

Exhibit No.
Issues: T&D Capital Investments and LED
Lighting Tariff
Witness: Jeffrey L. Westfall
Type of Exhibit: Direct Testimony
Sponsoring Party: The Empire District
Electric Company
Docket No.: 19-EPDE-223-RTS
Date: December 2018

Before the Kansas Corporation Commission

Direct Testimony

Of

Jeffrey L. Westfall

December 2018



**DIRECT TESTIMONY
OF
JEFFREY L. WESTFALL
ON BEHALF OF
THE EMPIRE DISTRICT ELECTRIC COMPANY
BEFORE THE
KANSAS CORPORATION COMMISSION
DOCKET NO. 19-EPDE-__-RTS**

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1 **I. INTRODUCTION**

2 **Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

3 A. My name is Jeffrey L. Westfall and my business address is 602 S. Joplin Avenue,
4 Joplin, Missouri, 64801.

5 **Q. WHO IS YOUR EMPLOYER AND WHAT POSITION DO YOU HOLD?**

6 A. I am employed by Liberty Utilities Service Corp. as the Central Region Director
7 of Electric Operations – T&D. My primary responsibilities include line and
8 substation transmission and distribution operations, transmission planning,
9 reliability, vegetation, construction design, dispatch, meters and transformers. I
10 am also responsible for engineering and accountable for proper budgeting and
11 accounting of capital, operating and maintenance expenses for The Empire
12 District Electric Company’s (“Empire” or “Company”) transmission and
13 distribution assets.

14 **Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?**

15 A. I am testifying on behalf of Empire.

16 **Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUND.**

17 A. I began my employment with Empire in December of 1989 in the building
18 services department where I held the position of night janitor, switchboard

1 operator and mail clerk. I transferred to our stores department in August of 1990
2 where I held the position of warehouseman. In March of 1991 I transferred to our
3 Asbury plant where I held the position of Labor and Labor semi-skilled. In March
4 of 1992 I accepted the position of ground man at our Aurora Missouri Service
5 center. I progressed in classification and obtained my Journeyman Lineman
6 status in June of 1995. I held this position until I was named Manager of Line
7 Operations in July of 2008 where my duties were to oversee the line operations
8 and maintenance for the Aurora area. Those duties included managing 4 line
9 crews and 3 service trucks by managing workload and outage response. I was
10 responsible for the capital and operation and maintenance budgets for the Aurora
11 area. In addition, I had the responsibility of submitting projects for consideration
12 to be included in our capital budget. In June of 2015 I accepted the position of
13 Director of Operations – East where my responsibilities expanded to include our
14 four operating areas on the east side of Empire’s service area. In October of 2016
15 I was named to Director of Operations where my duties increased with the
16 responsibility of all 8 of our operating areas. Finally in October of 2017 I was
17 named Central Region Director of Operations – T&D.

18 **Q. HAVE YOU PREVIOUSLY TESTIFIED IN A PROCEEDING BEFORE**
19 **THE KANSAS CORPORATION COMMISSION (“KCC” or**
20 **“COMMISSION”) OR BEFORE ANY OTHER UTILITY REGULATORY**
21 **AGENCY?**

22 A. No.

1 **II. PURPOSE OF TESTIMONY**

2 **Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?**

3 A. My testimony is to discuss the Transmission and Distribution investments since
4 the last rate case as well as future investments over the next several years. In
5 addition to the capital investments, I will provide insight into the proposed Light
6 Emitting Diode (LED) Tariff for the Municipal Street Light Rate Schedule.

7 **III. RELIABILITY IMPROVEMENTS**

8 **Q. HAS EMPIRE MADE EFFORTS TO IMPROVE THE RELIABILITY OF**
9 **SERVICE TO ITS KANSAS CUSTOMERS?**

10 A. Yes.

11 **Q. PLEASE DEFINE THOSE EFFORTS?**

12 A. In 2010, Empire developed a 10 year plan to construct system improvements
13 solely to improve the reliability of the system. This reliability plan is often
14 referred to as Operation Toughen-Up. We are still in the midst of implementation
15 of this plan which is slated for completion in 2022. The projects included in this
16 plan are discussed below.

17 **Q. PLEASE DESCRIBE OPERATION TOUGHEN UP.**

18 A. Operation Toughen Up is a multi-year effort in which Empire will commit a
19 minimum \$100 million over a 10 year span to improve the SAIDI and SAIFI
20 matrix goals used to measure the reliability to customers by way of various capital
21 improvement projects (new construction, excluding AFUDC). The majority of
22 the funds have been committed to system sectionalization, both transmission and
23 distribution.

1 **Q. PLEASE DESCRIBE THE CAPITAL SPEND MADE SINCE THE**
2 **INCEPTION OF THE PROGRAM.**

3 A. Since the inception of Operation Toughen Up, Empire has invested approximately
4 \$63.5 million in both transmission and distribution investments (which includes
5 AFUDC). Of the \$63.5 million investment to date, over \$20 million or 31% has
6 been spent on improving transmission and distribution lines within the state of
7 Kansas.

8 **Q. WHAT AMOUNT GOING FORWARD DOES EMPIRE HAVE**
9 **BUDGETED TO SPEND TO COMPLETE OPERATION TOUGHEN UP.**

10 A. Empire has budgeted to spend an additional \$87.5 million through 2022 (which
11 includes AFUDC). The budgeted capital spend by year is outlined below.

Year	Amount
Remaining 2018	\$1.9 M
2019	\$14.4M
2020	\$40.7M
2021	\$23.1M
2022	\$7.4M
Total	\$87.5M

12

13 **Q. WHAT OTHER CAPITAL INVESTMENTS HAVE BEEN MADE SINCE**
14 **THE LAST GENERAL RATE CASE WHICH HAVE BEEN INCLUDED**
15 **IN RATE BASE?**

1 A. In addition to the investments discussed in the direct testimony of Timothy N.
2 Wilson, the Kodiak Service Center and substations were completed in 2016. The
3 Kodiak Service Center houses our engineering team, meter shop, call center,
4 OMS Mapping area, among many other services.

5 **V. PLANNED FUTURE TRANSMISSION AND DISTRIBUTION PROJECTS**

6 **Q. DESCRIBE THE COMPANY'S PLANNED FUTURE TRANSMISSION**
7 **CAPITAL INVESTMENTS.**

8 A. Empire is planning to invest \$221.7 (including AFUDC) million in transmission
9 through 2024. The capital investments in transmission can be further broken
10 down into Transmission Additions (\$87.6M), Transmission Rebuilds (\$133.1M)
11 and Transmission Blankets (\$1M).

12 **Q. PLEASE DESCRIBE WHAT PROJECTS WOULD GENERALLY FALL**
13 **INTO THE CATEGORY OF TRANSMISSION ADDITIONS.**

14 A. Transmission Additions are budget items identified as being 34kV and above and
15 are new/added items to Empire's system. These projects are identified as
16 substation or line projects that involve new equipment such as a breaker, switches,
17 panels or circuits. Additions to the system may be required due to an increase in
18 load, new load entering a neighborhood or new initiatives within the system.

