Siemens PTI Report Number: R075-14

Loss Study for the KCP&L, MPS, and SJLP Systems - Year 2013

Prepared for

Kansas City Power & Light Company

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Revision History

Date	Rev.	Description
September 26, 2014	0	Initial draft
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Contents

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Executive Summary

Introduction

Siemens Industry, Inc., Siemens Power Technologies International (Siemens PTI) has performed an Electric Loss Study ("Study") for the service territories of Kansas City Power and Light Company ("KCP&L") in Kansas ("KS") and Missouri ("MO"); for Missouri Public Service ("MPS") and Saint Joseph Light &Power ("SJLP") operating companies of KCPL Greater Missouri Operations Company ("GMO"). Year 2013 was selected as the test year.

KCP&L and GMO are regulated investor owned electric utility company serving customers in Missouri and Kansas. KCPL has headquarters in Kansas City, Missouri. KCP&L and GMO currently served approximately 514,805 and 314,907 electric customers, respectively, in year 2013.

KCPL and GMO operate their own balancing area delivering energy across an interconnected transmission and distribution system. A balancing area is an electrical sub-region within a larger bounded electrical area that adjusts generation within the area to control the energy interchange schedules with the neighboring areas to regulate the electric system frequency. The operator of a balancing area is responsible for all losses that result from the operation of the balancing area.

This report documents the results of the calculations of the demand and energy losses from the customer meter to the generator set-up transformer. Separate calculations were performed for KCPL-KS, KCPL-MO, MPS, and SJLP, and all regions combined into a single system. The combined system was not studied as a single unit; the losses of the combined system were obtained by adding the results of the component systems.

The methods for calculating losses are described in the following sections.

Electric Losses

Electric power system losses are a consequence of doing business for a full service electric utility. The operation of the electric system is dynamic and decisions are made every day that affect the losses and efficiency of the system. The losses that result from the electric system operation must be properly charged to the customers that are responsible for those losses. To enhance the operational decision making process and fairly allocate the losses to customers, it is necessary to understand the losses in detail as a function of where they occur in the system.

Siemens PTI calculated both the technical and non-technical losses. The technical losses can be calculated and predicted from system data. The non-technical losses are not readily quantified. The non-technical losses are related to energy use that is not metered or recorded, such as energy diversion (theft) and unmetered company use in company-owned substations.

Unmetered company use is not actually an electric loss; it represents the power and light consumption in substations which is supplied by auxiliary transformers at the substation. This consumption is considered a non-technical loss if it is not recorded or metered. Despite the fact that the non-technical losses are not "electric losses" in the physical or technical sense, they are included as part of the losses in this study because they need to be paid for by KCP&L's electric customers.

KCP&L's data indicates that the company's energy diversion is very small.

Siemens PTI calculated the demand and energy components of the technical losses for the sub-system categories listed below:

- Transmission (lines, transformers, line corona)
- Primary transformers (substation transformers)
- Primary distribution lines
- Secondary transformers
- Secondary distribution lines and service drops
- Electric customer meters

The following non-technical losses were also calculated:

- Unmetered company use
- Energy diversion

Study Scope and Approach

Technical and Non-Technical Losses

Siemens PTI calculated the technical losses and estimated the non-technical losses. The technical losses are a function of both electric currents and voltage; most electrical losses are converted into heat. Technical losses occur in power system components such as transmission lines, transformers, distribution feeders, secondary lines, service drops, customer meters and other system components.

KCP&L estimated the energy diversion. Siemens PTI estimated the unmetered company use in KCPL-KS, KCPL-MO, MPS and SJLP substations assuming typical transformer sizes and an average demand and energy consumption.

Load and No-Load Losses

Siemens PTI calculated both load losses and no-load losses. Load losses are current-related losses in system components, also referred to as copper losses. No-load losses are voltage-related losses in transformers and high voltage transmission lines. The no-load losses in transformers are also called excitation or iron-core losses. No-load losses in high voltage transmission lines are caused by the corona phenomenon and typically constitute a small portion of the total losses.

Transmission and Distribution Losses

Transmission losses were determined with a detailed system model provided by KCP&L. Distribution system losses were determined by quantifying the losses for representative primary and secondary distribution circuits, including the service drops. The representative distribution circuits formed the basis for determining distribution losses for the primary and secondary distribution systems. KCP&L provided comprehensive lists of primary and secondary transformers with their electric parameters for calculating transformer load and no-load losses. The data included the peak loads of primary distribution transformers. Detailed load research data, and the number of customers by service level were also provided. The peak load of secondary transformers was determined from load research data.

Calculated and Allocated Losses

The losses calculated in this study had to be made consistent with KCP&L's FERC Form 1 reported energy loss for each region. When there was a difference between the FERC reported total energy loss and the study calculated total energy loss, an allocation process was performed in order to reconcile the two methodologies. The allocation procedure is described in this report.

Tables ES-1 through ES-6 show the allocated demand and energy losses for the KCP&L-KS, KCP&L-MO, KCPL (KS+MO), MPS, SJLP, and all regions combined. The corresponding calculated demand and energy losses are included in Appendix A.

Loss Multipliers

Loss multipliers are used to allocate losses to customers as a function of the service level. Therefore, transmission customers are only responsible for their share of losses that result from their service on the transmission system. Primary service customers are responsible for losses resulting from their load on the primary system and the transmission system. Secondary customers are responsible for losses that their load creates on all systems.

Siemens PTI calculated the demand and energy multipliers (also known as "loss factors") for each service level based on the loss results. The loss multipliers are organized as a function of where customers can be connected to a designated voltage service level such as transmission, primary distribution, or secondary distribution.

The Loss Multipliers for the KCP&L-KS, KCPL-MO, KCP&L (KS+MO), MPS, SJLP, and all regions combined are included in Appendix B.

Table ES-1

KCPL-KANSAS ALLOCATED LOSSES			
	COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	27,792	27,792	155,118,959
Line Corona	4,943	55	1,047,416
Transformer No-Load	866	866	7,587,109
Generator Step-Up No-Load	1,186	1,186	8,025,098
Sum	34,787	29,899	171,778,582
SUBSTATION SYSTEM			
Transmission to Distribution Load	9,122	9,073	24,404,934
Transmission to Distribution No-Load	3,661	3,661	31,834,304
Sum	12,783	12,734	56,239,238
PRIMARY DISTRIBUTION SYSTEM			
Distribution to Distribution Load	339	337	900,652
Distribution to Distribution No-Load	346	346	3,067,861
Primary Lines	42,321	42,094	97,856,569
Sum	43,006	42,777	101,825,082
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	4,317	4,270	7,526,865
Transformer No-Load	7,709	7,709	67,534,339
Lines and Service Drops	10,284	10,172	17,930,118
Customer Meters	58	58	514,114
Sum	22,368	22,209	93,505,436
NON-TECHNICAL LOSSES			
Substation Station Light & Power	1,467	1,451	7,709,250
Energy Diversion	17	16	56,411
Sum	1,484	1,467	7,765,661
Total	114,428	109,086	431,113,999
TOTAL SYSTEM LOSSES ALLOCATED			431,114,000

Table ES-2

KCPL- MISSOURI ALLOCATED LOSSES			
	COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	35,674	35,674	159,326,697
Line Corona	4,098	47	869,909
Transformer No-Load	596	596	5,218,575
Generator Step-Up No-Load	1,896	1,896	12,257,516
Sum	42,264	38,213	177,672,697
SUBSTATION SYSTEM			
Transmission to Distribution Load	9,891	9,680	26,474,018
Transmission to Distribution No-Load	4,059	4,059	35,422,576
Sum	13,950	13,739	61,896,594
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	113	110	304,876
Distribution to Distribution No-Load	194	194	1,709,992
Primary Lines	52,476	49,444	151,343,332
Sum	52,783	49,748	153,358,200
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	3,148	2,811	6,007,950
Transformer No-Load	7,189	7,189	62,968,059
Lines and Service Drops	8,330	7,441	15,899,824
Customer Meters	61	61	538,141
Sum	18,728	17,502	85,413,974
NON-TECHNICAL LOSSES			
Substation Station Light & Power	2,921	2,609	15,355,100
Energy Diversion	15	12	47,436
Sum	2,936	2,621	15,402,536
Total	130,661	121,823	493,744,001
TOTAL SYSTEM LOSSES ALLOCATED			493,744,000

Table ES-3

KCPL-KS & MO TOTAL ALLOCATED LOSSES			
	COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Line	63,466	63,466	314,445,656
Line Corona	9,041	102	1,917,325
Transformer No-Load	1,462	1,462	12,805,684
Generator Step-Up No-Load	3,082	3,082	20,282,614
Sum	77,051	68,112	349,451,279
SUBSTATION SYSTEM			
Transmission to Distribution Load	19,013	18,753	50,878,952
Transmission to Distribution No-Loa	7,720	7,720	67,256,880
Sum	26,733	26,473	118,135,832
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	452	447	1,205,528
Distribution to distribution No-Load	540	540	4,777,853
Primary Lines	94,797	91,538	249,199,901
Sum	95,789	92,525	255,183,282
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	7,465	7,081	13,534,815
Transformer No-Load	14,898	14,898	130,502,398
Lines and Service Drops	18,614	17,613	33,829,942
Customer Meters	119	119	1,052,255
Sum	41,096	39,711	178,919,410
NON-TECHNICAL LOSSES			
Substation Station Light & Power	4,388	4,060	23,064,350
Energy Diversion	32	28	103,847
Sum	4,420	4,088	23,168,197
Total	245,089	230,909	924,858,000
TOTAL SYSTEM LOSSES ALLOCATED			924,858,000

