

A-4. See attached.

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

Building Technologies Program
SOLID-STATE LIGHTING TECHNOLOGY FACT SHEET

Lifetime and Reliability

Long life has been billed as a key advantage of LEDs, but understanding and communicating how LED products fail and how long they last can be challenging. While LED-based products hold the potential to achieve lifetimes that meet or exceed their traditional counterparts, manufacturer claims can be misconstrued by users who do not fully understand LED product failure mechanisms or the difference between lifetime and reliability.


Concerns about lifetime and maintenance have been around for a long time. *Credit: Ford Motor Company*

Introduction

All lighting products fail at some point; that is, they reach the end of their useful life. Under normal use and conditions, product failure results from design flaws, manufacturing defects, or wear-out mechanisms. The familiar bathtub curve (Figure 1) shows how failure rate typically changes over the life of a product.

For conventional, lamp-based lighting systems (e.g., incandescent, fluorescent, and high-intensity discharge), failure most commonly results when a lamp "burns out"—otherwise referred to as catastrophic failure. In almost all cases, other system components (e.g., the ballast or luminaire housing) last longer than the lamp, and have lifetimes that are not dependent on the lamp. Further, lamp replacement is easy and relatively inexpensive. As a result, it has been sufficient to consider only the lifetime of the lamp itself. Typically, manufacturers assign a lifetime rating to a lamp based on the time at which 50% of a large sample is expected to have stopped working, using measurements and predictive models. Historically, the use of this median time, denoted B_{50}, to represent the useful life of a product has worked acceptably well for completing economic analyses and calculating associated design parameters.

Unlike conventional lighting systems, LED systems are not necessarily lamp based; commercially available LED products include fully integrated luminaires, integral-driver lamps (with conventional bases), lamps with external drivers, and modules (with newly developed interfaces to other components), among others. Regardless of product type, LED system performance is typically affected by interactions between system components; for example, LED package lifetime is highly dependent on thermal management, and LED lamp performance can be dependent on the luminaire in which it is installed. Establishing a rated lifetime for a complete LED system is further complicated by the cost and impracticality of traditional life testing, especially because the continued development and advancement of LED technology can render results obsolete before testing is finished. Consequently, the typical approach to characterizing lifetime is no longer viable for LED systems.

LED Product Failure

The failure of any LED system component—not just the array of LED packages, but also the electronics, thermal management, optics, wires, connectors, seals, or other weatherproofing, for example—can directly or indirectly lead to product failure. Further, while some LED products will fail in a familiar catastrophic way, others may exhibit parametric failure—meaning they stop producing an acceptable quantity or quality of light. A complete characterization of the useful life of an LED product must consider the possibility of catastrophic or parametric failure for each system component, operating together as a system. At this time, however, there is no standard or well-accepted method for performing such a characterization. Consequently, understanding the intricacies of failure, lifetime, and reliability is very important for evaluating LED products.

Some of the issues surrounding the lifetime of LED products are not completely unique. For example, fluorescent lamps also require a ballast and other system components that can fail, and lamp lifetime is somewhat dependent on ballast type. However, lamp designs and construction have changed slowly, allowing for the development of robust models for predicting lamp life and mature, reliable ballasts. As a result, the traditional focus on lamp rated life has been sufficient for deploying and managing fluorescent systems. When source life regularly meets or exceeds the lifetime of other components in a lighting system, however, lifetime management becomes more complicated. This is the case for a vast majority of LED products, as well as some new extra-long-life fluorescent lamps.

Failure of LED Packages

There are many components in an LED lighting system that can fail, but to date LED packages have been the focal point. LED packages rarely fail catastrophically, necessitating consideration

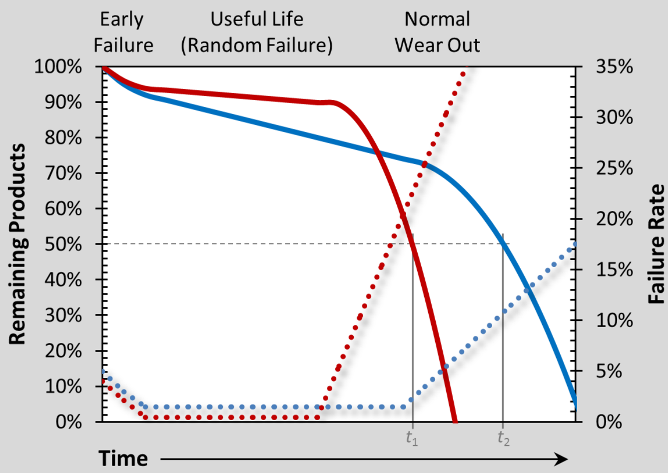

Figure 1. Failure rate (dotted lines) and percent remaining (solid lines) versus time for two hypothetical products. Reliability is the rate of random failure during the useful life phase, which is slightly lower (better) for the product shown in red. Using a 50% remaining metric for determining lifetime, the blue product has a longer rated life. Lifetime and reliability are not synonymous.

The plots of failure rate illustrate the bathtub curve, which typically arises from some combination of design flaws, material and manufacturing defects, and normal wear out. For LED products, design flaws may include insufficient thermal management, poor driver design, or incompatible materials, among others. Material and manufacturing defects are the primary contributors to early failure, otherwise known as infant mortality, as well as failure during the useful life period. Some manufacturers attempt to reduce or eliminate early failures by utilizing a "burn-in" period prior to shipment. Products that are well designed and well made should reach "normal" end of life, an event that can be caused by one or more failure mechanisms.

A desirable product has a short early failure period (with failures that can be identified during infant mortality testing), a long useful life with a low rate of random failure (i.e., is highly reliable), and a short wear out period (consistent with steeper slopes in the bathtub curve), allowing for more predictable end-of-life planning.

of parametric failures such as degradation or shifts in luminous flux, luminous intensity distribution, color temperature, color rendering, or efficacy. Of these, lumen depreciation has received the most attention, although there is little long-term data to confirm that it is the primary failure mechanism for LED products. Nonetheless, lumen maintenance is often used as a proxy for LED lamp or luminaire lifetime ratings, in large part due to the availability of standardized methods for measuring and projecting LED package lumen depreciation.

A lumen maintenance failure criterion is typically specified as a relative percentage of initial output, most often the point when output has dropped to 70% of the original value, denoted L_{70}. Because failures among a set of installed lamps or luminaires do not all occur simultaneously, lumen maintenance ratings are usually established based on the time at which 50% of a sample of products are expected to reach L_{70}, denoted L_{70}-B_{50}.

Other ways of conveying lumen maintenance performance have also been introduced. One notable method, offered as a reporting option for LED Lighting Facts,[1] is to identify the expected lumen maintenance at a fixed time interval (e.g., 25,000 hours). This may allow for more effective comparisons between products, especially when the calculated L_{70} value exceeds the intended product use cycle or the anticipated lifetime of another component in the system.

While lumen maintenance is important, other forms of parametric failure for LED packages must not be overlooked. For example, color shift may be more detrimental than lumen depreciation for some applications. It is, however, more difficult to predict, and is generally considered an aesthetic issue rather than a safety issue. For these reasons, it has received less attention than lumen depreciation. Substantial changes in luminous intensity distribution are also a potential cause of failure, but they are most often associated with changes in lumen output. For example, if half of the LEDs in a luminaire stop working, both the distribution and lumen output may be altered.

Failure of Other Components

Aside from the LED package itself, many other system components, like the driver, can cause an LED product to fail. Like any electronic device, a driver has a useful life that is related to the lifetime of its internal components, such as electrolytic capacitors, and that is strongly dependent on operating temperature. Ideally, the expected lifetime for the LED package(s) and the driver used in a product would be similar; however, given the long lifetimes of today's LED packages, the driver is the weak link for some currently available LED products, as illustrated in Figure 2. Market pressures to minimize cost or comply with specific form factors pose challenges for the longevity of LED drivers, particularly for lamp products.