19 **Q. DESCRIBE TRANSMISSION REBUILDS AND THEIR PURPOSE.**

20 A. Transmission Rebuilds are budget items identified as being 34kV and above that
21 modify existing equipment within the system. These projects are identified as
22 substation or line projects that involve replacing equipment such as breakers,
23 switches, panels or circuits. Rebuilds to the system may be required due to an

1 increase in load where the capacity of the equipment is no longer sufficient,
2 obsolete equipment that are no longer able to be maintained due to availability, or
3 upgrades/rebuilds needed for fiber communications. Future Transmission
4 investments are being proposed to be recovered through the TDC Rider requested
5 in this case. The TDC Rider is discussed in Company witness Aaron Doll's
6 Direct Testimony.

7 **Q. DESCRIBE THE COMPANY'S PLANNED FUTURE DISTRIBUTION**
8 **CAPITAL INVESTMENTS.**

9 A. Empire is planning to invest \$387.3 million (including AFUDC) in its distribution
10 system through 2024. The capital investments in distribution can be further
11 broken down into Distribution Additions (\$22.8M), Distribution Rebuilds
12 (\$154.3M) and Distribution Extensions and Services (\$161.5M). Other
13 Distribution projects are budgeted through 2024 of (\$48.7) million.

14 **Q. PLEASE DESCRIBE WHAT PROJECTS WOULD GENERALLY FALL**
15 **INTO THE CATEGORY OF DISTRIBUTION ADDITIONS.**

16 A. Distribution additions are budget items identified as being below 34kV and are
17 also new/added items to Empire's system. These projects are identified as
18 substation or line projections that involve new equipment such as substation,
19 breaker, switches, panels or circuits. Additions to the system may be required due
20 to an increase in load, newly positioned spot loads (e.g., extensions to a new
21 industry or commercial entities, etc.) or new initiatives within the system.

22 **Q. DESCRIBE DISTRIBUTION REBUILDS AND THEIR PURPOSE.**

1 A. Distribution rebuilds are specific capital improvement projects required to
2 maintain service to customers and which modify existing equipment within the
3 system. Typically projects are identified by review of loadings on existing
4 equipment and assessing the need for replacement given a myriad of inputs such
5 as age of equipment, identified vintages known to fail, or equipment capacity
6 exceedances. Projects of this type typically include overloaded transformers
7 where additional capacity is needed to be installed so as not to experience loss of
8 useful life of existing equipment.

9 **VI. LED MUNICIPAL STREET LIGHTING**

10 **Q. IS EMPIRE PROPOSING A NEW LED MUNICIPAL STREET**
11 **LIGHTING TARIFF?**

12 A. Yes. A new municipal street lighting LED tariff rate is being proposed in this
13 case. The tariff rate is included in the application. Please refer to Section 18 of
14 the application for a copy of the proposed tariff rate.

15 **Q. WHY IS EMPIRE FILING A NEW LED MUNICIPAL STREET**
16 **LIGHTING TARIFF?**

17 A. The Company is aware of the reduced maintenance cost, life of fixture, energy
18 efficiency, and improved visibility LED lights offer compared to other lighting
19 alternatives.

20 **Q. WHAT ADDITIONAL PROPOSAL IS THE COMPANY MAKING**
21 **REGARDING MUNICIPAL STREET LIGHTING?**

22 A. The Company is proposing to suspend the Mercury-Vapor Lamp portion of the
23 Municipal Street Lighting Service tariff (Schedule SPL). Furthermore, Empire is

1 proposing to replace all Mercury-Vapor Lamps within its Kansas jurisdiction with
2 new LED Municipal Street Lights and record a Regulatory account
3 (asset/liability) to track the actual cost and revenue impacts of the conversion of
4 Mercury-Vapor to LED lights for recovery in the next rate case.

5 **Q. HAS THE COMPANY SOUGHT AN LED MUNICIPAL STREET**
6 **LIGHTING TARIFF IN OTHER JURISDICTIONS?**

7 A. Yes. An LED Municipal Street Lighting Tariff was sought in Missouri after the
8 completion of a pilot program. The tariff was approved by the Missouri Public
9 Service Commission (“MPSC”) on July 27, 2018 in Docket No. JE-2018-0169 .

10 **Q. DID EMPIRE CONDUCT A STUDY AND FILE A REPORT WITH THE**
11 **MPSC REGARDING THE LED MUNICIPAL STREET LIGHT PILOT**
12 **PROGRAM?**

13 A. Yes. Empire filed the study along with a request for an LED Municipal Street
14 Lighting Tariff in Missouri in mid-2018. The study is attached to my testimony
15 as Direct Exhibit JLW-1.

16 **Q. IS EMPIRE AWARE OF OTHER UTILITIES IN KANSAS THAT HAVE**
17 **LED LIGHTING TARIFFS?**

18 A. Yes, Empire is aware that both Westar and Kansas City Power & Light have LED
19 tariffs. The tariffs were first approved in the dockets 12-WSEE-112-RTS and 12-
20 KCPE-205-TAR respectively.

1 **VIII. EFFECTS ON RATE DESIGN IN CURRENT CASE**

2 **Q. PLEASE DESCRIBE THE APPROACH USED TO DETERMINE THE**
3 **RATE PROPOSED IN THE LED MUNICIPAL STREET LIGHTING**
4 **TARIFF.**

5 A. Empire’s proposed Municipal Street Lighting LED Tariff rate is based upon the
6 cost of service calculated within this proceeding for Schedule SPL Municipal
7 Street Lighting Service for the High-Pressure Sodium (“HPS”)-Vapor Lamp Sizes
8 reduced by the expected reduction in costs as a result of the Missouri Pilot Study.
9 Refer to Direct Exhibit JLW-2 for the LED Tariff Annual Charge calculation.

10 **Q. DOES EMPIRE BELIEVE THAT THE COST OF SERVICE FOR AN LED**
11 **MUNICIPAL STREET LIGHT LAMP COULD BE LESS THAN THE HPS**
12 **LAMP?**

13 A. Yes. Based on the Pilot Study performed in Missouri, there is sufficient evidence
14 that an LED Municipal Street Light lamp would be less than the HPS lamp.

15 **Q. PLEASE EXPLAIN WHY THE COMPANY WOULD LIKE TO REPLACE**
16 **ALL MUNICIPAL STREET MERCURY VAPOR LIGHTS WITH LED**
17 **MUNICIPAL STREET LIGHTS.**

18 A. LED Municipal Street Lights will be more energy efficient than Mercury-Vapor
19 lights and will have reduced maintenance cost and a longer life. In addition,
20 reducing the environmental impact that Mercury exposure may have on our
21 communities is a continued goal of the Company.

22 **Q. WHAT IS THE TIMEFRAME TO CONVERT MERCURY VAPOR**
23 **LIGHTS TO LED?**

1 A. Empire would propose to convert all Company-owned, pole mounted Mercury
2 Vapor Municipal Street Lights in the Kansas jurisdiction with LED luminaries,
3 which is approximately 1,000 lights. Empire believes this conversion can be
4 completed over a 6 -18 month period of time.