Table ES-4

MPS ALLOCATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	24,235	24,235	79,152,411
Line Corona	2,332	26	496,292
Transformer No-Load	1,583	1,583	13,907,071
Generator Step-Up No-Load	1,376	1,376	12,087,858
Sum	29,526	27,220	105,643,632
SUBSTATION SYSTEM			
Transmission to Distrbution Load	2,798	2,798	6,580,624
Transmission to Distribution No-Load	4,043	4,043	35,217,881
Sum	6,841	6,841	41,798,505
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	126	126	296,691
Distribution to Distribution No-Load	301	301	2,619,034
Primary Lines	55,077	55,067	129,488,767
Sum	55,504	55,494	132,404,492
DISTRIBUTION SECONDARY SYSTEM			
Disribution to Distribution Load	7,673	7,673	17,141,369
Distribution to Distribution No-Load	10,623	10,623	93,271,199
Lines and Service Drops	18,303	18,303	40,793,920
Customer Meters	229	229	2,005,517
Sum	36,828	36,828	153,212,005
NON-TECHNICAL LOSSES			
Substation Station Light & Power	4,370	4,370	22,966,390
Energy Diversion	19	17	64,976
Sum	4,389	4,387	23,031,366
Total	133,088	130,770	456,090,000
TOTAL SYSTEM LOSSES ALLOCATED			456,090,000

Table ES-5

SJLP ALLOCATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	6,182	6,182	26,285,120
Line Corona	2,324	26	492,422
Transformer No-Load	226	226	1,989,787
Generator Step-Up No-Load	75	75	663,046
Sum	8,807	6,509	29,430,375
SUBSTATION SYSTEM			
Transmission to Distrbution Load	631	606	2,051,326
Transmission to Distribution No-Load	1,958	1,958	17,161,859
Sum	2,589	2,564	19,213,185
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	146	140	475,876
Distribution to Distribution No-Load	714	714	6,252,840
Primary Lines	10,518	10,110	34,241,587
Sum	11,378	10,964	40,970,303
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	1,120	1,079	2,424,802
Transformer No-Load	2,011	2,011	17,614,473
Lines and Service Drops	3,962	3,819	12,767,553
Customer Meters	37	37	326,552
Sum	7,130	6,946	33,133,380
NON-TECHNICAL LOSSES			
Substation Station Light & Power	977	941	5,134,289
Energy Diversion	3	3	11,468
Sum	980	944	5,145,757
Total	30,884	27,927	127,893,000
TOTAL SYSTEM LOSSES ALLOCATED			127,893,000

Table ES-6

KCPL- TOTAL SYSTEM ALLOCATED LOSSES			
	COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	93,883	93,883	419,883,187
Line Corona	13,697	154	2,906,039
Transformer No-Load	3,271	3,271	28,702,542
Generator Step-Up No-Load	4,533	4,533	33,033,518
Sum	115,384	101,841	484,525,286
SUBSTATION SYSTEM			
Transmission to Distribution Load	22,442	22,157	59,510,902
Transmission to Distribution No-Load	13,721	13,721	119,636,620
Sum	36,163	35,878	179,147,522
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	724	713	1,978,095
Distribution to distribution No-Load	1,555	1,555	13,649,727
Primary Lines	160,392	156,715	412,930,255
Sum	162,671	158,983	428,558,077
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	16,258	15,833	33,100,986
Transformer No-Load	27,532	27,532	241,388,070
Lines and Service Drops	40,879	39,735	87,391,416
Customer Meters	385	385	3,384,324
Sum	85,054	83,485	365,264,796
NON-TECHNICAL LOSSES			
Substation Station Light & Power	9,735	9,371	51,165,029
Energy Diversion	54	48	180,291
Sum	9,789	9,419	51,345,320
Total	409,061	389,606	1,508,841,001
TOTAL SYSTEM LOSSES ALLOCATED			1,508,841,000

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Section

1

Transmission Losses

1.1 Calculation Methodology

Siemens PTI calculated the demand and energy components of the transmission losses for KCP&L-Kansas, KCP&L-Missouri, Municipal Power Service, and Saint Joseph Light & Power. In this report, we designate these regions as KCPL-KS, KCPL-MO, MPS, and SJLP, respectively.

The losses result from the flow of electric currents through the resistance of transmission lines and transformers, the losses in the iron core of transformers, and the losses in transmission lines caused by the corona discharge. The resistive losses in lines and transformers are mostly a function of the square of the electric current and are load dependent losses. The corona and the transformer iron core losses are mostly a function of the square of the voltage and, for practical purposes, do not depend on the load. The corona and the iron core losses are relatively constant because the voltage remains relatively constant during normal steady state conditions.

Siemens PTI calculated the load losses in transmission lines and transformers using power flow simulations. The no-load iron core and corona losses were calculated separately.

The KCPL, MPS and SJLP transmission voltages are 345-kV, 161-kV, and 69-kV. The transmission system is comprised of lines operating at any of these voltages as well as transformers with both high and low side voltages in the transmission voltage range. The load losses in the generation step-up transformers (GSU's) were included as part of the transmission losses as the plant meters are located on the generating plant side of the transformers.

KCPL and the Greater Missouri Operations (GMO) companies MPS and SJLP operate their own balancing areas. The load losses in transmission lines and transformers are a function of the balancing area load, internal generation, purchases, power sales, wheeling, and inadvertent power flows through the balancing area. The flows related to these sources and loads do not follow a set pattern. In certain parts of the system at one point in time, the flows on a transmission line may go from north to south, and at other times from south to north. Null points during the transition periods (times when the flow is zero or near zero within the balancing area on any specific line) result in zero or near zero losses on those transmission lines. The relative unpredictability of these flows and the duration of null points complicate the loss calculation and all but eliminate the ability to use the same methodology that is used to calculate the losses in distribution systems where the flows go in a predictable direction from source to load.

The procedure that was used to calculate the transmission losses was to simulate a number of different power flow cases that were representative of the system operation in year 2013, from maximum to minimum load, taking into account the variation of generation and inter-tie flows.

The transmission loss analysis was performed using Siemens PTI's PSS®E Version 32 software tool. PSS®E is an integrated program for simulating, analyzing, and optimizing power system performance that uses the most advanced methods for performing power flow studies, fault analysis, and dynamic stability simulations.

The losses associated with the transmission lines and transformers can be tabulated on an area and zone basis. Within the PSS®E power flow model, the KCPL and GMO balancing areas have the number designations shown in Table 1-1. For zone KACP, KCPL provided the buses that belong to KCPL-KS and KCPL-MO. For each line or transformer, one end of the facility is designated as the metered end. For facilities interconnecting different areas or zones, the metered end can identify that change in responsibility. For example, in tabulating the losses in MPS the losses in any line or transformer that is connected at both ends to buses in MPS area 540 were assigned to MPS by PSS®E. If a line or transformer is connected to two different areas, the losses in that element were assigned to the area that is not the metered end.

Table 1-1. KCP&L and GMO PSS®E Area/Zone Designations

Region	Area	Zone
KCP&L-Kansas	541	1544 – KACP (some buses) 1548 – Johnson County 1550 – South District
KCP&L-Missouri	540	1544 – KACP (some buses) 1545 – Downtown 1546 – Metro 1547 – North 1549 – East District 1551 – Marshall 1552 – 69 kV
MPS	540	595
SJLP	540	596

1.1.1 Transmission Line and Transformer Load Losses

KCPL provided the 2013 hourly system loads for the KCPL and GMO systems. The data reflected zero loads for the spring and fall time change hours in March and November. The zero loads were replaced with the average demand that occurred at the contiguous hours. The hourly system loads were calculated in per unit of the maximum load. The hourly load shapes so obtained were used to develop the hourly system loads for KCPL-KS, KCPL-MO, MPS, and SJLP regions using the monthly system peak loads provided by KCPL for each region. We prepared load duration curves (LDC) for each region and the combination of all regions that were used in the hourly loss calculations. The hourly loads for all systems are the sum of the hourly loads of the regions. The LDC's are illustrated in Figure 1-1 to Figure 1-5