Other components in an LED system may similarly struggle to outlive the LED packages. Thermal management components may become less efficient as they accumulate dirt and debris, and optical materials have been known to discolor or otherwise degrade over time, especially in high temperature environments. Gaskets and other materials may age prematurely due to compatibility issues with adjoining components. Oftentimes, the failure of auxiliary components is difficult to predict, and may only be exposed by real-world installations that have been operating for some time. Thankfully, as the body of knowledge surrounding the construction and materials of LED lighting systems has grown, it has become easier to recognize and avoid potential problems.

Standards

The measurement of lumen (and color) maintenance for LED packages is prescribed by IES LM-80-08 (*Measuring Lumen Maintenance of LED Light Sources*), while the projection of lumen maintenance beyond the duration of available LM-80 data is prescribed by IES TM-21-11 (*Projecting Long Term Lumen Maintenance of LED Light Sources*). TM-21 lumen maintenance projections can be applied to luminaires (and possibly lamps), through the proper use of in-situ temperature measurement; however, even if this extrapolation is done correctly, it can only be used to estimate the onset of one failure mode: lumen depreciation. Two new documents are slated to define standards for measuring the lumen and color maintenance of lamps and luminaires (IES LM-84), and projecting the lumen maintenance of lamps (IES TM-28); the lumen maintenance projection for luminaires is likely to be addressed in a future revision of TM-28 or a separate standard.

[1] *http://www.lightingfacts.com/Downloads/Lumen_Maintenance_FAQ.pdf*

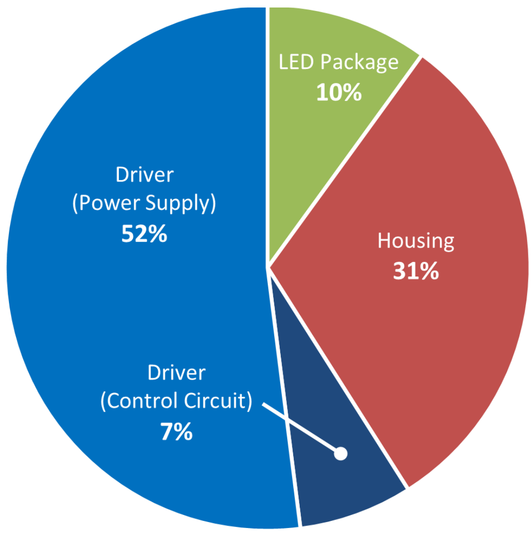

Figure 2. The distribution of failures over 34 million operating hours for one manufacturer's family of outdoor luminaires. A total of 29 fixtures failed out of more than 5,400 (0.56%). *Source: Appalachian Lighting Systems, Inc.*

Lifetime and Reliability

The rated lifetime assigned by a manufacturer is a statistical estimate of how long a product is expected to perform its intended functions under a specific set of environmental, electrical, and mechanical conditions. It is specifically related to normal wear out and end of life behavior. Typically, a single number is given as an estimate of a more complex distribution of failures; some products will fail before the rated lifetime, and some will fail afterwards. The rated lifetime of a product may be affected by its design, materials, component selection, manufacturing process, and use environment, among other factors. Importantly, the rated lifetime for a complete system cannot be longer than the in-situ lifetime for any of its components. The useful life of a product corresponds to the middle portion of the bathtub curve, where failures result from unexpected random events, and the failure rate is ideally constant.

Reliability is a different statistical measure of performance that, in principal, describes the ability of a product to perform its intended functions under a specific set of conditions and for a specific period of time. Reliability estimates are typically made for some portion of a product's useful life phase, prior to the point at which normal wear out starts to generate mass failures in a population of products. No matter how well engineered a product is, some samples will inevitably fail early; reliability is essentially a measure of the probability of these unanticipated failures, which are typically random. In relation to the bathtub curve, reliability estimates are made for the useful life (i.e., middle) portion of the curve, and are often reported as the mean time between failures (MTBF). Note that while both lifetime and MTBF are typically reported in hours or years, the latter is actually an average failure rate metric, rendering direct comparison between the two ratings meaningless and cause for misguided conclusions. For example, while a lifetime of 100,000 hours might be considered excellent, a ballast or driver MTBF of 100,000 hours means that over a 10-year (continuous) useful life period, 87.6% of the units will likely fail and need to be replaced.[2] Reliability metrics are useful for approximating the average maintenance interval of serviceable systems, but since MTBF only describes an average failure rate, the accuracy of such estimates is reduced for systems that do not have a constant failure rate during their useful life.

Serviceability

A serviceable product has components that are replaceable or repairable by regular maintenance personnel. Whereas lamp-based luminaires are almost all easily serviced in the field, some LED luminaires are not serviceable at all, or must be returned to the manufacturer for repair. Even for serviceable LED luminaires, the lack of standardized components—a situation that is improving—leads to several questions that must be answered on a product-by-product basis. For example, what components are replaceable and what are their rated lifetimes and reliabilities? Will replacement components be available in the future? Will next-generation components be backwards compatible?

Serviceability should factor into any purchasing decision where long or unproven system lifetime is expected, or where component lifetimes are not well known or well matched. While making a product serviceable typically adds some cost, concerns about the reliability of specific components over very long lifetimes can be alleviated if the components are replaceable or repairable. For some applications, a serviceable product with short-lived or less reliable components may be less costly to operate over its useful life than a more expensive product with well-matched component lifetimes.

Important Terms

Failure – The end of useful life; may occur either catastrophically (i.e., "burn out") or parametrically, where a product does not perform as intended (e.g., emits less than 70% of the initial output).

Lifetime – A statistical measure (or estimate) of how long a product is expected to perform its intended functions under a specific set of environmental, electrical and mechanical conditions. Lifetime specifications can only describe the behavior of a population; any single product may fail before or after the rated lifetime.

Mean Time Between Failures (MTBF) – The average time between failures during useful life for repairable or redundant systems.

Mean Time To Failure (MTTF) – The average time to failure during useful life for components or non-repairable systems.

Reliability – A statistical measure (or estimate) of the ability of a product to perform its intended functions under a specific set of environmental, electrical, and mechanical conditions, for a specific period of time. Reliability estimates for the entire useful life phase of a product are commonly reported using MTBF or MTTF.

Serviceability – The ability of a product to be repaired by regular maintenance personnel, typically through replacement of a subsystem or one or more associated components.

2 *Percent failures is equal to the period of use divided by the MTBF. In this case, 87,600 hours/100,000 hours × 100% = 87.6%.*

Discussion

The accurate portrayal of LED product lifetime and reliability is important for consumers, manufacturers, and the lighting industry as a whole. It was not long ago that the default lifetime claim for an LED product was 100,000 hours, often with little or no supporting evidence. Such unsubstantiated claims can lead to significant user frustration that hinders the adoption of LED technology. Similarly, portraying the lumen maintenance of LED packages as the lifetime of a complete LED lamp or luminaire may misrepresent the actual performance of some products.

While standards groups are making steady progress characterizing the lumen maintenance of LED lamps and luminaires, more work is needed to project lifetime considering all possible failure modes. Testing a statistically significant sample of complete luminaires while addressing all possible permutations of features is an arduous task, but an approach that uses statistical methods for combining test results from multiple components can significantly reduce the testing burden; Figure 3 shows an example of such an approach, with the cumulative probability of failure plotted for a theoretical product, considering only the LED packages and driver. Accelerated (overstress) testing methods may also help reduce required testing time and improve reliability through the identification of design flaws and manufacturing defects. Continued work to standardize testing procedures, projection methods, and reporting practices is necessary and ongoing.

Consumers and specifiers can find a wide range of lifetime ratings for LED products, from less than 10,000 hours to more than 100,000 hours, depending on the type and quality of the product. However, these ratings are usually based exclusively on the expected lumen depreciation of the LED package, and little other data is readily available. Therefore, it may be difficult for consumers and specifiers to identify a truly long-life, reliable LED product. Even if consistent reporting of system-level lifetime and reliability data becomes commonplace, LED product variability may necessitate weighing various tradeoffs and asking additional questions. A well-designed product may take many forms, some of which may be more or less acceptable to a given user:

- Failure results from a single, well known, and easily understood wear-out mechanism.
- Failure results from multiple sources or mechanisms, but the product is designed such that the lifetime of each component is similar. For example, the lifetime of the LED driver matches the lifetime of the LED package(s).
- Failure results from multiple sources or mechanisms, but components with a shorter lifetime or lower reliability are easily serviced or replaced, thereby enabling an acceptable maintained system lifetime (and cost).