5 **Q. IS EMPIRE REQUESTING A REGULATORY ACCOUNT TO TRACK**
6 **THE CONVERSION OF MERCURY-VAPOR LIGHTS TO LED LIGHTS?**

7 A. Yes. The LED Municipal Pilot Program conducted in Missouri indicates that a
8 lower rate should be utilized for LED Municipal Lights. However, Empire is
9 proposing to charge the LED Municipal Light rate proposed in this preceding
10 which is an estimate based on the Missouri Pilot Study. The amounts are
11 estimates and actual costs need to be determined and will not be known until we
12 are granted permission to perform the conversion. Empire requests that a
13 Regulatory Account be established to account for the difference between the
14 actual cost and revenue impacts to the estimated amounts being collected from
15 customers. The difference would be recovered in the next rate case.

16 **Q. DOES THIS CONCLUDE YOUR TESTIMONY?**

17 A. Yes, it does.



The Empire District Electric Company LED Street Lighting Pilot Summary

Pilot Purpose

In Docket No. ER-2012-0345, The Empire District Electric Company (“Empire”) agreed to conduct a Light Emitting Diode (“LED”) Street Lighting Pilot to study the overall suitability, feasibility and community acceptance of LED street light fixtures versus existing High-Intensity Discharge (“HID”) street light fixtures.

Pilot Scope

The LED Street Lighting Pilot tracked by Empire served to verify the mortality rate of the LED bulb, LED street light energy usage, and finally the maintenance costs of LED street lighting fixtures. The LED street lighting pilot program had an initial time frame of three (3) years, beginning in August 2014. The Pilot stipulated that it would be limited to five locations in five different municipalities within Empire’s Missouri service territory. These locations were limited to two (2) blocks of continuous roadway with connecting areas of principal traffic generation within the cities.

Pilot Implementation

Existing HID street lighting fixtures and photocontrols were replaced with LED street lighting fixtures and long life photocontrols at each location. When necessary, new poles with additional fixtures were installed to meet RP8 lighting standards. The Illuminating Engineering Society (“IES”) of North America provides recommended roadway design criteria in its document called Recommended Practice 8, Roadway Lighting (“RP8”). Fixtures below 150W do not provide enough light output to meet RP8 standards and fixtures above 400W are rarely used for roadway lighting. Based on this, the LED fixtures chosen for the pilot were limited to 150W and/or 250W High Pressure Sodium (“HPS”) equivalents. The implementation costs of the pilot project were tracked and the energy usage of the new LED street light fixture was metered at each pilot location. As required by the LED Street Lighting Pilot project terms, Empire charged identical rates as the HID street light fixtures.

Pilot Material Selection

Based on product quality and previous work experience using HPS light fixtures, Empire chose American Electric Lighting as the manufacturer for the LED street lighting fixtures. The LED light fixture ATB0 was chosen as the 150W HPS equivalent fixture, and the LED light fixture ATB2 was chosen as the 250W HPS equivalent fixture. A primary driver for choosing these specific fixtures was based on the delivered street side and house side lumens of each fixture type. A comparison is shown in Table 1 below.

Table 1 – Delivered Lumens Comparison

FIXTURE TYPE	150W HPS	ATB0	250W HPS	ATB2
STREET SIDE LUMENS	7,502	5,723	12,367	10,111
HOUSE SIDE LUMENS	3,450	1,649	7,357	2,809

Note that the table above uses 2014 lumen output data to match the LED lighting fixtures purchased. The lumen output has subsequently improved on the ATB0 and ATB2 since 2014.

Empire initially planned to utilize both “Ripley” and “Dark To Light” as the preferred long life photo control manufacturers for the LED street lighting pilot. Both of the manufacturer’s photocontrols are rated with a 20 year life. The Ripley photocontrol has a lower surge protection rating of 640J at 40kA, but uses zero cross switching. The Dark To Light photocontrol has a higher surge protection rating of 1,280J at 40kA, but does not offer zero cross switching. The goal was to test both photocontrol manufacturers during the pilot. However, the Dark To Light photocontrols were backordered at the time, and only Ripley photocontrols were installed.

Pilot Material Cost

Table 2 reflects the 20 year life cycle of certain costs of the LED street lighting fixture and photocontrol compared to an equivalent HPS fixture and photocontrol.

Table 2 – 20 Year Life Cycle Cost Comparison

FIXTURE	INSTALL COST	4YRS	8YRS	12YRS	16YRS	TOTAL COST
150W HPS	\$158.63	\$31.83	\$82.56	\$40.32	\$104.58	\$417.92
ATB0	\$363.93	\$0.00	\$0.00	\$0.00	\$0.00	\$363.93
250W HPS	\$208.64	\$32.17	\$80.81	\$40.75	\$102.37	\$464.74
ATB2	\$514.80	\$0.00	\$0.00	\$0.00	\$0.00	\$514.80

Note: Table 2 above includes material cost, labor capitalization rates, equipment costs and general overhead cost allocations based on pilot data as of 2017. Mounting brackets, mounting hardware, cable, and connectors are not included, as these costs would be the same cost regardless of which type of fixture and photocontrol type is used. In addition, an annual inflation rate of 3% was assumed for material, labor, and equipment. Due to the unpredictability and uncertainty of labor and equipment costs for travel to and from the light fixture for each maintenance event were not included. When travel costs are factored in, the overall life cycle cost of a HPS fixture could increase costs significantly. Based on prior maintenance event history of the HPS light fixtures, it is assumed that a standard photocontrol and light fixture are replaced every 4 years, and that on an 8 year interval, a HPS starter would need to be replaced.

Pilot Energy Usage

The main goal of the LED Street Light pilot was to provide the necessary illuminance on the target areas with the best lighting quality using the lowest possible energy consumption. To calculate the projected monthly and annual kWh values for a LED street light fixture and HPS street light fixture, the anticipated burn hours were used. To determine the anticipated burn hours, the daily sunrise and sunset times were utilized which are based on data provided by the US Naval Observatory. The specific LED street lighting photocontrols purchased for this pilot are designed to turn on approximately 16 minutes after sunset and turn off approximately 13.5 minutes after sunrise. Utilizing the run time specifications of the LED street

lighting photocontrols and the US Naval sunrise and sunset time, Empire calculated the estimated monthly and annual burn hours for Joplin and Branson, which were then averaged together to get a system wide estimate for Missouri. Table 3 below shows the estimated burn hours for Empire’s service territory in Missouri.

Table 3 – Estimated Burn Hours for Missouri Service Territory

MONTH	BURN HOURS (JOPLIN)	BURN HOURS (BRANSON)	BURN HOURS (AVERAGE)
JANUARY	419.85	419.23	419.54
FEBRUARY	355.07	354.31	354.69
MARCH	357.91	357.48	357.70
APRIL	310.59	311.13	310.86
MAY	289.86	290.90	290.38
JUNE	265.37	266.65	266.01
JULY	281.83	283.08	282.46
AUGUST	308.99	309.70	309.35
SEPTEMBER	333.35	333.04	333.20
OCTOBER	380.56	380.16	380.36
NOVEMBER	398.96	398.34	398.65
DECEMBER	429.09	427.87	428.48
TOTAL	4,131.43	4,131.89	4,131.68

Using the estimated average burn hours, the projected monthly and annual kWh per LED light fixture and HPS light fixture were determined. Table 4 below shows these results.