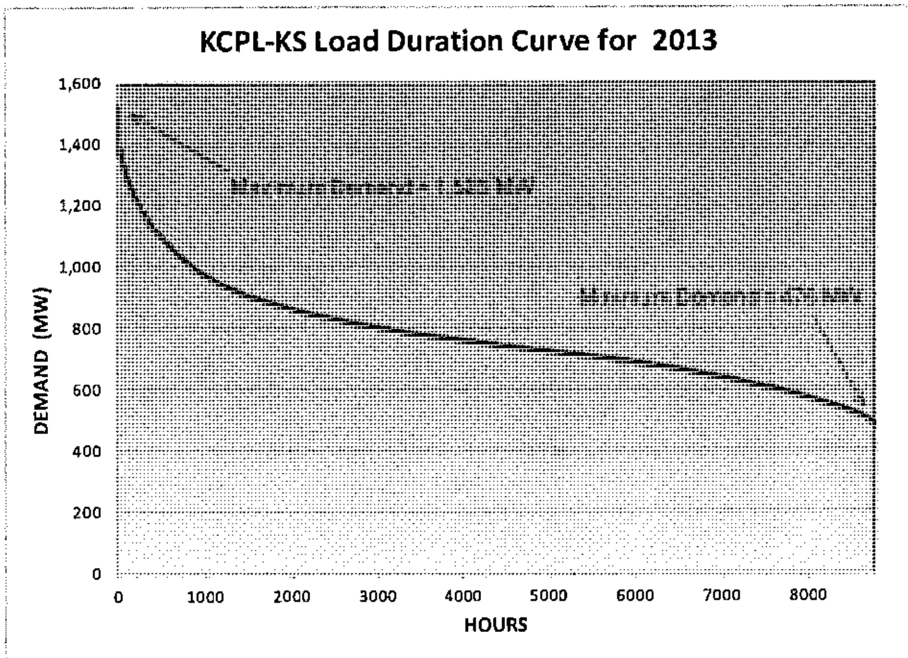

Figure 1-1. Load Duration Curve for KCPL-KS

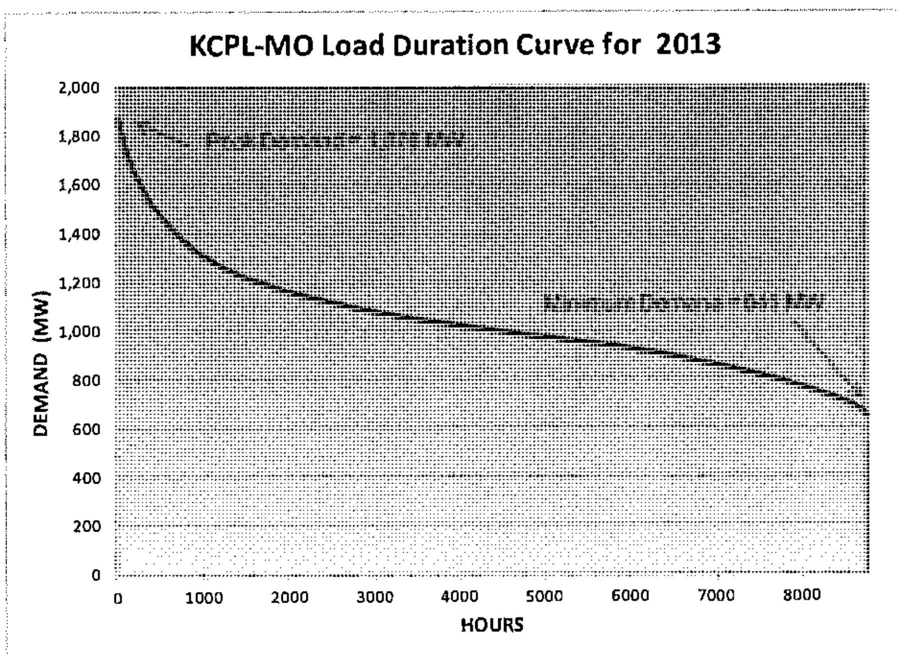

Figure 1-2. Load Duration Curve for KCPL-MO

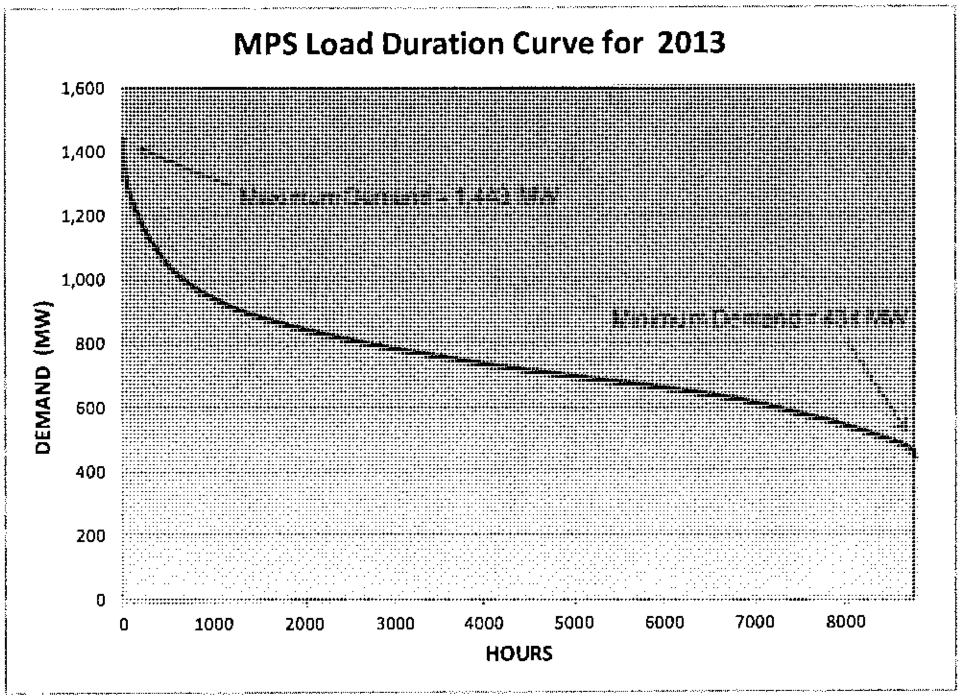

Figure 1-3. Load Duration Curve for MPS

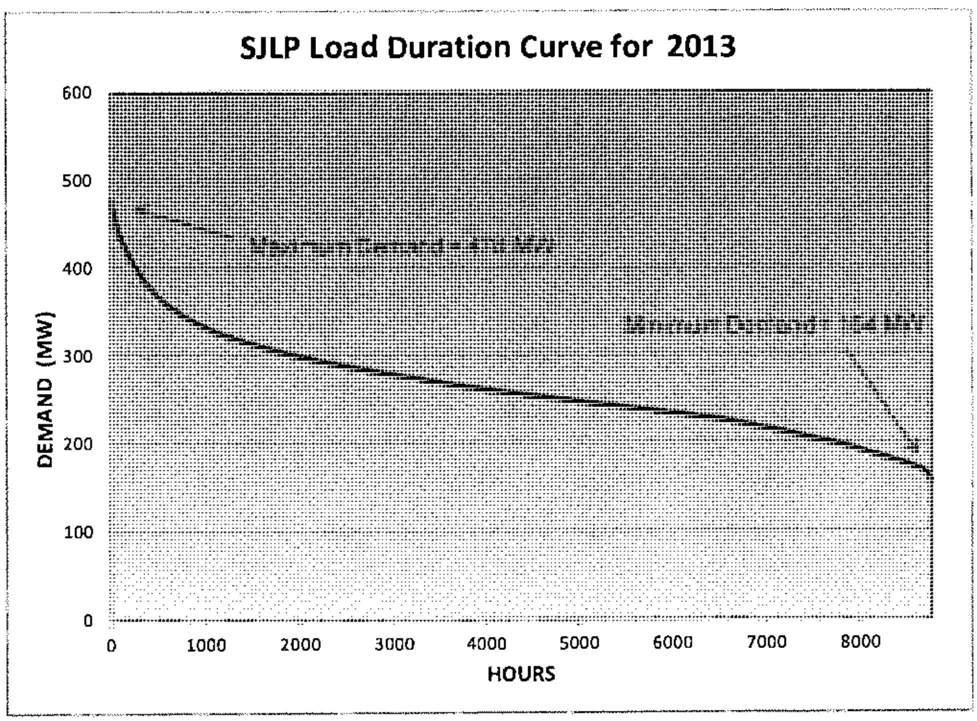

Figure 1-4. Load Duration Curve for SJLP

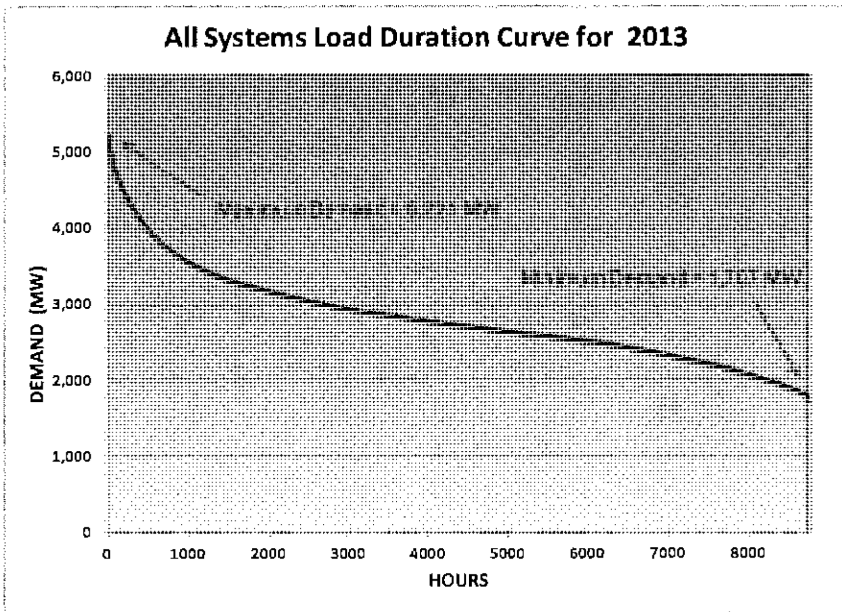

Figure 1-5. KCPL + GMO Load Duration Curve

KCP&L provided six 2013 power flow models representing different system conditions for the Southwestern Power Pool (SPP) electric system, described below. The SPP system includes the KCPL, GMO, and other SPP and non-SPP balancing areas. The system load conditions represented in the cases are listed below:

- Summer peak
- Summer shoulder
- Fall
- Winter
- Spring
- Minimum

Most resistances of transmission transformers were missing in the power flow models. We added the missing resistances using data provided by KCPL so that the transformer load losses could be determined during the power flow simulations. The no-load losses of transformers were calculated separately as the magnetization branch of transformers was not represented in the power flow models.