Users are advised to give thought to what balance between lifetime, reliability, serviceability, warranty, sustainability, and cost is necessary or ideal for their lighting application. Typically, the design and manufacture of products that last longer comes at a cost, yet the advantages of longer life may not be realized if the expected use cycle is less than the lifetime. For example, a building scheduled to be renovated in the next 10 to 15 years may not benefit from lighting products with a 30-year lifetime. Instead, it may be better to use a less expensive product with a shorter useful life, but higher reliability. On the other hand, shorter-lived products generate more waste and compromise sustainability goals or requirements. Minimizing the net amount of disposed material ideally results in the lowest user cost and environmental impact.

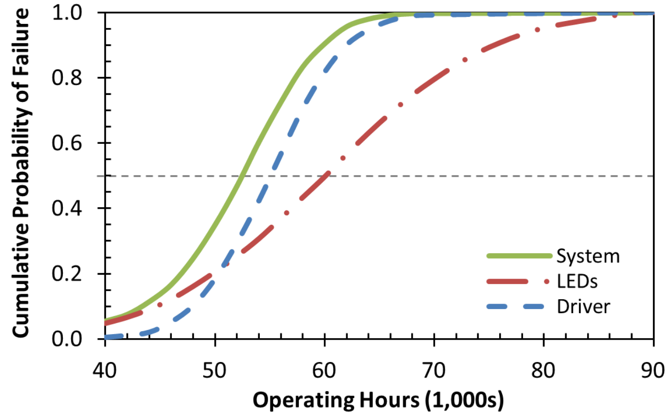

Figure 3. In this theoretical example, the rated life of the LED system is a function of both the LEDs and the driver. The rated life of the combined system is approximately 52,000 hours, which is less than for either component individually.

Lumen maintenance projections can help sophisticated users compare products, as long as their limitations are properly understood. Evaluating lifetime projections for other system components should also be considered, since the lifetime of a lamp or luminaire cannot be longer than the lifetime of any of its components. If payback period is critical, it may also be advisable to give extra consideration to the terms and credibility of the manufacturer's warranty.

Conclusion

As LED technology matures, some of the current issues surrounding the measurement and reporting of lifetime and reliability may abate. However, it is likely that products will continue to fail both catastrophically and parametrically, through various mechanisms. The dependence of LED package performance on other components will continue to require that discussions about lifetime be focused at the luminaire, and not component or even lamp level, as lamp performance in different luminaires can vary. Innovative luminaire designs and control strategies—such as variable drive products that maintain lumen output—will further complicate the measurement and reporting of lifetime. As with many performance attributes, LEDs have the potential to best other technologies in terms of longevity, but choosing the right product requires some understanding of expected failure mechanisms, lifetime, reliability, and serviceability, as well as asking the right application-specific questions.

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Energy Efficiency & Renewable Energy

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KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 5

Responding Witness: John K. Wolfe

Q-5. Please refer to Attachment to response to LFUCG-1-5(a) Page 64 of 66. Explain whether the Company reviewed Kentucky D.O.T. requirements when evaluating LED offerings. If so, include within your response copies of any such requirements and a narrative description of how the Company did or did not incorporate such requirements into its LED offerings.

A-5. No specific Kentucky D.O.T. requirements were referenced as part of the LED evaluation processes.

When a roadway lighting application is designed and constructed (including Company's existing lighting installations), it is done so to meet applicable requirements such as those from Kentucky D.O.T. As part of the LED product selection processes, the Company evaluated lumen output and pattern to be comparable to the existing HID offerings. In choosing fixtures with comparable criteria, this will allow the utility to replace or upgrade existing HID fixtures to LED's without needing to redesign lighting layouts – providing the same roadway lighting as before with the added benefits of LED fixtures (e.g., less light trespass, crisper light, lower energy usage).

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 6

Responding Witness: John K. Wolfe

Q-6. Please refer to response to LFUCG 1-7, which asked whether the Company had systematic plans to convert restricted lighting to LED by geography or rate code. The testimony referenced in the response does not appear to address this question. Attachments supplied in response to LFUCG 1-9 indicate that various alternatives have been considered by the Company, including complete change out of lights. Please explain whether the Company has systematic plans to convert restricted lighting to LED by geography or rate code.

A-6. The Company evaluated various alternatives to converting existing in-service lighting assets to LED, but does not have any plans to proactively convert restricted lighting to LED by geography or rate code in its five-year business plan. The Company plans to convert non-LED lighting assets to LED upon failure and upon customer request.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 7

Responding Witness: John K. Wolfe

Q-7. Please refer to response to LFUCG 1-8.

a. Does the Company plan to have a routine visual inspection of LED lights to determine if light levels are low due to lumen depreciation, or will it be up to the municipality to request replacement of dim LED lights?

b. Do industry standards permit visual inspections to determine whether lumens depreciate below 70% of initial output or do industry standards require testing by photometers or other devices?

A-7.

a. The Company plans to continue to conduct proactive lighting patrols in Fayette County as part of its normal operations, as described in LFUCG 1-23. The Company will also continue to rely on its customers and the municipality to report and request replacement of dim or non-working LED lights.

b. The Company is not currently aware of any utility standard or practice for the use of a photometer to determine if a LED fixture has depreciated below 70% lumen output. It is the Company's understanding that visual inspection is the standard process across the industry for determining when a light's output has diminished below this threshold.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 8

Responding Witness: Robert M. Conroy

Q-8. Please refer to response to LFUCG 1-9. On page 15 of Attachment 1, it says "Bill maintenance other than burn-out in tariffs but not being billed" and implies that the Company will begin such billing.

a. Does the Company intend to start billing for maintenance calls other than for burn-out?

i. If so, what tariff provisions permit the Company to do so.

ii. If so, will the revenue from that billing offset revenue requirements met through the operations and maintenance portion of monthly lighting bills? What is the estimated revenue from billing for maintenance other than burn-out?

b. For LED lights, will maintenance due to lumen depreciation be billed or will that be considered equivalent of "burn-out" for purposes of this tariff provision?

A-8.

a. All activities related to the maintenance of lighting assets provided under the LS and RLS Rate Schedules are recovered through the monthly rate associated with each asset. The Company has no plans to bill for any maintenance costs beyond the monthly rates paid under the LS and RLS Rate Schedules.

i. N/A

ii. N/A

b. All maintenance for LED lights is recovered through the monthly rates paid under the LS Rate Schedule. Specifically, the replacement of an LED fixture is a capital expense that will be recovered throughout the depreciable life of that asset through the monthly LS rate.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 9

Responding Witness: John K. Wolfe

Q-9. Attachment 3 to Response to LFUCG 1-9 Page 1 of 11 states, "LKE estimates up to 1% of LED lights will fail each year, prior to end of their estimated useful life." Identify and provide any and all support for this statement.

A-9. The Company's LED vendors have advised that their current line of LED products have seen less than .05% of failures per year due to manufacturing defects. The Company estimates that various other factors (e.g. lightning strikes and vandalism) could result in additional premature failures of LED assets. See also the response to Question No. 8(b).

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 10

Responding Witness: John K. Wolfe

Q-10. Attachment 3 to Response to LFUCG 1-9 Page 3 of 11 states, "LKE currently does not have any information related to outdoor lighting on the LGE-KU webpage. LKE should develop a landing page on its webpage for lights that describe all of the current offerings and provide proper contacts to secure outdoor lighting based on the customer's location. LKE should provide uniform informational materials, which explain the different lights available, to operations and customer service representatives who handle lighting requests and should make an effort to explain the new LED offerings to customers and the benefits of LEDs." Explain whether the Company has developed a landing page for lights as recommended in this statement. If so, identify the website location.