Table 4 – LED Light Fixture VS HPS Light Fixture kWh Comparison

FIXTURE	INPUT WATTS	JAN KWH	FEB KWH	MAR KWH	APR KWH	MAY KWH	JUN KWH	JUL KWH	AUG KWH	SEP KWH	OCT KWH	NOV KWH	DEC KWH	TOTAL KWH
150W HPS	190	79.71	67.39	67.96	59.06	55.17	50.54	53.67	58.78	63.31	72.27	75.74	81.41	785.02
ATB0	92	38.60	32.63	32.91	28.60	26.71	24.47	25.99	28.46	30.65	34.99	36.68	39.42	380.11
250W HPS	295	123.76	104.63	105.52	91.70	85.66	78.47	83.32	91.26	98.29	112.21	117.60	126.40	1,218.84
ATB2	143	59.99	50.72	51.15	44.45	41.52	38.04	40.39	44.24	47.65	54.39	57.01	61.27	590.83

Pilot Locations

The LED Street Lighting Pilot was conducted in the following communities in Missouri: Branson, Neosho, Ozark, Republic, and Webb City. Per the parameters of the pilot project, a two (2) block section of continuous roadway was chosen in each city. Empire personnel, in conjunction with guidance from city personnel, performed a field assessment for each location in order to determine a suitable street location to conduct the research.

Specific criteria used in determining street location included the class type for the street, pedestrian conflict, dimensions of the street and/or sidewalks, and the dimensions of surrounding buildings. The existing HPS light fixtures, mounting heights, and pole spacing were also determined during the field assessment. After performing the initial field assessment, a 2D layout was created for each location using AutoCAD. The AutoCAD layouts were input into Visual, a software program used to create exterior lighting layouts for roadways. The result was a lighting layout in 2D and 3D, which was used to evaluate whether or not the existing pole locations would meet RP8 new LED lighting standards. If it was determined that additional light poles were required, Visual was used to determine the specific pole locations. This is critical in designing a lighting layout that will meet RP8 Standards. Depending on the design, the pole locations can vary and still meet RP8 Standards.

For the Branson pilot location, the location of the new pole was chosen based on lighting calculations performed in Visual, while also keeping similar spacing between poles. Empire utilized an Extech light meter to verify the expected light level output in the foot candles at each location after the initial LED light fixture installation. Furthermore, a follow up measurement was taken at each location roughly halfway into the pilot project to verify if significant light output degradation had occurred for any of the installed LED light fixtures. It should be noted that Empire did not detect any significant change in light output for any of the newly installed LED fixtures. The remaining report provides further LED Street lighting scope details, installation costs, spare material costs and metering results of each pilot location.

Pilot Location: Branson – Roark Valley Rd from Forsythe Blvd to Truman Dr



The Road Class for this location was Major with low pedestrian conflict. The existing HPS street light had seven (7) 150W HPS cobra head fixtures installed on wood poles. ATB0 replacement LED light fixtures were installed on the first four (4) existing poles on Forsythe Blvd. ATB2 LED light fixtures, rather than ATB0 LED light fixture replacements, were installed on existing poles on the last three (3) lights before Truman Drive in order to meet RP8 lighting standards. A new ATB2 light fixture and a new 45' Class 4 wood pole 165' were installed to the right of the fourth ATB0 light fixture pass Forsythe Blvd. These were required to meet RP8 lighting standards. Tables 5 and 6 below contain values for the total installation cost (excluding metering) and spare material cost.

Table 5 – Branson Installation Costs

INSTALLATION TYPE	INSTALL COST	QUANTITY	TOTAL COST
ATB0 (EXISTING POLE)	\$354.40	4	\$1,417.60
ATB2 (EXISTING POLE)	\$632.53	3	\$1,897.59
ATB2 (NEW POLE)	\$1,447.23	1	\$1,447.23
TOTAL INSTALLATION COST			\$4,762.42

Table 6 – Branson Spare Material Costs

SPARE TYPE	MATERIAL COST	QUANTITY	TOTAL COST
ATB0	\$238.82	5	\$1,194.10
ATB2	\$470.01	3	\$1,410.03
DTL PHOTOCONTROL	\$19.74	4	\$78.96
TOTAL SPARE MATERIAL COST			\$3,172.84

It should be noted that an accident involving a non-Empire vehicle hit one of the ATB2 LED light fixture poles, which required a complete rebuild of that portion of the 3PH circuit. This accident triggered a

maintenance event, but the expenses pertaining to this accident are not attributed to the LED street lighting pilot. If the cost to replace the fixture, photocontrol, and street light cable is determined to be a component of the pilot, it is estimated to cost approximately \$792.80.

A comparison of Metered LED Street Lighting kWh energy usage versus Projected (based on Table 4 above) kWh energy usage for the LED street lighting pilot circuit in Branson for 2015, 2016, and 2017 is shown in Tables 7, 8 and 9 below.

Table 7 – Branson Metered LED Street Lighting versus Projected LED Street Lighting kWh usage for 2015

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-15	394.36	396.13	1.77	0.45%
Feb-15	333.40	337.20	3.80	1.13%
Mar-15	336.24	342.22	5.98	1.75%
Apr-15	292.20	295.04	2.84	0.96%
May-15	272.92	277.26	4.34	1.57%
Jun-15	250.04	250.31	0.27	0.11%
Jul-15	265.52	265.23	-0.29	-0.11%
Aug-15	290.80	290.74	-0.06	-0.02%
Sep-15	313.20	310.27	-2.93	-0.94%
Oct-15	357.52	355.45	-2.07	-0.58%
Nov-15	374.76	374.99	0.23	0.06%
Dec-15	402.76	401.52	-1.24	-0.31%
TOTAL	3,883.72	3,896.36	12.64	0.32%

Table 8 – Branson Metered LED Street Lighting versus Projected LED Street Lighting kWh usage for 2016

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-16	394.36	394.74	0.38	0.10%
Feb-16	333.40	345.84	12.44	3.60%
Mar-16	336.24	337.46	1.22	0.36%
Apr-16	292.20	293.84	1.64	0.56%
May-16	272.92	275.02	2.10	0.76%
Jun-16	250.04	249.57	-0.47	-0.19%
Jul-16	265.52	265.10	-0.42	-0.16%
Aug-16	290.80	290.35	-0.45	-0.15%
Sep-16	313.20	311.55	-1.65	-0.53%
Oct-16	357.52	355.72	-1.80	-0.51%
Nov-16	374.76	374.39	-0.37	-0.10%
Dec-16	402.76	405.00	2.24	0.55%
TOTAL	3,883.72	3,898.58	14.86	0.38%

Table 9 – Branson Metered LED Street Lighting versus Projected LED Street Lighting kWh usage for 2017

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-17	394.36	397.10	2.74	0.69%
Feb-17	333.40	333.89	0.49	0.15%
Mar-17	336.24	340.05	3.81	1.12%
Apr-17	292.20	299.14	6.94	2.32%
May-17	272.92	277.08	4.16	1.50%
Jun-17	250.04	252.44	2.40	0.95%
Jul-17	265.52	265.89	0.37	0.14%
Aug-17	290.80	288.90	-1.90	-0.66%
Sep-17	313.20	318.15	4.95	1.56%
Oct-17	357.52	366.59	9.07	2.47%
Nov-17	374.76	388.19	13.43	3.46%
Dec-17	402.76	419.10	16.34	3.90%
TOTAL	3,480.96	3,527.42	62.80	1.59%

The average annual energy usage was calculated to be 0.76% higher than projected. Had the previously installed HPS lighting fixtures been setup to meet RP8 lighting standards, the projected average annual energy savings from switching to LED lighting fixtures, in the pilot location in Branson, would have been 50.76%.