Using these models as starting points, by scaling the load and generation, we developed a series of power flow snapshots of the steady state system operation for each region. A total of 21 power flow cases were developed for each region. Typical system conditions of loads, internal generation, and tie flows were modeled from maximum system load to minimum load. For each region, Siemens PTI determined the transmission losses for each of the 21 system load levels using power flow simulations. We obtained Loss vs. System Load data pairs from the power flow simulations and performed a regression analysis using the least square approach to find the mathematical equation that best fitted the results of the power flow simulations. Figure 1-6 through Figure 1-9 illustrate the Transmission Loss vs. System Load relationships for the KCPL-KS, KCPL-MO, MPS, and SJLP regions, respectively.

We calculated the hourly demand losses by applying the equations developed for each region to the corresponding hourly loads represented in the LDC's. The non-coincident peak demand loss at the transmission level occurs at the time of the non-coincident peak load. Typically, the coincident factor at the transmission level is 1.0 and the non-coincident and coincident peak demand losses are equal. The annual transmission energy losses were calculated by summing up the hourly demand losses.

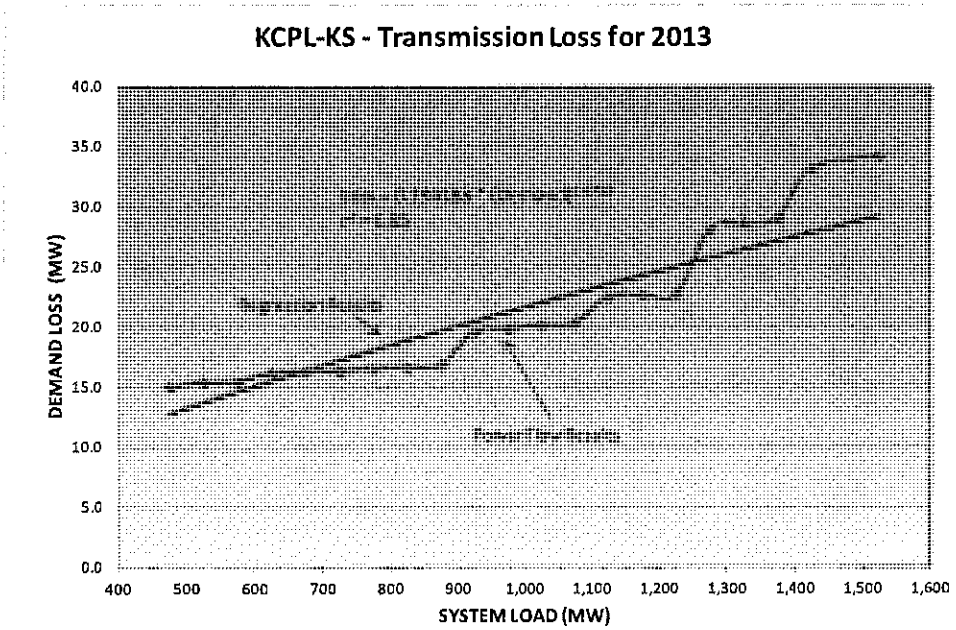

Figure 1-6. Transmission Loss vs. System Load Relationship for KCPL-KS

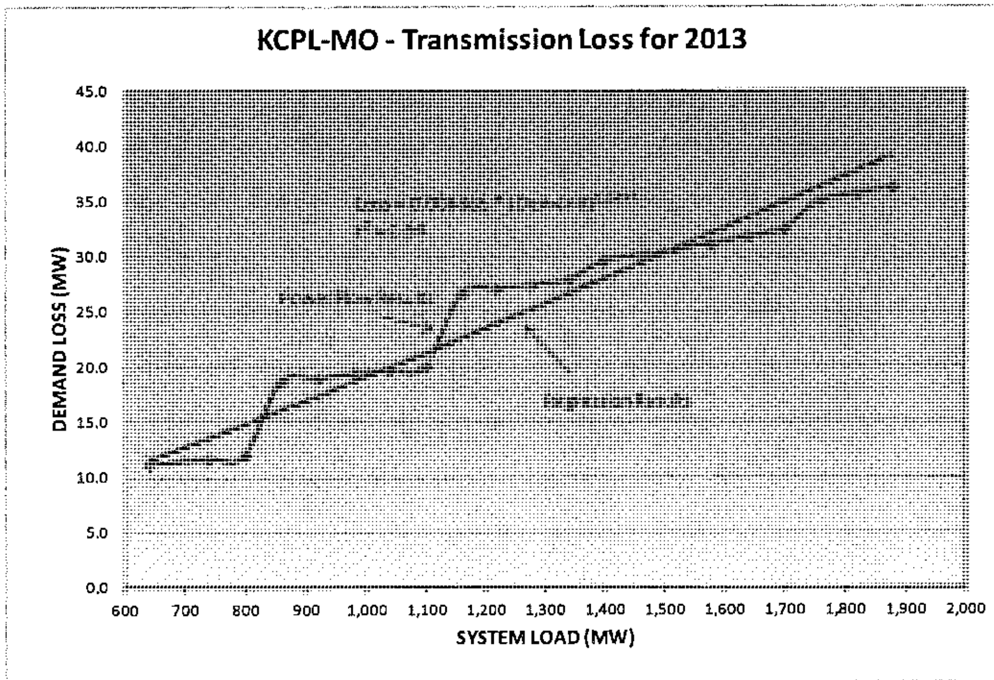

Figure 1-7. Transmission Loss vs. System Load Relationship for KCPL-MO Region

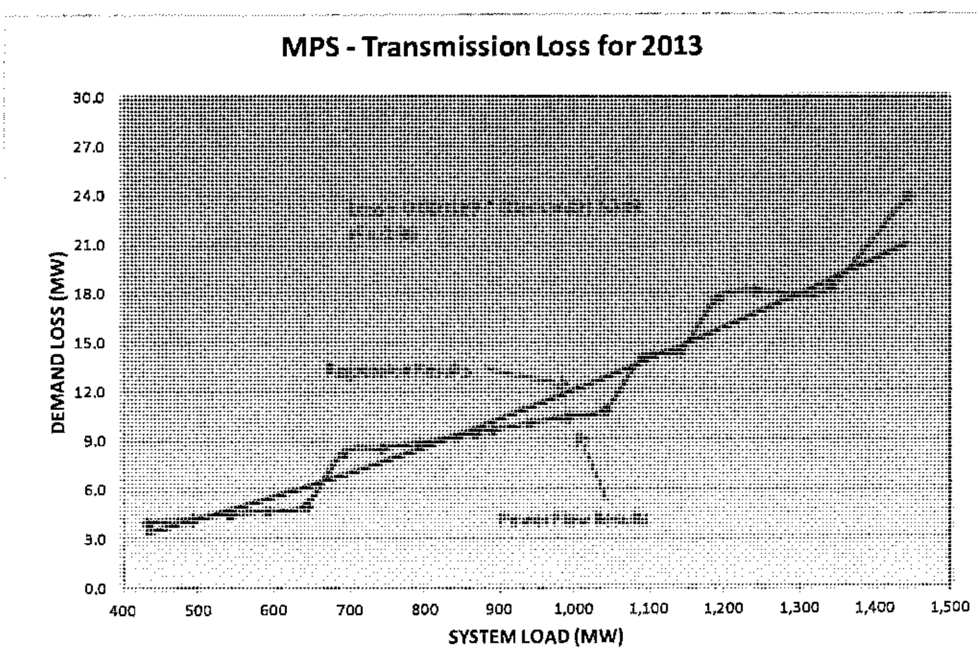

Figure 1-8. Transmission Loss vs. System Load Relationship for MPS Region

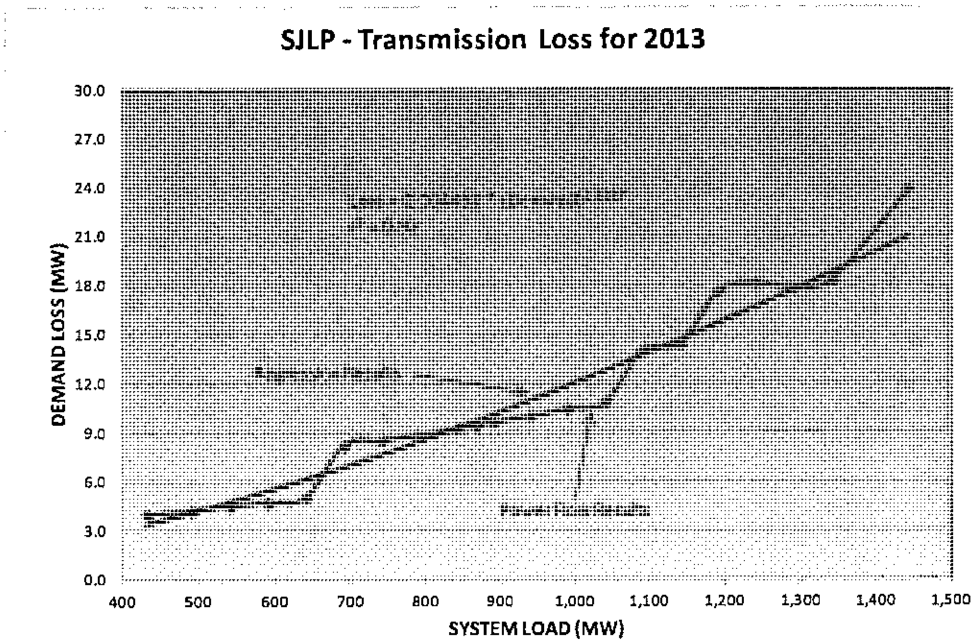

Figure 1-9. Transmission Loss vs. System Load Relationship for SJLP Region

1.1.2 GSU and Transmission Transformers No-Load Losses

Transformers have two distinctive characteristics that result in losses. The first one is called the "no-load" iron loss or excitation loss, and it is caused by the excitation or magnetizing current in the transformer. The no-load loss is always present as long as the transformer is energized and is a function of the voltage squared. The iron or excitation loss is called no-load because it does not depend on the transformer loading; the no-load loss is nearly constant throughout the year as voltages remain nearly constant in normal steady state conditions. No-load losses are in the form of heat energy and noise.