A-10. The Company has not yet developed a landing page for outdoor lighting on the LG&E and KU webpage, but continues to assess and consider electric utility customer interfacing practices for outdoor lighting.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 11

Responding Witness: John K. Wolfe

Q-11. Please refer to response to LFUCG 1-10. Using the referenced tool, provide cost estimates for the following scenarios by rate code, including respective fixture count:

a. Conversion of all LFUCG leased lighting to recommend LED offering.

b. Conversion of all LFUCG leased lighting currently in service over 5 years/60 months.

A-11.

a. See attached.

b. See attached. The number of KU lights in service over 5 years is estimated. In order to provide a more accurate cost estimate, extensive original review work would be required of existing outdoor lighting records and contracts.

KU HID-LED Comparison Tool and Estimated Bill Calculator

LFUCG HID Lighting Conversion to Recommended Comparable LED (All Lights) *All numbers are estimated

	Rate Code	Description	Number of Fixtures
1	404	RLS 404: OH MV Open Bottom 7000L Fixture	1
2	489	LS 489: OH HPS Directional 50000L Fix	1
3	447	RLS 447: OH MV Cobra Head 10000L Fixture	570
4	474	LS 474: OH HPS Cobra 22000L Ornamental	252
5	464	LS 464: OH HPS Cobra Head 22000L Fixture	680
6	458	RLS 458: OH MV Cobra 20000L Fixture/Pole	386
7	462	LS 462: OH HPS Cobra Head 5800L Fixture	1,724
8	475	LS 475: OH HPS Cobra 50000L Ornamental	50
9	474	LS 474: OH HPS Cobra 22000L Ornamental	3,167
10	475	LS 475: OH HPS Cobra 50000L Ornamental	215
11	472	LS 472: OH HPS Cobra 5800L Ornamental	9,113
12	465	LS 465: OH HPS Cobra Head 50000L Fixture	161
13	457	RLS 457: OH MV Cobra 10000L Fixture/Pole	10
14	430	LS 430: UG HPS Acorn 9500L Historic	7
15	461	RLS 461: OH HPS Cobra Head 4000L Fixture	596
16	472	LS 472: OH HPS Cobra 5800L Ornamental	137
17	463	LS 463: OH HPS Cobra Head 9500L Fixture	1,098
18	471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	3,365
19	473	LS 473: OH HPS Cobra 9500L Ornamental	1,867
20	457	RLS 457: OH MV Cobra 10000L Fixture/Pole	336
21	473	LS 473: OH HPS Cobra 9500L Ornamental	46
22	471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	26
23	448	RLS 448: OH MV Cobra Head 20000L Fixture	217
24	458	RLS 458: OH MV Cobra 20000L Fixture/Pole	191
25	420	LS 420: UG HPS Acorn 9500L Decorative	23
26	476	LS 476: UG HPS Contemporary 5800L Deco	4,873
27	478	LS 478: UG HPS Contemporary 22000L Deco	556
28	479	LS 479: UG HPS Contemporary 50000L Deco	85
29	477	LS 477: UG HPS Contemporary 9500L Deco	495
30	467	LS 467: UG HPS Colonial 5800L Deco	56
31	468	LS 468: UG HPS Colonial 9500L Deco	357
	Total		30,661

Estimated HID Bill Calculator
Current Monthly HID Bill Amount
$483,193.47
May 2019 Monthly HID Bill Amount
$517,515.20
Increase in monthly bill for May 2019
$34,321.73

Estimated LED Bill Calculator
Projected Monthly LED Bill Amount
$512,789.40
Total monthly conversion fee
$187,645.32
Combined monthly LED and conversion fee bill
$700,434.72

Estimated Energy Usage Calculator	
Annual HID energy usage	
16,046,020	(kWh)
$1,165,582.89	($)
Annual LED energy usage	
6,904,712	(kWh)
$501,558.28	($)
Annual energy savings by switching to LEDs	
9,141,308	(kWh)
$664,024.61	($)

LFUCG HID Lighting Conversion to Recommended Comparable LED (All Lights) *All numbers are estimated

Rate Code	Rate Description	Proposed Monthly HID Bill May '19	Monthly Bill Oct '18 HID	Proposed LED	Annual HID energy usage (kwh)	Annual HID energy usage ($) using current LE Rate	Annual LED energy usage (kwh)	Annaul LED energy usage ($) using current LE rate
404	RLS 404: OH MV Open Bottom 7000L Fixture	$12.81	$11.96	$8.80	828	$60.15	192	$13.95
489	LS 489: OH HPS Directional 50000L Fix	$23.66	$22.09	$15.96	1,884	$136.85	700	$50.85
447	RLS 447: OH MV Cobra Head 10000L Fixture	$7,877.40	$7,353.00	$5,831.10	670,320	$48,692.04	161,880	$11,758.96
474	LS 474: OH HPS Cobra 22000L Ornamental	$5,513.76	$5,148.36	$5,042.52	243,936	$17,719.51	122,976	$8,932.98
464	LS 464: OH HPS Cobra Head 22000L Fixture	$11,852.40	$11,070.40	$8,391.20	658,240	$47,814.55	331,840	$24,104.86
458	RLS 458: OH MV Cobra 20000L Fixture/Pole	$7,044.50	$6,577.44	$7,723.86	699,432	$50,806.74	188,368	$13,683.05
462	LS 462: OH HPS Cobra Head 5800L Fixture	$18,653.68	$17,412.40	$15,429.80	572,368	$41,576.81	151,712	$11,020.36
475	LS 475: OH HPS Cobra 50000L Ornamental	$1,527.50	$1,426.50	$1,167.00	94,200	$6,842.69	38,800	$2,818.43
474	LS 474: OH HPS Cobra 22000L Ornamental	$69,293.96	$64,701.81	$63,371.67	3,065,656	$222,689.25	1,545,496	$112,264.83
475	LS 475: OH HPS Cobra 50000L Ornamental	$6,568.25	$6,133.95	$5,018.10	405,060	$29,423.56	166,840	$12,119.26
472	LS 472: OH HPS Cobra 5800L Ornamental	$134,416.75	$125,486.01	$151,458.06	3,025,516	$219,773.48	801,944	$58,253.21
465	LS 465: OH HPS Cobra Head 50000L Fixture	$4,440.38	$4,145.75	$2,522.87	303,324	$22,033.46	124,936	$9,075.35
457	RLS 457: OH MV Cobra 10000L Fixture/Pole	$161.90	$151.20	$178.90	11,760	$854.25	2,840	$206.30
430	LS 430: UG HPS Acorn 9500L Historic	$189.28	$176.75	$172.20	3,276	$237.97	1,120	$81.36
461	RLS 461: OH HPS Cobra Head 4000L Fixture	$5,763.32	$5,381.88	$5,334.20	143,040	$10,390.43	52,448	$3,809.82
472	LS 472: OH HPS Cobra 5800L Ornamental	$2,020.75	$1,886.49	$2,276.94	45,484	$3,303.96	12,056	$875.75
463	LS 463: OH HPS Cobra Head 9500L Fixture	$12,330.54	$11,518.02	$11,232.54	513,864	$37,327.08	311,832	$22,651.48
471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	$44,518.95	$41,557.75	$55,926.30	807,600	$58,664.06	296,120	$21,510.16
473	LS 473: OH HPS Cobra 9500L Ornamental	$28,714.46	$26,810.12	$33,400.63	873,756	$63,469.64	530,228	$38,515.76
457	RLS 457: OH MV Cobra 10000L Fixture/Pole	$5,439.84	$5,080.32	$6,011.04	395,136	$28,702.68	95,424	$6,931.60
473	LS 473: OH HPS Cobra 9500L Ornamental	$707.48	$660.56	$822.94	21,528	$1,563.79	13,064	$948.97
471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	$343.98	$321.10	$432.12	6,240	$453.27	2,288	$166.20
448	RLS 448: OH MV Cobra Head 20000L Fixture	$3,383.03	$3,159.52	$2,677.78	393,204	$28,562.34	105,896	$7,692.29
458	RLS 458: OH MV Cobra 20000L Fixture/Pole	$3,485.75	$3,254.64	$3,821.91	346,092	$25,140.12	93,208	$6,770.63
420	LS 420: UG HPS Acorn 9500L Decorative	$438.15	$409.17	$399.51	10,764	$781.90	3,680	$267.32
476	LS 476: UG HPS Contemporary 5800L Deco	$102,284.27	$95,510.80	$93,025.57	1,617,836	$117,519.61	1,111,044	$80,706.24
478	LS 478: UG HPS Contemporary 22000L Deco	$18,487.00	$17,263.80	$12,248.68	538,208	$39,095.43	318,032	$23,101.84
479	LS 479: UG HPS Contemporary 50000L Deco	$3,482.45	$3,252.10	$2,256.75	160,140	$11,632.57	74,800	$5,433.47
477	LS 477: UG HPS Contemporary 9500L Deco	$12,771.00	$11,924.55	$10,023.75	231,660	$16,827.78	172,260	$12,512.97
467	LS 467: UG HPS Colonial 5800L Deco	$770.00	$719.04	$890.40	18,592	$1,350.52	9,856	$715.94
468	LS 468: UG HPS Colonial 9500L Deco	$4,998.00	$4,665.99	$5,676.30	167,076	$12,136.40	62,832	$4,564.12
	Totals	$517,515.20	$483,193.47	$512,789.40	16,046,020	$1,165,582.89	6,904,712	$501,558.28