Pilot Location Neosho – W Hickory St from S Jefferson St to S Washington St



The Road Class for this location was Collector with medium pedestrian conflict. The existing installation had ten (10) 150W HPS cobra head fixtures on steel poles. LED light fixture ATB0 replacements were used on all ten (10) HPS lighting fixtures. All existing poles were used for the ten (10) lights. Tables 10 and 11 below contain values for the total installation cost (excluding metering) and spare material cost.

Table 10 – Neosho Installation Costs

INSTALLATION TYPE	INSTALL COST	QUANTITY	TOTAL COST
ATB0 (EXISTING POLE)	\$354.40	10	\$3,544.04

Table 11 – Neosho Spare Material Costs

SPARE TYPE	MATERIAL COST	QUANTITY	TOTAL COST
ATB0	\$238.82	2	\$477.64
DTL PHOTOCONTROL	\$19.74	6	\$118.44
TOTAL SPARE MATERIAL COST			\$596.08

A comparison of LED street lighting metered vs projected LED street lighting (based on Table 4 above) kWh energy usage for the LED pilot circuit in Neosho for 2015, 2016 and 2017 is shown in Tables 12, 13 and 14 below.

Table 12 – Neosho Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2015

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-15	386.00	399.84	13.84	3.46%
Feb-15	326.30	341.02	14.72	4.32%
Mar-15	329.10	343.27	14.17	4.13%
Apr-15	286.00	296.83	10.83	3.65%
May-15	267.10	279.13	12.03	4.31%
Jun-15	244.70	250.23	5.53	2.21%
Jul-15	259.90	265.16	5.26	1.98%
Aug-15	284.60	291.74	7.14	2.45%
Sep-15	306.50	312.51	6.01	1.92%
Oct-15	349.90	358.32	8.42	2.35%
Nov-15	366.80	378.89	12.09	3.19%
Dec-15	394.20	406.69	12.49	3.07%
TOTAL	3,801.10	3,923.63	122.53	3.12%

Table 13 – Neosho Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2016

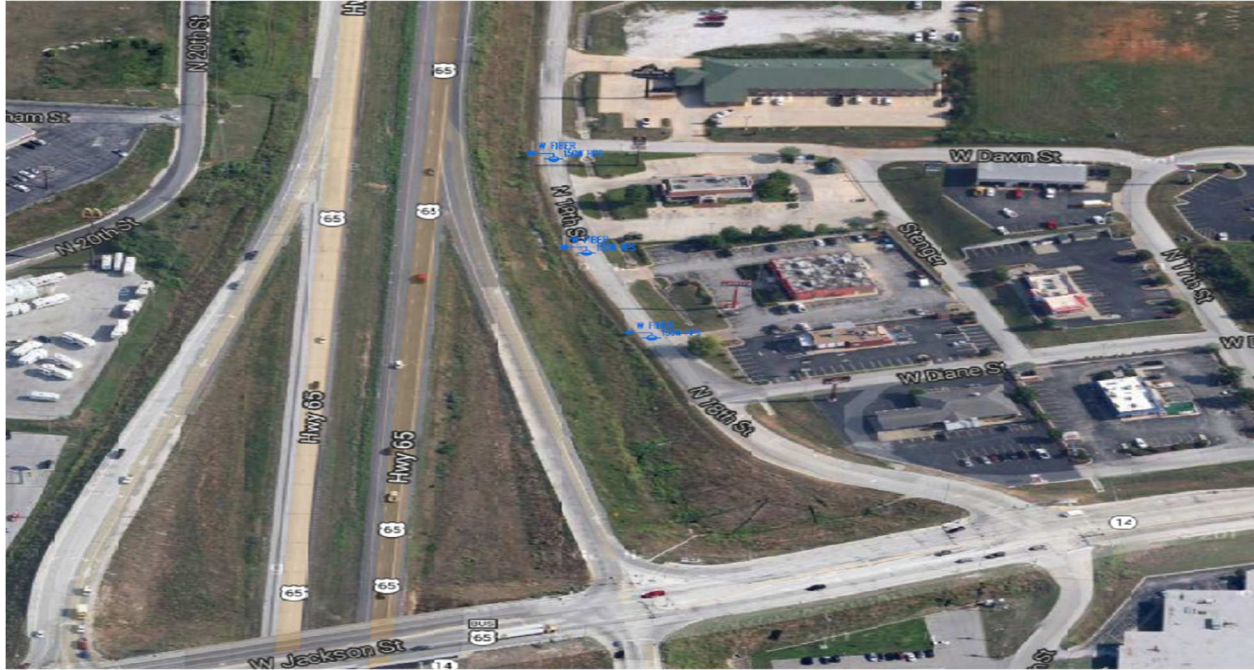
MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-16	386.00	400.7	14.70	3.67%
Feb-16	326.30	348.66	22.36	6.41%
Mar-16	329.10	340.44	11.34	3.33%
Apr-16	286.00	295.71	9.71	3.28%
May-16	267.10	276.12	9.02	3.27%
Jun-16	244.70	248.69	3.99	1.60%
Jul-16	259.90	265.47	5.57	2.10%
Aug-16	284.60	290.79	6.19	2.13%
Sep-16	306.50	312.99	6.49	2.07%
Oct-16	349.90	358.34	8.44	2.36%
Nov-16	366.80	376.49	9.69	2.57%
Dec-16	394.20	409.47	15.27	3.73%
TOTAL	3,801.10	3,923.87	122.77	3.13%

Table 14 – Neosho Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2017

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-17	386.00	400.77	14.77	3.69%
Feb-17	326.30	336.36	10.06	2.99%
Mar-17	329.10	342.91	13.81	4.03%
Apr-17	286.00	301.84	15.84	5.25%
May-17	267.10	278.49	11.39	4.09%
Jun-17	244.70	252.08	7.38	2.93%
Jul-17	259.90	264.67	4.77	1.80%
Aug-17	284.60	293.27	8.67	2.96%
Sep-17	306.50	313.38	6.88	2.20%
Oct-17	349.90	359.16	9.26	2.58%
Nov-17	366.80	378.69	11.89	3.14%
Dec-17	394.20	409.14	14.94	3.65%
TOTAL	3,801.10	3,930.76	129.66	3.30%

The average annual energy usage was calculated to be 3.18% higher than projected. By replacing the existing 150W HPS fixtures with equivalent LED light fixtures, the projected average annual energy savings is calculated to be 49.99%.