The transformer no-load demand loss was calculated by multiplying the capacity value of each individual transformer by the per unit no-load loss parameter provided by the equipment manufacturer in the test report. In those cases where the data was not available, typical parameters were used. The energy loss was calculated by multiplying the demand loss by 8,760, the number of hours in 2013. The no-load coincident and non-coincident demand losses are equal because the no-load loss remains approximately constant. The calculated demand and energy no-load losses for each transformer are documented in Appendix D. Transmission transformers where typical data was used for the no-load loss calculation appear shaded in Appendix D.

1.2 Corona Losses in Transmission Lines

Corona loss is an electric discharge into the air surrounding a conductor. Under relatively high humidity conditions, the air surrounding the conductors of high voltage transmission lines becomes ionized and conducts electricity to a limited extent. As a result, a very small part of the electric energy flowing in the transmission line leaks into the air resulting in electric loss. The amount of the corona discharge depends on the voltage level, the diameter of the conductor and the weather conditions. Other factors affect the corona discharge, such as, adverse weather conditions, elevation, conductor spacing, and the presence of a shield wire. Rain increases the corona loss substantially.

Siemens PTI calculated the corona demand losses separately for the 345-kV, 161-kV, and 69-kV transmission lines using the Bonneville Power Administration computer program, CORONAII, Corona and Field Effects. Corona loss is negligible for voltages below 69-kV for fair weather conditions. KCPL provided the lengths of transmission lines for the three transmission voltages in every region.

For the corona loss calculation precipitation data for 2013 was obtained from public sources. The coincident demand corona loss occurred with no precipitation at the same time of the system peak load. The non-coincident peak demand corona loss occurred with precipitation and was calculated using actual precipitation data.

The calculated corona losses for each region are summarized in Appendix C.

1.3 Allocated Transmission System Losses

The allocated transmission system losses are summarized in Table 1-2 for each region.

Table 1-2. Allocated Transmission Losses Summary

Loss Type	Non-Coincident Peak Demand Loss kW	Coincident Peak Demand Loss kW	Energy Loss kWh
KCPL - Kansas			
Transmission lines and transformers (load)	27,792	27,792	155,118,959
Transformers (no-load) – including GSU's	2,052	2,052	15,612,207
Corona	4,943	55	1,047,416
KCPL - Missouri			
Transmission lines and transformers (load)	35,674	35,674	159,326,697
Transformers (no-load) – including GSU's	2,492	2,492	17,476,091
Corona	4,098	47	869,909

Loss Type	Non-Coincident Peak Demand Loss kW	Coincident Peak Demand Loss kW	Energy Loss kWh
MPS			
Transmission lines and transformers (load)	24,235	24,235	79,152,411
Transformers (no-load) – including GSU's	2,959	2,959	25,994,929
Corona	2,332	26	496,292
SJLP			
Transmission lines and transformers (load)	6,182	6,182	26,285,120
Transformers (no-load) – including GSU's	301	301	2,652,833
Corona	2,324	26	492,422
ALL REGIONS			
Transmission lines and transformers (load)	93,883	93,883	419,883,187
Transformers (no-load) – including GSU's	7,804	7,804	61,736,060
Corona	13,697	154	2,906,039
TOTALS	**115,384**	**101,841**	**484,525,286**

Section

2

Primary Distribution Losses

2.1 Calculation Methodology

The Substation System and Primary Distribution losses are comprised of both demand (kW) and energy (kWh) components. Included in this category are the load and no-load losses in the Transmission to Distribution Transformers (Substation System), Distribution to Distribution Transformers and the losses in primary distribution lines.

The Substation Transformers have nominal high side voltages at transmission levels (345-kV, 161-kV or 69-kV), and low side voltages at primary distribution levels (25-kV, 13-kV, 12-kV, 8-kV, 4-kV, and 2-kV). There are also primary distribution transformers with primary distribution voltages on both sides (Distribution to Distribution Transformers).

Losses were calculated for three categories, each with demand and energy components:

- Distribution Substation Transformer load and no-load losses
- Distribution to Distribution Transformer load and no-load losses
- Primary Distribution line load losses

KCPL provided the 2013 non-coincident peak demand loads for the Primary Distribution Transformers. We used these demands to calculate the non-coincident peak demand losses. Those losses are called "non-coincident" because they typically occur at different times than the system peak. We also calculated the coincident peak demand losses and the annual energy losses using the primary distribution Loss Factor[1] and the Coincident Factor[2] for KCPL, MPS, and SJLP.

Transformer losses have a load and a no-load component. The transformer load losses depend on the electric current and the resistance of the transformer. The transformer no-load losses are voltage dependent. During steady state conditions voltages remain relatively constant in the primary distribution system and the no-load losses are relatively constant. No-load losses occur whenever the transformer is energized, whether or not the transformer is connected to a load. We determined the no-load transformer losses at the transformer nominal voltages using the transformer no-load parameters for every transformer. KCPL provided the transformer loss characteristics for most transformers; typical values were used to estimate the transformer losses for those cases in which the parameters were unavailable; estimated values appear shaded in Appendix D.

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[1] Loss Factor of a subsystem (e.g. distribution primary system) is the energy loss in a period divided by the non-coincident peak demand for that system and the number of hours in a year.
[2] Coincident Factor of a subsystem is the subsystem peak demand divided by the subsystem demand at the time of the system peak.

2.2 Primary Distribution Transformer Loss Calculations

Siemens PTI calculated the losses in Substation Transformers and Distribution to Distribution transformers.

2.2.1 Transformer Load Loss Calculation

Transformers load losses, also called copper losses, are associated with the current flowing through the transformer. We used the non-coincident peak load for each transformer to calculate the non-coincident peak demand losses using the transformer's resistance. We also calculated the average non-coincident peak loading for those transformers with recorded load information. The average peak demand loading was used to estimate the peak demand for those transformers with no historical loading information. The transformer loading data in the Appendix D are shaded to indicate those demand values that were estimated.

Appendix D includes the basic OA (Oil to Air) rating of each primary distribution transformer and the corresponding non-coincident peak loading for 2013. The OA rating is the lowest rating given to a transformer. The OA rating is the most basic cooling rating, as there are no oil pumps to circulate the oil, and cooling fans are offline and only natural convection occurs. In some cases, the transformer's non-coincident peak loading may be greater than the OA rating as these transformers have additional cooling stages which add about 33% of additional kVA capacity for every additional cooling stage.

The annual transformer energy loss for each transformer was determined from the non-coincident peak demand loss, the primary distribution loss factor, and 8,760 hours in the year. The coincident peak demand loss for each transformer was also calculated using the coincident factor of the primary distribution system. The loss and coincident factors were determined from load research data. The coincident and loss factors at the primary distribution level are included in Table 2-1. KCPL maintains a sophisticated load research program that enables the calculation of loss and coincident factors directly from the load research data without having to use empirical formula methods.

Table 2-1. Primary Distribution Loss and Coincident Factors

Region	Loss Factor	Coincident Factor
KCPL-KS	0.2640	1.01
KCPL-MO	0.3292	1.06
MPS	0.2684	1.00
SJLP	0.3716	1.04

2.2.2 Transformer No- Load Losses

No-load losses, also called iron core losses, are, approximately, a function of the square of the applied voltage. For this study the voltage applied to the primary distribution primary was assumed to be relatively constant and equal to the nominal voltage (1.0 per unit). Due to the relative constancy of the voltages, the variation in the no-load losses due to voltage variations was not considered significant.

The transformer no-load loss parameter has a relatively small variance when converted to per unit based on the OA transformer rating. Therefore, if the manufacturer's no-load parameters were not available typical values were used.

The no-load demand losses were calculated from the transformer no-load parameters. The coincident and non-coincident transformer demand no-load losses are both equal. The no-load energy losses were calculated from the no-load loss multiplied by the 8,760 hours.

2.3 Summary of Substation Transformer Losses

The allocated no-load and load losses of the substation transformer are summarized in Table 2-2 for each system. The detailed calculated losses for the individual substation transformers are included in Appendix D.

Table 2-2. Allocated Substation System Losses

	No-Load Losses		Load Losses	
Region	Demand kW	Energy kWh	Non-Coincident Peak Demand kW	Energy kWh
KCPL-KS	3,661	31,834,304	9,122	24,404,934
KCPL-MO	4,059	35,422,576	9,891	26,474,018
MPS	4,043	35,217,881	2,798	6,580,624
SJLP	1,958	17,161,859	631	2,051,326
All Systems	13,721	119,636,620	22,442	59,510,902

2.4 Distribution to Distribution Transformer Losses

The allocated losses of those transformers with distribution voltages on the high and low voltage sides are summarized in Table 2-3. The detailed calculated losses of individual transformers are included in Appendix D. The relative disproportion of the KCPL-KS losses compared to the KCPL-MO losses in these transformers does not mean much by itself; a more realistic proportion is obtained when the losses in these transformers are added to the losses in the substation transformers. A similar comment can be made for the losses in the MPS and SJLP regions.