KU HID-LED Comparison Tool and Estimated Bill Calculator

LFUCG HID Lighting Conversion to Recommended Comparable LED (Estimated Lights Older than 5 years) *All numbers are estimated

	Rate Code	Description	Number of Fixtures
1	404	RLS 404: OH MV Open Bottom 7000L Fixture	1
2	420	LS 420: UG HPS Acorn 9500L Decorative	23
3	430	LS 430: UG HPS Acorn 9500L Historic	7
4	447	RLS 447: OH MV Cobra Head 10000L Fixture	570
5	448	RLS 448: OH MV Cobra Head 20000L Fixture	217
6	457	RLS 457: OH MV Cobra 10000L Fixture/Pole	346
7	458	RLS 458: OH MV Cobra 20000L Fixture/Pole	577
8	461	RLS 461: OH HPS Cobra Head 4000L Fixture	589
9	462	LS 462: OH HPS Cobra Head 5800L Fixture	1,666
10	463	LS 463: OH HPS Cobra Head 9500L Fixture	1,066
11	464	LS 464: OH HPS Cobra Head 22000L Fixture	653
12	465	LS 465: OH HPS Cobra Head 50000L Fixture	158
13	467	LS 467: UG HPS Colonial 5800L Deco	36
14	468	LS 468: UG HPS Colonial 9500L Deco	281
15	471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	3,365
16	472	LS 472: OH HPS Cobra 5800L Ornamental	8,819
17	473	LS 473: OH HPS Cobra 9500L Ornamental	1,906
18	474	LS 474: OH HPS Cobra 22000L Ornamental	3,047
19	475	LS 475: OH HPS Cobra 50000L Ornamental	221
20	476	LS 476: UG HPS Contemporary 5800L Deco	4,499
21	477	LS 477: UG HPS Contemporary 9500L Deco	474
22	478	LS 478: UG HPS Contemporary 22000L Deco	486
23	479	LS 479: UG HPS Contemporary 50000L Deco	77
	Total		29,084

Estimated HID Bill Calculator
Current Monthly HID Bill Amount
$454,892.12
May 2019 Monthly HID Bill Amount
$487,204.81
Increase in monthly bill for May 2019
$32,312.69

Estimated LED Bill Calculator
Projected Monthly LED Bill Amount
$484,447.08
Total monthly conversion fee
$177,994.08
Combined monthly LED and conversion fee bill
$662,441.16

Estimated Energy Usage Calculator	
Annual HID energy usage	
15,121,800	(kWh)
$1,098,447.55	($)
Annual LED energy usage	
6,459,260	(kWh)
$469,200.65	($)
Annual energy savings by switching to LEDs	
8,662,540	(kWh)
$629,246.91	($)

LFUCG HID Lighting Conversion to Recommended Comparable LED (Estimated Lights Older than 5 years) *All numbers are estimated

Rate Code	Rate Description	Proposed Monthly HID Bill May '19	Monthly Bill Oct '18 HID	Proposed LED	Annual HID energy usage (kwh)	Annual HID energy usage ($) using current LE Rate	Annual LED energy usage (kwh)	Annaul LED energy usage ($) using current LE rate
404	RLS 404: OH MV Open Bottom 7000L Fixture	$12.81	$11.96	$8.80	828	$60.15	192	$13.95
420	LS 420: UG HPS Acorn 9500L Decorative	$438.15	$409.17	$399.51	10,764	$781.90	3,680	$267.32
430	LS 430: UG HPS Acorn 9500L Historic	$189.28	$176.75	$172.20	3,276	$237.97	1,120	$81.36
447	RLS 447: OH MV Cobra Head 10000L Fixture	$7,877.40	$7,353.00	$5,831.10	670,320	$48,692.04	161,880	$11,758.96
448	RLS 448: OH MV Cobra Head 20000L Fixture	$3,383.03	$3,159.52	$2,677.78	393,204	$28,562.34	105,896	$7,692.29
457	RLS 457: OH MV Cobra 10000L Fixture/Pole	$5,601.74	$5,231.52	$6,189.94	406,896	$29,556.93	98,264	$7,137.90
458	RLS 458: OH MV Cobra 20000L Fixture/Pole	$10,530.25	$9,832.08	$11,545.77	1,045,524	$75,946.86	281,576	$20,453.68
461	RLS 461: OH HPS Cobra Head 4000L Fixture	$5,695.63	$5,318.67	$5,271.55	141,360	$10,268.39	51,832	$3,765.08
462	LS 462: OH HPS Cobra Head 5800L Fixture	$18,026.12	$16,826.60	$14,910.70	553,112	$40,178.06	146,608	$10,649.61
463	LS 463: OH HPS Cobra Head 9500L Fixture	$11,971.18	$11,182.34	$10,905.18	498,888	$36,239.22	302,744	$21,991.32
464	LS 464: OH HPS Cobra Head 22000L Fixture	$11,381.79	$10,630.84	$8,058.02	632,104	$45,916.03	318,664	$23,147.75
465	LS 465: OH HPS Cobra Head 50000L Fixture	$4,357.64	$4,068.50	$2,475.86	297,672	$21,622.89	122,608	$8,906.25
467	LS 467: UG HPS Colonial 5800L Deco	$495.00	$462.24	$572.40	11,952	$868.19	6,336	$460.25
468	LS 468: UG HPS Colonial 9500L Deco	$3,934.00	$3,672.67	$4,467.90	131,508	$9,552.74	49,456	$3,592.48
471	RLS 471: OH HPS Cobra Hd 4000L Fix/Pole	$44,518.95	$41,557.75	$55,926.30	807,600	$58,664.06	296,120	$21,510.16
472	LS 472: OH HPS Cobra 5800L Ornamental	$130,080.25	$121,437.63	$146,571.78	2,927,908	$212,683.24	776,072	$56,373.87
473	LS 473: OH HPS Cobra 9500L Ornamental	$29,314.28	$27,370.16	$34,098.34	892,008	$64,795.46	541,304	$39,320.32
474	LS 474: OH HPS Cobra 22000L Ornamental	$66,668.36	$62,250.21	$60,970.47	2,949,496	$214,251.39	1,486,936	$108,011.03
475	LS 475: OH HPS Cobra 50000L Ornamental	$6,751.55	$6,305.13	$5,158.14	416,364	$30,244.68	171,496	$12,457.47
476	LS 476: UG HPS Contemporary 5800L Deco	$94,434.01	$88,180.40	$85,885.91	1,493,668	$108,500.04	1,025,772	$74,512.08
477	LS 477: UG HPS Contemporary 9500L Deco	$12,229.20	$11,418.66	$9,598.50	221,832	$16,113.88	164,952	$11,982.11
478	LS 478: UG HPS Contemporary 22000L Deco	$16,159.50	$15,090.30	$10,706.58	470,448	$34,173.34	277,992	$20,193.34
479	LS 479: UG HPS Contemporary 50000L Deco	$3,154.69	$2,946.02	$2,044.35	145,068	$10,537.74	67,760	$4,922.09
	Totals	$487,204.81	$454,892.12	$484,447.08	15,121,800	$1,098,447.55	6,459,260	$469,200.65

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 12

Responding Witness: Robert M. Conroy

Q-12. Please refer to response to LFUCG 1-13(b), in which the Company responds that it does not have a system that tracks infrastructure pre-paid through CIAC. Explain how the Company will know whether to charge the overhead or underground rate, as individual lights are converted to LED.