Pilot Location: Ozark – N 18th St from W Dawn St to W Diane St



The Road Class for this location was Collector with low pedestrian conflict. The existing installation had three (3) 150W HPS cobra head fixtures on fiberglass poles. ATB0 LED Street Light Fixtures replacements were installed on existing poles for all three (3) lights. Tables 15 and 16 below contain values for the total installation cost (excluding metering) and spare material cost.

Table 15 – Ozark Installation Costs

INSTALLATION TYPE	INSTALL COST	QUANTITY	TOTAL COST
ATB0 (EXISTING POLE)	\$354.40	3	\$1,063.21

Table 16 – Ozark Spare Material Costs

SPARE TYPE	MATERIAL COST	QUANTITY	TOTAL COST
ATB0	\$238.82	3	\$716.46
DTL PHOTOCONTROL	\$19.74	3	\$59.22
RIPLEY PHOTOCONTROL	\$29.27	3	\$87.81
TOTAL SPARE MATERIAL COST			\$863.49

A comparison of Metered LED Street Lighting vs Projected LED Street Lighting (based on Table 4 above) kWh energy usage for the LED pilot circuit in Ozark for 2015, 2016 and 2017 is shown in Tables 17, 18 and 19 below.

Table 17 – Ozark Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2015

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-15	115.80	122.04	6.24	5.11%
Feb-15	97.89	104.05	6.16	5.92%
Mar-15	98.73	104.98	6.25	5.95%
Apr-15	85.80	90.55	4.75	5.25%
May-15	80.13	85.45	5.32	6.23%
Jun-15	73.41	76.93	3.52	4.58%
Jul-15	77.97	81.71	3.74	4.58%
Aug-15	85.38	89.11	3.73	4.19%
Sep-15	91.95	95.32	3.37	3.54%
Oct-15	104.97	109.21	4.24	3.88%
Nov-15	110.04	115.13	5.09	4.42%
Dec-15	118.26	123.71	5.45	4.41%
TOTAL	1,140.33	1,198.19	57.86	4.83%

Table 18 – Ozark Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2016

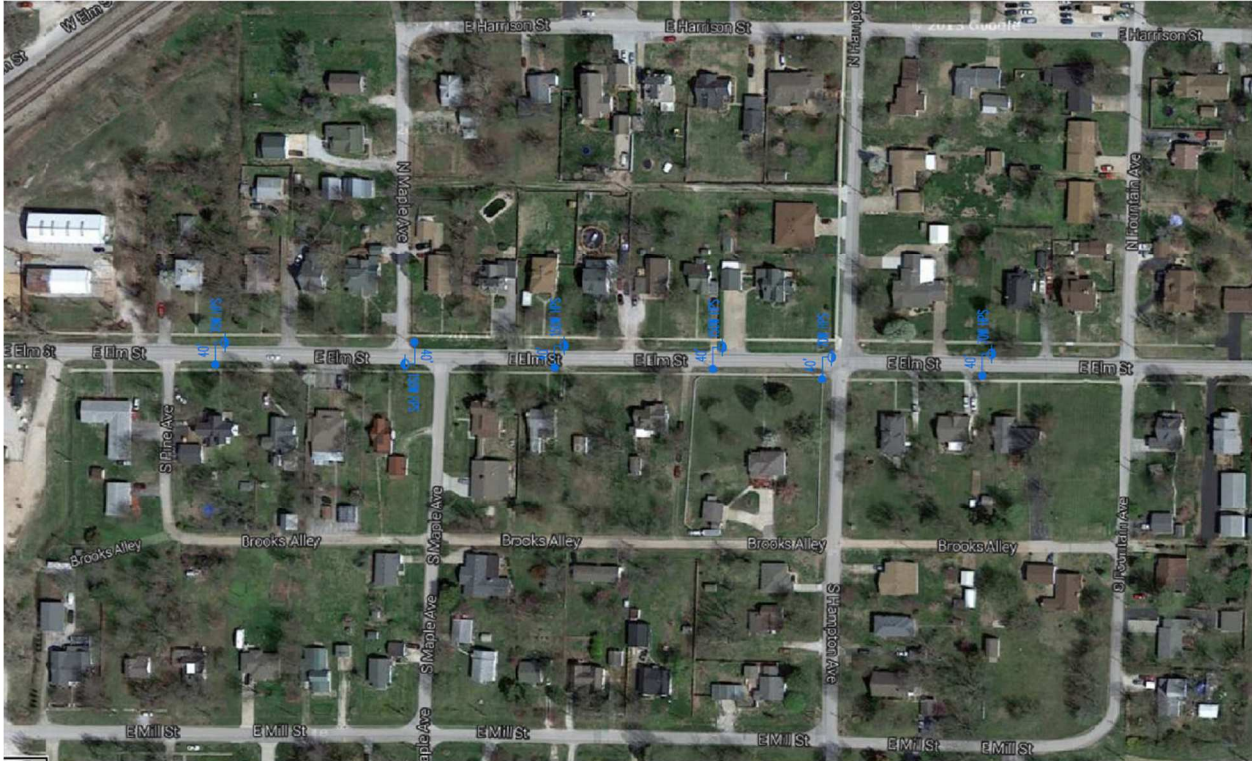
MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-16	115.80	122.11	6.31	5.17%
Feb-16	97.89	106.48	8.59	8.07%
Mar-16	98.73	104.01	5.28	5.08%
Apr-16	85.80	90.05	4.25	4.72%
May-16	80.13	84.56	4.43	5.24%
Jun-16	73.41	76.44	3.03	3.96%
Jul-16	77.97	81.06	3.09	3.81%
Aug-16	85.38	88.96	3.58	4.02%
Sep-16	91.95	95.35	3.40	3.57%
Oct-16	104.97	109.19	4.22	3.86%
Nov-16	110.04	115.15	5.11	4.44%
Dec-16	118.26	124.79	6.53	5.23%
TOTAL	1,140.33	1,198.15	57.82	4.83%

Table 19 – Ozark LED Street Lighting Metered vs Projected LED Street Lighting kWh for 2017

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-17	115.80	122.46	6.66	5.44%
Feb-17	97.89	102.68	4.79	4.66%
Mar-17	98.73	104.81	6.08	5.80%
Apr-17	85.80	91.8	6.00	6.54%
May-17	80.13	84.88	4.75	5.60%
Jun-17	73.41	77.12	3.71	4.81%
Jul-17	77.97	79.21	1.24	1.57%
Aug-17	85.38	88.82	3.44	3.87%
Sep-17	91.95	94.53	2.58	2.73%
Oct-17	104.97	108.46	3.49	3.22%
Nov-17	110.04	114.42	4.38	3.83%
Dec-17	118.26	123.79	5.53	4.47%
TOTAL	1,022.07	1,069.19	47.12	4.41%

The average annual energy usage was calculated to be 4.69% higher than projected. By replacing the existing 150W HPS light fixtures with equivalent LED light fixtures, the projected average annual energy savings is calculated to be 49.34%.

Pilot Location: Republic – E Elm St from S Pine Ave to S Fountain Ave



The Road Class for this location was Local with low pedestrian conflict. The existing HPS installation had six (6) 70W open bottom fixtures on fiberglass poles. Installed ATB0 LED light fixture replacements on existing poles for all six (6) lights. Tables 20 and 21 below contain values for the total installation cost (excluding metering) and spare material cost.