Table 2-3. Allocated Distribution to Distribution Transformer Losses

	No-Load Losses		Load Losses	
Region	Demand kW	Energy kWh	Non-Coincident Peak Demand kW	Energy kWh
KCPL-KS	346	3,067,861	339	900,652
KCPL-MO	194	1,709,992	113	304,876
MPS	301	2,619,034	126	296,691

	No-Load Losses		Load Losses	
Region	Demand kW	Energy kWh	Non-Coincident Peak Demand kW	Energy kWh
SJLP	714	6,252,840	146	475,876
All Systems	1,555	13,649,727	724	1,978,095

2.5 Distribution Primary Line Losses

As shown in Table 2-4, there are 1,543 primary distribution circuits in KCPL, MPS, and SJLP systems. The circuits have nominal primary distribution voltages ranging from 2.4-kV to 34.5-kV. The vast majority of circuits operate at the 12.47-kV and 13.2-kV nominal voltage levels, most of them in KCPL; a few circuits have nominal voltages of 2.4-kV, 7.2-kV, 8.32-kV and 13.8-kV.

Table 2-4. Primary Distribution Circuits

Circuit kV	KCPL	MPS	SJLP	TOTALS
2.4	0	2	5	7
4.16	4	45	9	58
7.2	2	2	0	4
8.32	0	11	0	11
12.47	604	357	129	1,090
13.2	286	0	0	286
13.8	0	7	1	8
24.9	0	18	0	18
34.5	19	14	28	61
TOTALS	915	456	172	1,543

KCPL provided the 2013 non-coincident peak load for each primary circuit. The corresponding power factor was used if available; typical power factors were used in those cases where the power factor was not available. Due to the large number of circuits, it was not practical to perform a detailed loss calculation on each circuit. Instead, we calculated the losses for a representative subset of 79 circuits, selected by KCPL, having different voltage and load levels. We modeled the selected circuits and applied the corresponding non-coincident peak demand for 2013 on each circuit considering the load distribution represented in the distribution models. From power flow simulations we determined Loss vs. Load data points for different voltage levels. We used regression analysis and the Least Squares approach to find the Loss vs. Load mathematical relationships that best fitted the data for different voltage levels. The mathematical equations were selected from options that included logarithmic, power, polynomial, and exponential equations. We applied the equations to calculate the non-coincident peak demand loss for each circuit; the energy loss was calculated using the non-coincident peak demand loss, the loss factor at the primary distribution level, and the number of hours in the year. The coincident peak demand losses were calculated using the coincident factor at the primary distribution level. The loss and coincident factors were calculated from load research data; these factors are shown in Table 2-1 above.

The circuits selected for detailed analysis are listed in Table 2-5.

Table 2-5. Selected Circuits for Detailed Analysis

Circuit ID	Substation	Service Center	Voltage	Region	Type
21423	Blue Springs East	Blue Springs	12.47	GMO-MPS	Suburban
22313	Clinton Plant	Clinton	12.47	GMO-MPS	Suburban/Rural
22711	Concordia	Warrensburg	4.16	GMO-MPS	Suburban/Rural
22712	Concordia	Warrensburg	4.16	GMO-MPS	Suburban
22713	Concordia	Warrensburg	4.16	GMO-MPS	Suburban
26313	Holden	Warrensburg	4.16	GMO-MPS	Suburban/Rural
24811	Grandview City	Belton	8.32	GMO-MPS	Suburban
24812	Grandview City	Belton	8.32	GMO-MPS	Suburban
24813	Grandview City	Belton	8.32	GMO-MPS	Suburban
24814	Grandview City	Belton	8.32	GMO-MPS	Suburban
24815	Grandview City	Belton	8.32	GMO-MPS	Suburban
24711	Grandview West	Belton	8.32	GMO-MPS	Suburban
24712	Grandview West	Belton	8.32	GMO-MPS	Suburban
24713	Grandview West	Belton	8.32	GMO-MPS	Suburban
24722	Grandview West	Belton	8.32	GMO-MPS	Suburban
24723	Grandview West	Belton	8.32	GMO-MPS	Suburban
11823	Duncan Road	Blue Springs	12.47	GMO-MPS	Suburban
34711	Sedalia Plant	Sedalia	12.47	GMO-MPS	Suburban/Rural
27311	Kingsville Rural	Warrensburg	12.47	GMO-MPS	Rural
37231	Warrensburg Plant	Warrensburg	4.16	GMO-MPS	Suburban
37234	Warrensburg Plant	Warrensburg	4.16	GMO-MPS	Suburban
22511	Cole Camp City	Sedalia	4.16	GMO-MPS	Suburban/Rural
22512	Cole Camp City	Sedalia	4.16	GMO-MPS	Suburban
28511	Lexington	Henrietta	12.47	GMO-MPS	Suburban/Rural
31911	Platte City	Platte	24.9	GMO-MPS	Suburban/Rural
31912	Platte City	Platte	24.9	GMO-MPS	Suburban/Rural
32111	Pope Lane	Platte	24.9	GMO-MPS	Rural
23811	Ferrelview	Platte	24.9	GMO-MPS	Suburban

Circuit ID	Substation	Service Center	Voltage	Region	Type
23812	Ferrelview	Platte	24.9	GMO-MPS	Suburban
23813	Ferrelview	Platte	24.9	GMO-MPS	Suburban
23822	Ferrelview	Platte	24.9	GMO-MPS	Suburban
23823	Ferrelview	Platte	24.9	GMO-MPS	Suburban
32131	Pope Lane	Platte	13.8	GMO-MPS	Suburban/Rural
32132	Pope Lane	Platte	13.8	GMO-MPS	Suburban/Rural
35511	Pope Lane	Smithville	13.8	GMO-MPS	Suburban/Rural
35512	Pope Lane	Smithville	13.8	GMO-MPS	Suburban/Rural
35522	Pope Lane	Smithville	13.8	GMO-MPS	Suburban/Rural
37612	Western Electric	Lee's Summit	12.47	GMO-MPS	Suburban
39011	East Side	St Joe	34.5	GMO-SJLP	Suburban
39012	East Side	St Joe	34.5	GMO-SJLP	Suburban
39021	East Side	St Joe	34.5	GMO-SJLP	Suburban
407771	Maryville	Maryville	34.5	GMO-SJLP	Suburban
39921	Industrial Park	St Joe	34.5	GMO-SJLP	Suburban
40413	Lake Road	St Joe	34.5	GMO-SJLP	Suburban
40423	Lake Road	St Joe	34.5	GMO-SJLP	Suburban
40422	Lake Road	St Joe	34.5	GMO-SJLP	Suburban
41721	Oregan	Maryville	12.47	GMO-SJLP	Rural
41611	Oak Street	St Joe	12.47	GMO-SJLP	Urban/Suburban
41621	Oak Street	St Joe	12.47	GMO-SJLP	Urban/Suburban
43313	Woodbine	St Joe	12.47	GMO-SJLP	Urban/Suburban
40121	Kellog	St Joe	12.47	GMO-SJLP	Rural
2941	Lenexa	JOCO	12.47	KCPL-KS	Suburban
3833	Oxford	JOCO	12.47	KCPL-KS	Suburban
6811	Roeland Park	JOCO	12.47	KCPL-KS	Suburban
11722	Bucyrus	South Dist	12.47	KCPL-KS	Rural
12113	North Louisburg	South Dist	12.47	KCPL-KS	Suburban/Rural
3211	Mt. Leonard	East District	12.47	KCPL-MO	Rural
1562	Grand Avenue	F&M	13.2	KCPL-MO	Urban
1567	Grand Avenue	F&M	13.2	KCPL-MO	Urban
7411	Northeast	F&M	13.2	KCPL-MO	Urban
7414	Northeast	F&M	13.2	KCPL-MO	Urban

Circuit ID	Substation	Service Center	Voltage	Region	Type
7444	Northeast	F&M	13.2	KCPL-MO	Urban
2454	Crosstown	F&M	13.2	KCPL-MO	Urban
2464	Crosstown	F&M	13.2	KCPL-MO	Urban
3111	Forest	Dodson	13.2	KCPL-MO	Urban
3114	Forest	Dodson	13.2	KCPL-MO	Urban
4414	Chouteau	F&M	13.2	KCPL-MO	Urban
2333	Southtown	Dodson	13.2	KCPL-MO	Urban
2373	Southtown	Dodson	13.2	KCPL-MO	Urban
7453	Northeast	Dodson	13.2	KCPL-MO	Urban
6134	Leeds	Dodson	13.2	KCPL-MO	Urban
6131	Leeds	Dodson	13.2	KCPL-MO	Urban
3511	Loma Vista	Dodson	12.47	KCPL-MO	Urban
3531	Loma Vista	Dodson	12.47	KCPL-MO	Urban
3543	Loma Vista	Dodson	12.47	KCPL-MO	Urban
6613	Martin City	Dodson	12.47	KCPL-MO	Urban/Suburban
6631	Martin City	Dodson	12.47	KCPL-MO	Urban/Suburban
4841	Tomahawk	Dodson	12.47	KCPL-MO	Urban/Suburban
4822	Tomahawk	Dodson	12.47	KCPL-MO	Urban/Suburban

Siemens PTI used its propriety PSS®SINCAL distribution software program to calculate the losses in the distribution feeders. KCPL provided the distribution circuit models in SynerGEE format. PSS®SINCAL and SynerGEE have similar capabilities. The data provided by KCPL included conductor length, type, phasing (A, B, C, AB, BC, AC, and ABC), loads by phase, and capacitors and other distribution equipment. The total circuit load was scaled for each circuit to match the SCADA system recorded non-coincident peak loads on that circuit provided by KCPL.