A-12. The proposed LED rates and pole rates include recovery of costs that mirror the costs currently recovered through the existing LS and RLS rates. Any infrastructure costs pre-paid through CIAC are not recovered through the existing or proposed LS and RLS rates and are, thus, not impacted.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 13

Responding Witness: Robert M. Conroy / Christopher M. Garrett / William Steven Seelye

Q-13. Please refer to response to Staff 2-14, in which the Company responded that it "considered an amortization period from three to five years, which is consistent with the amortization periods that have been used for amortization of regulatory assets of similar magnitude." Identify what other regulatory assets the Company believes are of a similar magnitude with the Conversion Fee and provide each of those regulatory asset's amortization periods.

A-13. The Companies consider rate case expenses, Green River station expenses, management audit expenses, mountain storm expenses, and the 2011 summer storm expenses likely to be within the range of magnitude comparable to the stranded investment assets for LED conversion, particularly rate case expense and management audit expenses. Rate case expenses, Green River station expenses, and the management audit expenses were amortized over three years, and the mountain storm expenses and 2011 summer storm expenses were amortized over five years. The Companies are proposing a five-year amortization rather than a three-amortization of the stranded costs of LED conversions to strike a balance between (i) minimizing the impact of the conversion fee on lighting customers choosing to convert to LED lights and (ii) not encouraging a sudden migration to LED lights by lighting customers, while at the same time preventing the shifting of stranded costs to non-lighting customers.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 14

Responding Witness: John K. Wolfe

Q-14. Refer to proposed tariff sheets 35.4 and 36.3. Sheet 36.4 states, "Temporary suspension of lighting service is not permitted. Upon permanent discontinuance of service, lighting units and other supporting facilities solely associated with providing service under this tariff, except underground facilities and pedestals, will be removed." Sheet 35.4 states, "If Customer requests the removal of an existing lighting system, including, but not limited to, fixtures, poles, or other supporting facilities, Customer agrees to pay to Company its cost of labor to remove existing facilities." State whether a removal fee will be assessed any time a customer discontinues lighting service or only when the customer requests removal of an existing lighting system.

A-14. A removal fee will be assessed any time a customer discontinues lighting service (triggering removal of the lighting assets) or requests removal of a lighting system. See also response to LFUCG 1-15.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 15

Responding Witness: John K. Wolfe

Q-15. Please refer to response to LFUCG 1-20. The response indicates that KU permanently removed 479 lights in Lexington-Fayette County. If the removal fee that is proposed on tariff sheet 35.4 was effective in 2016, would a customer have been charged that removal fee for the removal of each of those 479 lights?

A-15. No. If the removal fee had been effective in 2016, the Customer would only have been charged a removal fee for 97 of the 479 permanently removed lights. KU sold 382 (Granville – rate code 360 – GRN) of the 479 permanently removed lights to LFUCG in 2016.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 16

Responding Witness: Christopher M. Garrett / John K. Wolfe

Q-16. Please refer to response to LFUCG 1-24.

a. For each of the material items listed, would the Company book that item as a maintenance expense or as a capital expenditure in the event of installation as a replacement for a failed or failing item?

b. For each of the material items listed, would the Company book the associated installation costs as a maintenance expense or as a capital expenditure in the event of installation as a replacement for a failed or failing item?

A-16.

a. The replacement of individual lamps, starters, and refractors are considered maintenance expense. Fixtures and photocontrols are a unit of property and thus, the costs are capitalized. The general practice for KU when replacing a lamp or starter is to also replace the photocontrol so the entire cost is capitalized. Additionally, when a photocontrol is replaced, the lamp is also replaced and capitalized.

b. See the response to part a. The installation costs follow the same accounting treatment as the materials.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 17

Responding Witness: John K. Wolfe

Q-17. In response to LFUCG 1-30, KU indicated that it performed 4,863 repairs to Fayette County street lights, which averages to more than 13 per day. Given this magnitude of repairs, please explain how KU proposes to conduct coordination with LFUCG to determine if LFUCG wishes to upgrade a broken fixture to LED.

A-17. As stated in response to LFUCG 1-24, the primary maintenance activity on lights is bulb and photocell replacement, indicating that the majority of those 4,863 repairs are for replacing bulbs and photocells, not replacing failed fixtures. KU will coordinate with LFUCG when a non-LED fixture fails (not when a bulb burns out or photocell becomes inoperable) to determine if LFUCG would like for KU to replace the failed fixture with an LED equivalent fixture.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 18

Responding Witness: John K. Wolfe

Q-18. The Company's response to Staff 2-5 estimates that it will take one year to deplete non-LED inventory. The response to LFUCG 1-9 indicates a 6-week supply of inventory (page 7 of Attachment 1).

a. Please explain the discrepancy between these timeframes.

b. Please clarify whether these inventories refer to fixtures or lamps

A-18.

a. KU's supplier maintains a 6-week supply of outdoor lighting fixtures based on past annual usage rates for new fixture installations and failed fixture replacements. KU plans to stop installing non-LED fixtures for new installations upon approval of this proceeding, and estimates that failed fixture replacements will deplete the remaining non-LED inventory in approximately one year.

b. These inventories refer to fixtures.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 19

Responding Witness: William Steven Seelye

Q-19. Reference the direct testimony of Seelye, page 39, lines 6-8 and lines 12-15. Explain and provide calculations of the fixture charges proposed in this case, as follows:

a. Are the capital costs of fixtures computed as a carrying cost rate multiplied by the cost of a new fixture or the average embedded cost of a fixture?

b. Explain whether the carrying cost rate simply sums return of and return on capital on the original capital cost or the fixture or adjusts for the life-cycle average net book value of the asset.

c. Explain what fixture costs are booked as maintenance and what are booked as capital.

d. For costs booked as maintenance, explain how they are allocated to fixture types.

A-19.

a. The annual carrying costs are computed as a carrying charge rate multiplied by the cost of a new fixture. There are no average embedded costs for these fixtures since they are lights that the company currently does not offer.

b. The rate for a fixture was not calculated as a levelized rate; therefore, the carrying charge rate does not adjust for the life-cycle average net book value of the fixture.

c. See the response to LFUCG 2-16.

d. The maintenance costs were not allocated to each fixture. The forecasted maintenance costs were divided by the number of light months to create a maintenance charge per month; this charge was then added to rates for overhead fixtures and poles.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 20

Responding Witness: William Steven Seelye

Q-20. Please refer to response to Staff 2-21. Please confirm that the calculated carrying charges are reduced if a lower ROE is utilized in the calculations.

A-20. Yes, the carrying charge would be reduced if a lower ROE is utilized in the calculations.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 21

Responding Witness: Robert M. Conroy

Q-21. Once the Company has recovered their costs for a lighting unit, is ownership of the asset transferred to the customer? If not, explain why not.

A-21. No. The Company provides street lighting as a service. As with any service provider, the equipment the Company uses to provide the service remains the property of the Company unless and until the Company determines to dispose of it by sale or otherwise.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 22

Responding Witness: Lonnie E. Bellar

Q-22. Please refer to Exhibit LEB-2, page 15.

a. What is the annual peak reserve margin projected by PJM for the years 2019-2033?

b. Does PJM project by season? By month? If so, please state those seasonal and/or monthly projections by PJM for 2019-2033.

c. When the capacity auction benefits are computed for purposes of its RTO study, did the Companies assume that it would participate as an RPM member? If not, why not?