Table 20 – Republic Installation Costs

INSTALLATION TYPE	INSTALL COST	QUANTITY	TOTAL COST
ATB0 (EXISTING POLE)	\$354.40	6	\$2,126.42

Table 21 – Republic Spare Material Costs

SPARE TYPE	MATERIAL COST	QUANTITY	TOTAL COST
ATB0	\$238.82	2	\$477.64
DTL PHOTOCONTROL	\$19.74	5	\$98.70
RIPLEY PHOTOCONTROL	\$29.27	2	\$58.54
TOTAL SPARE MATERIAL COST			\$634.88

A comparison of Metered LED Street Lighting vs Projected LED Street Lighting (based on Table 4 above) kWh energy usage for the LED pilot circuit in Republic for 2015, 2016 and 2017 is shown in Tables 22, 23 and 24 below.

Table 22 – Republic Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2015

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-15	231.60	245.52	13.92	5.67%
Feb-15	195.78	208.93	13.15	6.29%
Mar-15	197.46	210.75	13.29	6.31%
Apr-15	171.60	181.77	10.17	5.59%
May-15	160.26	171.11	10.85	6.34%
Jun-15	146.82	153.92	7.10	4.61%
Jul-15	155.94	163.48	7.54	4.61%
Aug-15	170.76	179.38	8.62	4.81%
Sep-15	183.90	191.56	7.66	4.00%
Oct-15	209.94	219.84	9.90	4.50%
Nov-15	220.08	232.22	12.14	5.23%
Dec-15	236.52	249.5	12.98	5.20%
TOTAL	2,280.66	2,407.98	127.32	5.29%

Table 23 – Republic Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2016

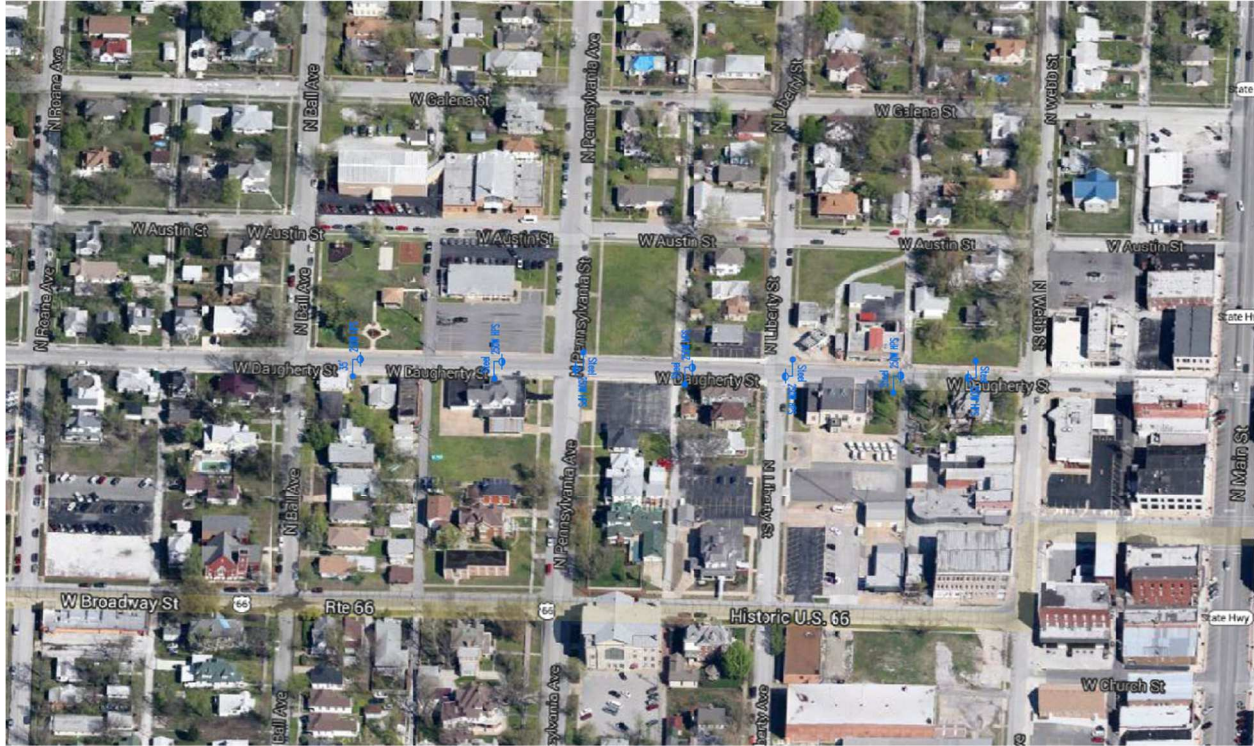
MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-16	231.60	245.53	13.93	5.67%
Feb-16	195.78	214.29	18.51	8.64%
Mar-16	197.46	209.06	11.60	5.55%
Apr-16	171.60	184.66	13.06	7.07%
May-16	160.26	170.08	9.82	5.77%
Jun-16	146.82	153.34	6.52	4.25%
Jul-16	155.94	163.21	7.27	4.45%
Aug-16	170.76	178.8	8.04	4.50%
Sep-16	183.90	191.92	8.02	4.18%
Oct-16	209.94	219.56	9.62	4.38%
Nov-16	220.08	231.17	11.09	4.80%
Dec-16	236.52	251.08	14.56	5.80%
TOTAL	2,280.66	2,412.70	132.04	5.47%

Table 24 – Republic Metered LED Street Lighting vs Projected LED Street Lighting kWh for 2017

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-17	231.60	246.23	14.63	5.94%
Feb-17	195.78	206.32	10.54	5.11%
Mar-17	197.46	210.61	13.15	6.24%
Apr-17	171.60	184.66	13.06	7.07%
May-17	160.26	169.45	9.19	5.42%
Jun-17	146.82	154.99	8.17	5.27%
Jul-17	155.94	161.61	5.67	3.51%
Aug-17	170.76	202.92	32.16	15.85%
Sep-17	183.90	191.28	7.38	3.86%
Oct-17	209.94	219.23	9.29	4.24%
Nov-17	220.08	230.84	10.76	4.66%
Dec-17	236.52	229.63	-6.89	-3.00%
TOTAL	2,280.66	2,407.77	127.11	5.28%

The average annual energy usage was calculated to be 5.35% higher than projected. By replacing the 70W HPS open bottom fixtures on fiberglass poles with ATB0s LED light fixtures, the projected average annual energy savings is calculated to be 48.85%.

Pilot Location: Webb City – W Daugherty St from N Ball Ave to N Main St



The Road Class for this location was Local with low pedestrian conflict. The existing HPS light fixture installation had six (6) 250W cobra head fixtures on steel poles and one (1) 250W cobra head fixture on a wood pole. During the site evaluation, Webb City line operations personnel made a determination to change the scope to only include the six (6) 250W HPS cobra head fixtures on steel poles and installed ATB2 LED replacement light fixtures on existing poles for six (6) lights. Tables 25 and 26 below contain values for the total installation cost (excluding metering) and spare material cost.