We represented the models in a format suitable for use with our distribution software program. Our circuit models were validated using loss results provided by KCPL. PSS®SINCAL can represent three phase, two phase, and single line to ground distribution lines. We did not include the secondary transformers in our circuit models as the loss calculation for the secondary transformers was performed separately. The transformer node was utilized as the connected load node. We performed the loss calculation on a per-phase basis considering the phase unbalances represented in the circuit models provided by KCPL.

The curves and equations determined from the detailed loss calculations and the regression analysis are shown in Figure 2-1 through Figure 2-6 for voltages ranging from 4.16-kV through 35-kV. The losses for the 2.4-kV, 7.2-kV, and 13.8-kV circuits were calculated using the equations developed for the 4.16-kV, 8.32-kV, and 12.47-kV circuits, respectively. The same equations were applied to the circuits in all three systems.

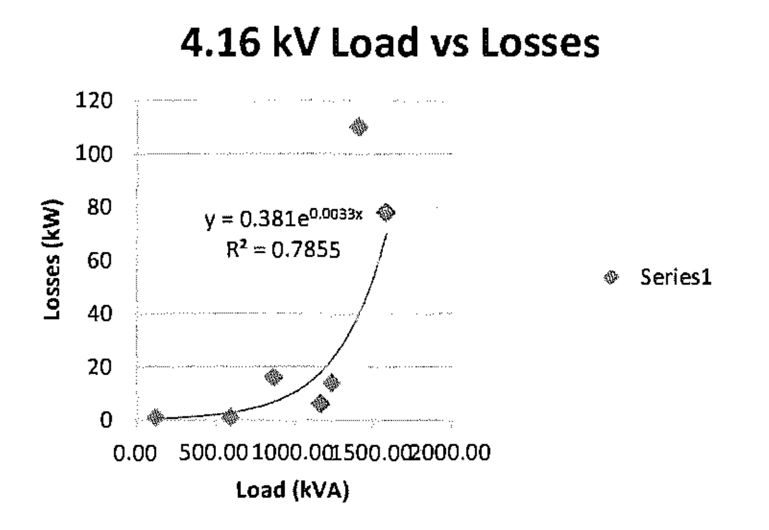

Figure 2-1. Calculated Loss Results and Regression Curve for 4.16-kV Circuits

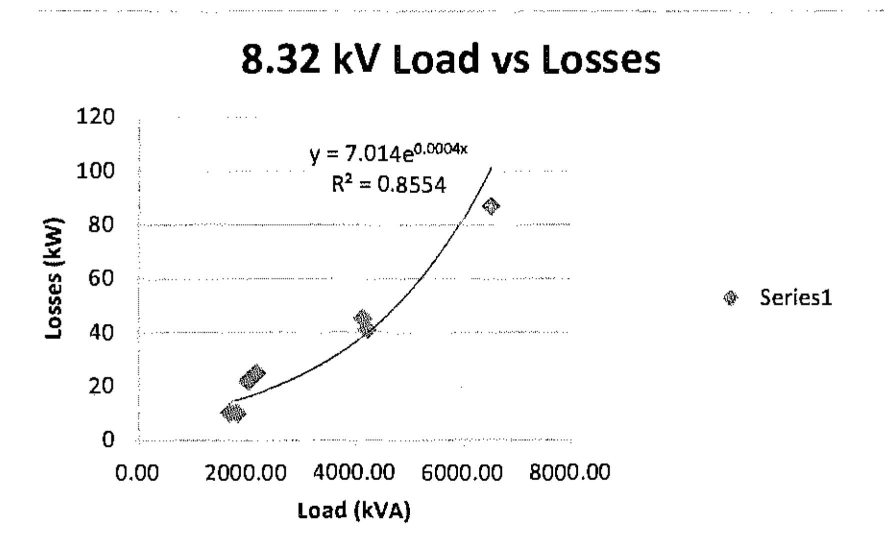

Figure 2-2. Calculated Loss Results and Regression Curve for 8.32-kV Circuits

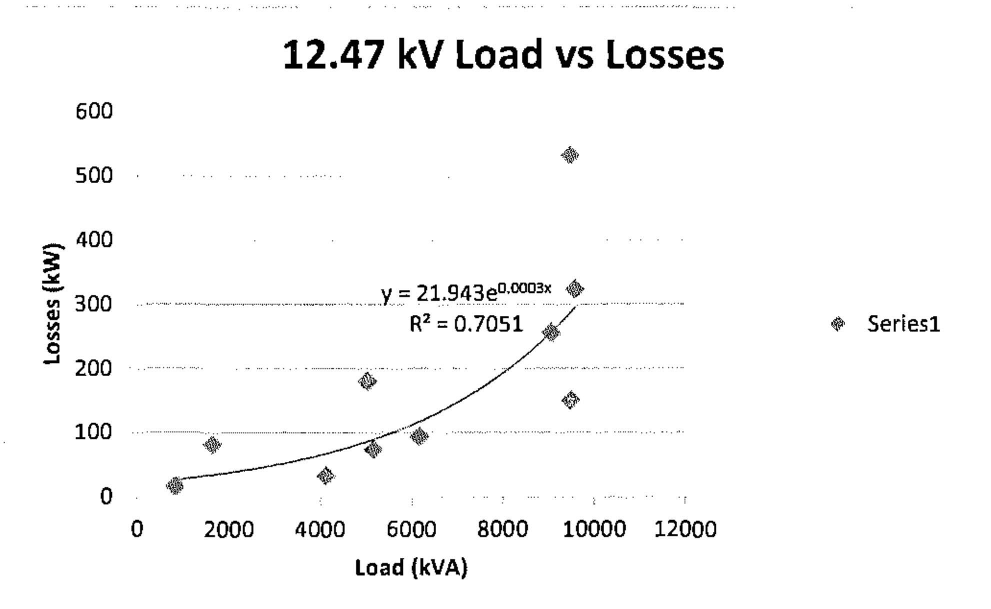

Figure 2-3. Calculated Loss Results and Regression Curve for 12.47-kV Circuits

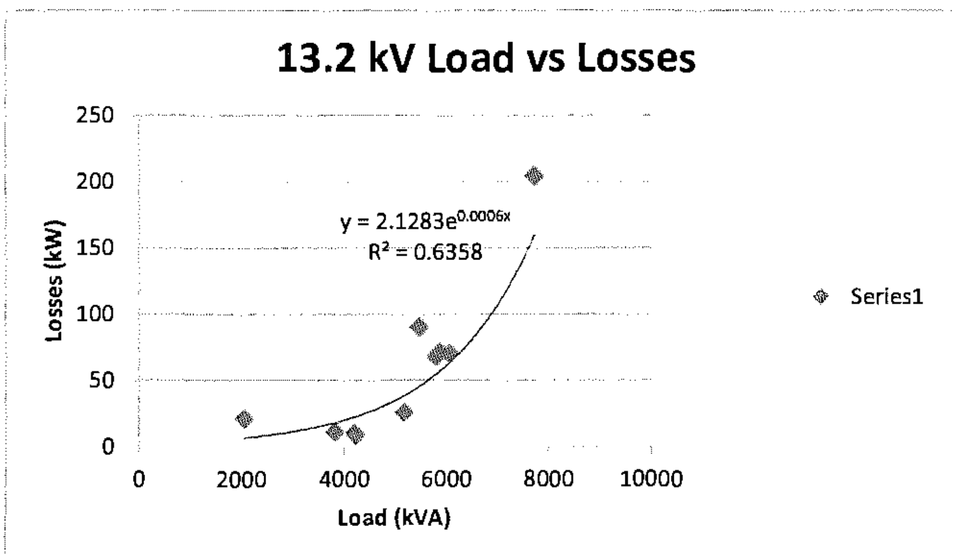

Figure 2-4. Calculated Loss Results and Regression Curve for 13.2-kV Circuits

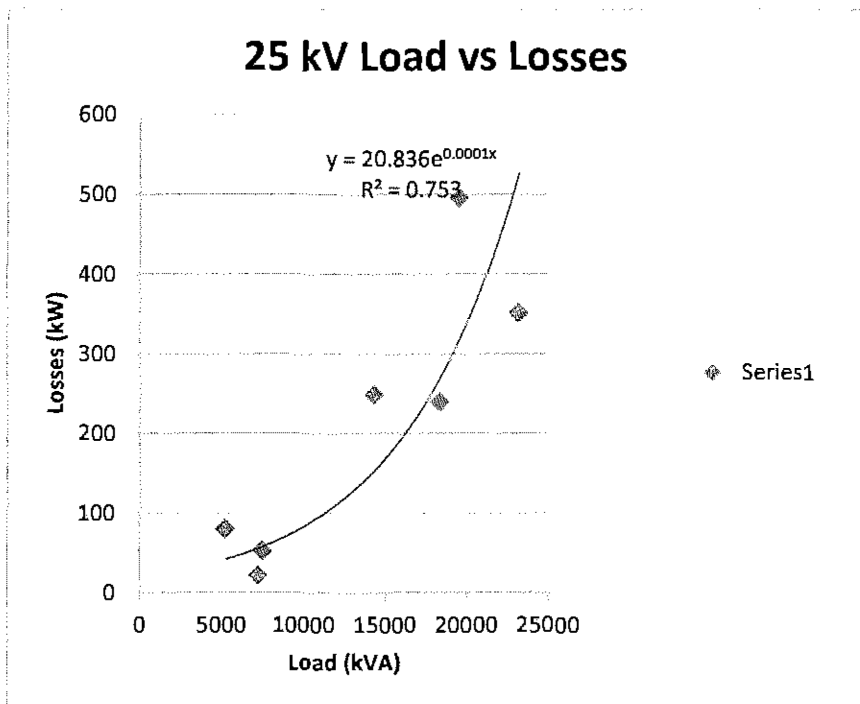

Figure 2-5. Calculated Loss Results and Regression Curve for 25-kV Circuits

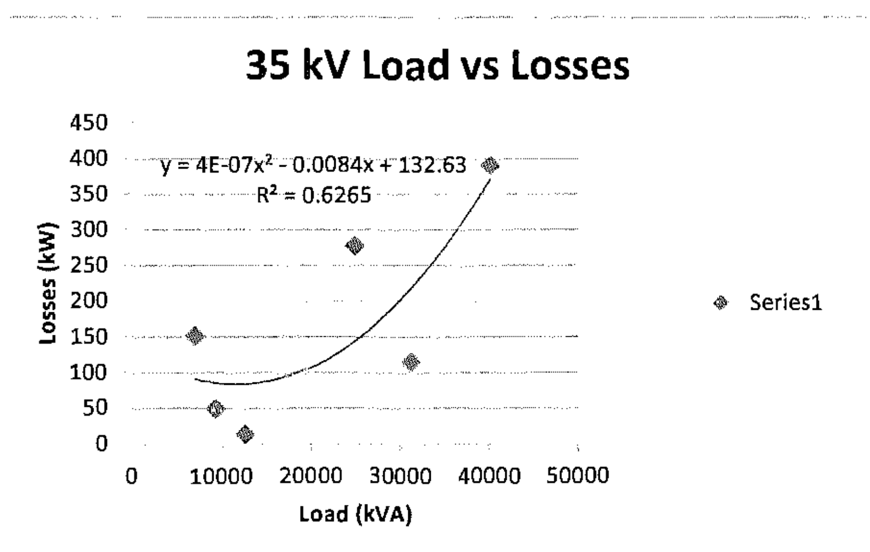

Figure 2-6. Calculated Loss Results and Regression Curve for 35-kV Circuits

2.6 Summary of Primary Distribution Line Losses

The calculated energy losses in the primary distribution lines are summarized in Table 2-6 by region and nominal voltage. The losses in the KCPL system are broken down for Kansas and Missouri. The detailed calculated losses by circuit are included in Appendix E.

Table 2-6. Calculated Primary Distribution Losses by System and Nominal Voltage

Nominal Voltage kV	KCPL- KS	KCPL MO	MPS	SJLP	Totals
2.4	-	-	87,641	-	87,641
4.2	-	627,997	2,838,592	-	3,466,590
7.2	-	25,727	41,178	-	66,905
8.3	-	-	893,753	-	893,753
12.5	98,740,415	81,240,092	100,226,655	35,094,132	315,301,295
13.2	-	78,604,680	-	-	78,604,680
13.8	-	-	1,936,794	-	1,936,794
24.9	-	-	2,341,984	-	2,341,984
34.5	-	-	3,058,383	11,176,227	19,509,949
Totals	**98,740,415**	**165,773,836**	**111,424,980**	**46,270,359**	**422,209,591**

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Section

3

Secondary Distribution Losses

The secondary distribution system is comprised of secondary transformers, secondary lines, service drops, and customer electric meters. Secondary transformers connect the primary and secondary distribution systems. Service drops connect the customers to the secondary distribution system. Demand losses were calculated for each of these components; the energy losses were determined from the demand losses, loss factors, and the number of hours in a year.

The electric energy utilized by customers connected to the secondary distribution system flows through all the other sub-systems, including transmission, primary transformers, primary distribution lines, secondary transformers, secondary distribution lines, service drops and customer meters. Due to the large number of customers at this service level and the very large number of equipment elements required to serve the load at this service level, metering of each customer load at small time increments, such as each hour, has been impractical so far.

The very large number of elements at the secondary service level, for which electric losses need to be calculated, dictates that loss calculation methods at this level be somewhat less rigorous than the loss calculation methods used for the other sub-systems. For the present study, Siemens PTI has used the best methodology to fit the data available.

3.1 Distribution Secondary Transformers

For 2013, KCPL reported an approximate total of 199,114 units, with a total capacity of about 14,771 MVA. The secondary transformers by type for each system are summarized in Table 3-1.

Table 3-1. Secondary Transformers

	KCPL - KS	KCPL - MO	MPS	SJLP	TOTALS
OVERHEAD					
No. of Units	28,888	33,954	41,146	17,916	121,904
kVA Size Range	0.5 - 34,500	0.5 - 34,500	3 - 12480	.5 - 7560	0.5 - 34,500
Total Installed kVA	1,377,856	1,938,769	1,476,333	578,436	5,371,394
UNDERGROUND					
No. of Units	25,064	13,707	34,055	4,384	77,210
kVA Size Range	5 – 34,500	5 – 34,500	3-7,500	15-10,000	0.5 - 34,500
Total Installed kVA	2,890,316	3,104,231	2,567,880	836,988	9,399,415

	KCPL - KS	KCPL - MO	MPS	SJLP	TOTALS
TOTALS					
No. of Units	53,952	47,661	75,201	22,300	199,114
Total Installed kVA	4,268,172	5,043,000	4,044,213	1,415,424	14,770,809