A-22.

a. The assumption for PJM's target annual peak reserve margin in the Companies' 2018 RTO Membership Analysis, which was conducted through the 2029/2030 planning year, is shown as "Installed Reserve Margin (RTO)" on page 3 of Attachment 6 to the response to LFUCG 1-40(d).

b. The Companies are not aware of seasonal or monthly target peak reserve margins projected by PJM.

c. Yes. See Exhibit LEB-2, Section 7.2.1, which is titled "PJM Reliability Pricing Model ("RPM")."

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 23

Responding Witness: Robert M. Conroy / Elizabeth J. McFarland / Counsel

Q-23. Please refer to the answer to LFUCG 1-36. Does KU agree that any future franchise or extension of the current franchise can have identical provision to Section 18(c) that would supersede the proposed tariff amendment regarding internal communication network facilities of governmental units and educational institutions in Rate PSA with respect to LFUCG?

A-23. No. If the proposed revisions to Rate PSA become effective, a provision identical to Section 18(c) of the current LFUCG agreement in a franchise agreement executed after the proposed revisions become effective would not supersede the revised Rate PSA.

Section 18(c) requires that KU permit LFUCG "to utilize its pole, conduit or raceway space at no charge when such space is vacant or available for public safety or governmental purposes. If such space is not available, then the Company shall make such space available on the most favorable terms extended to any other customer." In effect, Section 18(c) prescribes the rates that KU may charge LFUCG for utility service. *See Kentucky CATV Association v. Volz*, 675 S.W.2d 393, (Ky. 1983) (holding that utilities are providing a service when they allow persons to attach their cables to unused space on an existing utility pole.)

The Commission has established Rate PSA to address the attachment of the facilities of cable television providers and telecommunication carriers to KU's structures, but until this proceeding has not attempted to apply this rate schedule to the attachments of governmental entities. Under the proposed revisions to Rate PSA, governmental entities would be permitted to attach their facilities to KU structures under the same rates and terms and conditions currently applied to telecommunication carriers and cable television providers. Governmental entities with existing license agreements would be exempted from the revised Rate PSA until the existing agreement expired. At the expiration of such agreement, the revised Rate PSA would apply to the governmental entity's attachments. As stated in KU's response to LFUCG 1-37(b), KU considers existing franchise agreements that contain language regarding attachments to Company structures to be the functional equivalent of a license agreement as it relates to the franchisor's right to place attachments on Company structures. Thus, those franchise agreement provisions will continue until the expiration of the agreements' current terms, at which time those cities will take service under the PSA tariff if they have attachments to Company structures.

Going forward, KU cannot agree to include terms like Section 18(c) in franchise agreements. If the proposed revisions to Rate PSA become effective, KRS 278.160(2) would require KU to assess the attachment fees to all governmental entities in accordance with Rate PSA's terms, except for those with existing license agreements. The statute provides:

No utility shall charge, demand, collect, or receive from any person a greater or less compensation for any service rendered or to be rendered than that prescribed in its filed schedules, and no person shall receive any service from any utility for a compensation greater or less than that prescribed in such schedules.

Thus, KRS 278.160(2) would require KU to apply the provisions of the revised Rate PSA to governmental entities with existing attachment agreements, such as LFUCG, upon the expiration of the current franchise agreement. If KU were to do otherwise, it would be in violation of KRS 278.160(2) and subject to administrative and civil sanctions.

KRS 278.170(2) also prohibits KU from continuing to permit LFUCG to attach its facilities to KU structures at no charge upon the establishment of the revised Rate PSA and the expiration of the current franchise agreement. KRS 278.170(2) prohibits free or reduced rate service for most customer types. While it permits such service for some customer types, the statute does not include municipalities and urban-county governments in these types.

KRS 278.035 also prohibits KU from making exceptions to the revised Rate PSA for governmental entities. A provision in a future franchise agreement that requires KU to provide pole space at no charge would confer preferential rate treatment on LFUCG. As LFUCG is a political subdivision of the Commonwealth and receives more than 50 percent of its operating expenses from public funds, the preference is contrary to KRS 278.035.

KU is unable to identify any special characteristic of LFUCG's use of KU structures that would justify a special contract or different classification permitting LFUCG's use at no charge. LFUCG's use of KU's structures does not significantly differ from that of cable television providers or telecommunication carriers, nor are the costs or risks imposed by its use significantly different than those imposed by attachment customers who are cable television providers or telecommunication carriers.

Placement of a provision similar to Section 18(c) in a future franchise agreement would not alter this analysis. Kentucky Courts have recognized that a city has "the right to impose conditions, even to the extent of fixing rates… in its franchise ordinance permitting the entry of a public utility within its border, but subject to the right of the state in the exercise of its police power to regulate rates and service after they were first fixed, or provided for by the city in its franchise contract…" *Peoples Gas Co. v. Barbourville*, 165 S.W.2d 567, 572 (Ky. 1942).

In enacting the Public Service Commission Act and providing that the Public Service Commission has exclusive jurisdiction over the rates and services of utilities, the Legislature has removed from municipalities and urban-county governments any power to regulate utility rates and instead has placed such authority with the Public Service Commission. *See, e.g., Southern Bell Tel. & Tel. Co. v. Louisville*, 96 S.W.2d 695, 698 (Ky. 1936). This action preempts any attempt by any municipality or urban-county government from requiring KU to charge or collect a rate for governmental unit pole attachments that differs from that specified in a Public Service Commission-approved rate schedule.

A municipal ordinance is invalid if it conflicts with a state statute. Any future franchise agreement containing a provision similar to Section 18(c) would conflict with KRS 278.160 which requires a utility to charge and collect the rates prescribed in its filed rate schedules. It would represent an exercise of power directly in conflict with KRS 278.160 and the comprehensive scheme for regulating utility rates under KRS Chapter 278.

Finally, placement of a provision similar to Section 18(c) in a future franchise agreement would be an attempt to modify or amend KRS 278.160 to exclude LFUCG from the provisions of KRS 278.160. The Kentucky courts have recognized that "[a]n ordinance may cover an authorized field of local laws not occupied by general laws, but cannot forbid what a statute expressly permits and may not run counter to the public policy of the state as declared by the Legislature." *Harlan v. Scott,* 162 S.W.2d 8, 9 (1942).

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 24

Responding Witness: Daniel K. Arbough / Christopher M. Garrett / David S. Sinclair

Q-24. Please refer to the answer to LFUCG 1-41.

a. Explain the reasons for the significant increase in PJM revenues from 2014 to 2015.

b. Provide the forecasted PJM and MISO Revenues included in this proceeding using the same format presented in the response to LFUCG-KU 1.041.

c. Provide an explanation on how the forecast for PJM and MISO revenues were developed.

A-24.

a. The Companies always seek to sell excess power to the market with the most favorable prices and available transmission. The change in PJM revenues from 2014 to 2015 is attributable to the change in KU's generation fleet that occurred in 2015. When Cane Run 7 began commercial operations in June 2015, KU was allowed to utilize more of its higher cost capacity for off-system sales.

b.

	Forecasted Test Period
MISO	$0
PJM	$2,033,655

c. When forecasting revenue from off-system sales, the Companies forecast revenues from PJM as a proxy for revenues from all external markets. Therefore MISO revenues are not explicitly forecasted. The process of developing the off-system sales forecast is included in the document entitled "Generation Forecast Process" attached at Tab 16, Section 16(7)(c) – Item G of the Companies' Applications.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 25

Responding Witness: David S. Sinclair

Q-25. Please refer to the answer to LFUCG 1-45.

a. Please detail with specificity by listing every reduction in costs and expenses that have been made as a result of the notice sent to Kentucky Utilities that certain municipalities would not be receiving service from Kentucky Utilities.

b. Please detail with specificity by listing all efforts the Company has made to increase load to replace the loss of the Municipalities.

A-25.

a. The actions taken by the Companies since 2014 upon receiving the departing municipals' termination notices are summarized in KU's September 20, 2017 response to the June 22, 2017 Order of the Kentucky Public Service Commission in Case No. 2016-00370.

b. See the response to AG 1-22.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 26

Responding Witness:

Q-26. This item is intentionally left blank in order to maintain consistent numbering with Case No. 2018-00295.