Table 25 – Webb City Installation Costs

INSTALLATION TYPE	INSTALL COST	QUANTITY	TOTAL COST
ATB2 (EXISTING POLE)	\$632.53	6	\$3,795.15

Table 26 – Webb City Spare Material Costs

SPARE TYPE	MATERIAL COST	QUANTITY	TOTAL COST
ATB2	\$470.01	4	\$1,880.04
DTL PHOTOCONTROL	\$19.74	6	\$118.44
RIPLEY PHOTOCONTROL	\$29.27	3	\$87.81
TOTAL SPARE MATERIAL COST			\$2,086.29

A comparison of Metered LED Street Lighting vs Projected LED Street Lighting (based on Table 4 above) kWh energy usage for the LED pilot circuit in Webb City for 2015, 2016 and 2017 is shown in Tables 27, 28 and 29 below.

Table 27 – Webb City Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2015

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-15	359.94	366.29	6.35	1.76%
Feb-15	304.32	312.2	7.88	2.59%
Mar-15	306.90	313.68	6.78	2.21%
Apr-15	266.70	272.29	5.59	2.10%
May-15	249.12	254.7	5.58	2.24%
Jun-15	228.24	228.41	0.17	0.07%
Jul-15	242.34	241.98	-0.36	-0.15%
Aug-15	265.44	266.45	1.01	0.38%
Sep-15	285.90	285.78	-0.12	-0.04%
Oct-15	326.34	328.69	2.35	0.72%
Nov-15	342.06	347.33	5.27	1.54%
Dec-15	367.62	372.79	5.17	1.41%
TOTAL	3,544.92	3,590.59	45.67	1.27%

Table 28 – Webb City Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2016

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-16	359.94	367	7.06	1.92%
Feb-16	304.32	319.23	14.91	4.67%
Mar-16	306.90	311.39	4.49	1.44%
Apr-16	266.70	270.03	3.33	1.23%
May-16	249.12	252.69	3.57	1.41%
Jun-16	228.24	228.06	-0.18	-0.08%
Jul-16	242.34	241.56	-0.78	-0.32%
Aug-16	265.44	266.36	0.92	0.35%
Sep-16	285.90	286.22	0.32	0.11%
Oct-16	326.34	328.9	2.56	0.78%
Nov-16	342.06	345.25	3.19	0.92%
Dec-16	367.62	375.39	7.77	2.07%
TOTAL	3,544.92	3,592.08	47.16	1.31%

Table 29 – Webb City Metered LED Street Lighting versus Projected LED Street Lighting kWh for 2017

MONTH	PROJECTED KWH	ACTUAL KWH	KWH ERROR	%ERROR
Jan-17	359.94	368.22	8.28	2.25%
Feb-17	304.32	308.43	4.11	1.33%
Mar-17	306.90	313.45	6.55	2.09%
Apr-17	266.70	275.52	8.82	3.20%
May-17	249.12	253.65	4.53	1.79%
Jun-17	228.24	230.47	2.23	0.97%
Jul-17	242.34	241.98	-0.36	-0.15%
Aug-17	265.44	268.48	3.04	1.13%
Sep-17	285.90	287.17	1.27	0.44%
Oct-17	326.34	329.7	3.36	1.02%
Nov-17	342.06	347.75	5.69	1.64%
Dec-17	367.62	375.47	7.85	2.09%
TOTAL	3,544.92	3,600.29	55.37	1.54%

The average annual energy usage was calculated to be 1.37% higher than projected. By replacing the existing 250W HPS light fixtures with its equivalent LED light fixtures, the projected average annual energy savings is calculated to be 50.85%.

Pilot Results Summary

From a high level evaluation of the data, it appears the average annual energy usage (kWh) for all five (5) pilot locations was approximately 3.07% higher than projected. The information used to project the kWh usage is based upon sunrise and sunset hours provided by the US Naval Observatory. This data does not take into consideration cloud coverage or stormy weather. This contributed to a variance in the projected kWh and the actual kWh used at each location. Our test sample consisted of thirty-three lights spread over five different locations.

If all five (5) pilot locations had been initially installed to the RP8 lighting standards, with HPS fixtures, then switching to the LED light fixtures would have provided projected average annual energy usage savings of 49.96%. During the time frame of the LED street lighting pilot, no LED light fixtures or long life photocontrols failed, except for the ATB2 light fixture. As previously mentioned in the report, this failure was the result of an accident involving a non-Empire vehicle hitting a pole.

The total cost (excluding metering costs) for the LED Street Light Pilot project is broken out below:

●Installation cost	\$15,291.24
●Maintenance cost	\$ 792.80
● <u>Spare material cost</u>	<u>\$ 7,353.58</u>
Total cost	\$23,437.62

Conclusion

A major outcome of the LED Street Light Pilot was the exposure of energy-efficient LED street lights to community leaders and residents. The participating communities were pleased with the performance of the LED streetlights and gained valuable knowledge regarding the benefits of switching to LED streetlights. The benefits included, but were not limited to, twenty-year life cycles, high-efficiency light fixtures, the ability to operate in very low temperatures, and instant on/off switches. The communities preferred the LED fixtures over the HPS fixtures and confirmed that the LED lights provided better uniformity and quality of light on roadway surfaces while limiting glare and the unintended spill of light. These benefits provided comfort and safety to motorists in low natural light driving conditions.

Another important factor that developed during the LED Street Light pilot was the maintenance of the current Series Street Lighting systems. With the exception of Joplin, Missouri, Empire has systematically replaced the Series Street Lighting systems with HPS systems within its service territory. Empire is now experiencing a critical issue with obtaining these maintenance parts as manufacturers no longer produce these parts. Empire is hopeful that the LED Street Light tariff can be developed soon so that the obsolete Series Street Lighting system can be renovated with LED Streetlights.

The LED Streetlights installed demonstrated lower energy usage compared to the conventional HPS streetlights. Though there were variances in the predicted kWh usage compared to the actual kWh usage, we feel this was due to the low sample size spread out over five different locations.

Empire plans to push forward in the development of a LED Street Light tariff and will continue to encourage community leaders to convert to the energy-efficient LED Street Light system.

LUMENS	Watts	Annual Charge per Lamp ¹	Fixed Charge per COS Study ²	Variable Charge per COS Study ²	Energy Usage of LED compared to HPS ³	HPS/MHP Annual Maintenance Cost	LED Annual Charge Conversion
7,500-9,500	150	\$ 163.53	97%	3%	50.04%	(\$13.34)	\$ 148.05
13,000-16,000	250	\$ 205.99	97%	3%	50.04%	(\$13.69)	\$ 189.61
19,000-22,000	400	\$ 255.68	97%	3%	50.04%	(\$13.69)	\$ 238.65

¹The Empire District Electric Company Kansas Street Lighting Service Tariff proposed in Docket 19-EPDE-XXX-RTS

²Calculation rate per EDE-Kansas 2018 Cost of Service Study filed in 19-EPDE-XXX-RTS

³As calculated in The Empire District Electric Company Missouri LED Tariff Pilot Report, filed in Docket ER-2012-0345 on March 12, 2018