A-26.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 27

Responding Witness:

Q-27. This item is intentionally left blank in order to maintain consistent numbering with Case No. 2018-00295.

A-27.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 28

Responding Witness: Daniel K. Arbough

Q-28. Please refer to the answer to LFUCG 1-50. The Company has indicated that it has spent $69 million and will spend an additional $184 million on various activities. Those additional expenses have not been incurred. Of the $184 million, the Company is contractually bound to spend $35 million.

a. Explain what makes up the $59 million portion of the expenses not yet incurred listed as "All Other" in the response to the referenced data request.

b. Has the estimate of the $184 million yet to be spent been updated? If the response is negative, provide the reason.

c. Does the $184 million include a contingency factor? If the response is affirmative, what is that amount and percentage?

A-28.

a. The $59 million is comprised of the following:

All Other	KU ($ Millions)
Generating Unit Reliability	$36
Environmental (Non ECR)	$12
Balance of Plant	$5
Ghent CCR Pipe Conveyor	$3
Safety	$1
Mobile Equipment	$2
Total	$59

b. The Company establishes a business plan on an annual basis. The plan is adjusted throughout the year to account for changes on major projects and meet emergent needs of the business.

c. The $184 million does contain contingency. The following projects in the response to KU-LFUCG-1-50 part b include a contingency of $2M (8% of the overall project value) for the relative time period: Ghent Stacker Reclaimer Certification and Brown Combustion Turbine Site Gas Pipeline Relocation. The Demolition of Retired Coal Plants at Tyrone, Pineville, and Green River do not include contingency during the relative time period. For the less complex capital projects, contingency is not normally budgeted as a separate line item. The initial level of contingency included on a project typically ranges between 10 and 15 percent depending on the level of engineering completed at the time the project estimate is prepared, the risk profile associated with the project, and past experience based on similar projects. Also, depending on the timing of a project, contingency dollars may not be in the amount discussed above if the project extends beyond October 31, 2019 as contingency is typically budgeted at the end of multi-year projects.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 29

Responding Witness: Daniel K. Arbough

Q-29. Please refer to the answer to LFUCG 1-51. The Company indicated that as a result of retiring the Brown units 1 and 2 that it expects to save approximately $2.4 million in O&M and additional amounts in outage-related expenses.

a. Confirm that the $2.4 million of reduced O&M expenses is included in the expense forecast in this proceeding. If the response is negative, provide the reason.

b. Quantify the estimated O&M and capital outage expense savings. Are those savings reflected in the cost projections in this proceeding? If the response is negative, provide the reason.

A-29.

a. The $2.4 million of reduced O&M expenses is included in the expense forecast in this proceeding.

b. The O&M outage expense decrease attributable to the planned retirement of Brown 1 and Brown 2, exclusive of outage normalization, is $5.4M when comparing the prior forecast period ended 6/30/2018 to the current forecast period ending 4/30/2020. Brown 1 and Brown 2 outage expenses are excluded from the current forecast period eight-year average outage expense calculation.

   The outage capital expenditure decrease attributable to the planned retirement of Brown 1 and Brown 2 is $8.1M when comparing the prior forecast period ended 6/30/2018 to the current forecast period ending 4/30/2020, and therefore reflected in the cost projections included in this proceeding.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 30

Responding Witness: David S. Sinclair

Q-30. Please refer to the answer to LFUCG 1-52. Please detail changes which the Company has undertaken in response to PPL's Climate Assessment Report.

A-30. As described in the document, PPL Corporation prepared the Climate Assessment Report as a commitment to shareowners to assess the potential impacts on PPL from requirements and technological advances aimed at limiting global warming to 2º Celsius over pre-industrial levels. The report details PPL's approach to climate change and steps the Company is taking to manage climate-related risks. The report did not prescribe changes but described how the Company effectively manages the risks of climate change across its operations and assesses risks and opportunities through enterprise risk management and long-range planning activities. However, the report does highlight that CO_2 emissions are expected to decline over time as coal units reach a typical useful life of between 55 years and 65 years. Hence, the Companies' proposed depreciation rates in this case are consistent with the CO_2 reduction scenarios shown in the report.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 31

Responding Witness: William Steven Seelye

Q-31. Please refer to the answer to LFUCG 1-55 and Mr. Seelye's testimony at 14:14-16. Explain how an electric vehicle rate would incorporate a daily service charge.

A-31. An electric vehicle rate could incorporate a daily Basic Service Charge by either (i) charging the daily Basic Service Charge whenever an electric vehicle charges at a station or (ii) charging a pro-rated portion of the daily charge depending on the hours used to charge a vehicle. It should be noted that these are simply hypothetical examples. The Company has no plans at this time to utilize the daily Basic Service Charge in this manner.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 32

Responding Witness: Robert M. Conroy

Q-32. Please refer to the answer to LFUCG 1-57. Please explain why the Company does not agree that the increase in the customer charge will have a disproportionate impact on lower income customers.

A-32. The usage pattern of lower income customers is similar to the residential class as a whole with customer usage both above and below the average of the residential class. As shown in the responses to CAC 1-15 and CAC 1-16, those customers receiving third party assistance (lower income customers) have an average annual usage greater than the residential class. Therefore, a higher basic service charge is beneficial to the average customer receiving third party assistance. In addition, during periods of extremely hot or cold temperatures when usage is typically higher, the proposed rate structure will benefit all customers including lower income customers in that they will not pay for fixed costs based on a per kWh charge.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 33

Responding Witness: William Steven Seelye

Q-33. Please refer to the answer to LFUCG 1-58 and Mr. Seelye's testimony at 66:14-15. Confirm that the average credit per residential customer for the Late Payment credit for KU customers is $3.25 ($337,386/103,782) as calculated in the Company's proposed revenue reduction.

A-33. The $3.25 figure represents the average late payment charges that is expected to be waived.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 34

Responding Witness: Robert M. Conroy

Q-34. Please refer to the answer to LFUCG 1-59(d). Please perform the calculation for each rate code.

A-34. As previously stated, the Company has not performed the requested calculation for each of the LFUCG accounts. LFUCG has all of the information on their accounts and can perform their own calculations using the current and proposed rates for each rate class contained in Schedule M-2.3 at Tab 66 of the filing requirements.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 35

Responding Witness: Robert M. Conroy

Q-35. Please refer to the answer to LFUCG 1-60. Please perform the calculation for each LFUCG account.

A-35. As previously stated, the Company has not performed the requested calculation for each of the LFUCG accounts. LFUCG has all of the information on their accounts and can performed their own calculations using the current and proposed rates for each rate class contained in Schedule M-2.3 at Tab 66 of the filing requirements.

KENTUCKY UTILITIES COMPANY

Response to Lexington-Fayette Urban County Government's Second Request for Information Dated December 13, 2018

Case No. 2018-00294

Question No. 36

Responding Witness: Robert M. Conroy / Elizabeth J. McFarland

Q-36. Please refer to the answer to LFUCG 1-67. Please provide an itemized list of each tariff/customer class for which the franchise fee does not apply without cross-referencing the Company's tariff.

A-36. If the franchise fee rider applies to a particular schedule in the Company's tariff, that schedule expressly mentions the rider in the Adjustment Clause section of that schedule. The LFUCG franchise fee only applies to consumption based rate schedules. It does not apply to the following charges:

- Pole and Structure Attachment fees
- Returned Payment charges
- Meter Test Charges
- Disconnect/Reconnect Service Charges
- Unauthorized Reconnect Charges
- Meter Pulse Charges
- Riders to Standard rate schedules
    - Curtailable Service Riders (CSR)
    - Small Capacity Cogeneration Qualifying Facilities (SQF)
    - Large Capacity Cogeneration Qualifying Facilities (LQF)
    - Excess Facilities (EF)
    - Redundant Capacity (RC)
    - Small & Large Green Energy (SGE & LGE)
- Purchased Power
- Line Extensions
- LFUCG Street Light Accounts (per Original Sheet 90 under Billing item #4, which provides that a city may request franchise fees not be applied to the city's accounts)
- Home Energy Assistance Program
- School Taxes
- Late Payments