Similar to the primary distribution transformers, secondary transformers have also a load and a no-load loss component. Siemens PTI calculated the no-load losses using the rated no-load characteristics provided by KCPL for each transformer size. The no-load demand loss was calculated by multiplying the rated no-load value for each transformer size by the number of transformers in that size category. The energy no-load losses were determined by multiplying the no-load demand losses by 8,760 hours in the test year. Transformers were assumed to operate at constant nominal voltage throughout the year.

The most accurate method to calculate the peak demand loss of each secondary transformer is to consider the actual peak demand of the transformer. The peak demand of each secondary transformer was not known and an approximate method was used. Using he data supplied, for each region we calculated the average non-coincident peak demand kVA load per installed transformer kVA capacity. The average peak loading was 25% for KCPL-KS, 21% for KCPL-MO, 30% for MPS, and 25% for SJLP. We used these average peak loadings to estimate the non-coincident peak demand supplied by the secondary transformers. However, the average peak demand is not the peak demand on all transformers as this number represent an average peak loading. For a group of transformers the peak demand load may be higher than the average and for other groups of transformers the peak demand may be lower. Therefore, we created a frequency distribution of the peak loading that had an average equal to the average peak loading observed in the load data. The purpose of the frequency distribution of transformer loadings is to capture the loadings above and below the average. Additionally, the fact that the demand loss is proportional to the square of the load must also be considered in the calculation of the non-coincident peak demand losses.

Siemens PTI calculated the coincident peak demand losses my multiplying the non-coincident peak demand loss of each transformer by the coincident factor at the secondary distribution level. The energy losses were calculated by multiplying the non-coincident peak demand loss by the loss factor at the secondary distribution level and the number of hours in the test year. The coincident and loss factors, calculated using load research data, are shown in Table 3-2.

Table 3-2. Secondary Distribution Loss and Coincident Factors

Region	Loss Factor	Coincident Factor
KCPL-KS	0.1990	1.01
KCPL-MO	0.2179	1.12
MPS	0.2544	1.00
SJLP	0.3679	1.04

The allocated load and no-load losses for the secondary transformers are summarized in Table 3-3. The detailed calculated losses of individual transformers are included in Appendix D.

Table 3-3. Allocated Secondary Transformer Losses

	No-Load Losses		Load Losses	
Region	**Demand kW**	**Energy kWh**	**Non-Coincident Peak Demand kW**	**Energy kWh**
KCPL-KS	7,709	67,534,339	4,317	7,526,865
KCPL-MO	7,189	62,968,059	3,148	6,007,950
MPS	10,623	93,271,199	7,673	17,141,369
SJLP	2,011	17,614,473	1,120	2,424,802
All Systems	27,532	241,388,070	16,258	33,100,986

3.2 Distribution Secondary Lines and Service Drops

Losses that occur on the secondary lines and service drops are the most difficult to calculate due to the sheer number of secondary lines and service drops in the secondary systems, and the lack of data measurements for each secondary line and service drop. Information such as configuration, conductor size, and length for each of the services to customers would be helpful in this type of studies, but this information is not usually kept on drawings because of the large number of drawings that would be required. As an altemative approach, drawing sets of secondary distribution installations were used. To a certain extent, each customer's electric service installation is unique and slightly different than the standard. As a result, installations are somewhat customized to fit each customer's needs and location.

Based on KCPL standards, 12 different secondary and service drop configurations were used with the average non-coincident peak demands for each customer. The customer load was assumed to be unbalanced for the 240/120 volt configurations with 50 percent of the load on one leg, 40 percent on the other leg and 10 percent on the neutral. The non-coincident peak demand losses were calculated based on these loads and configurations.

Siemens PTI calculated the coincident peak demand and energy losses using the coincident and loss factors for the secondary level documented in Table 3-2 above and the number of hours in the test year. The allocated peak demand and energy losses are summarized in Table 3-4. The calculated losses are included in the tables of Appendix A.

Table 3-4. Allocated Secondary Distribution Lines and Service Drops Losses

Region	Non-Coincident Peak Demand Losses - kW	Energy Losses kWh
KCPL-KS	10,284	17,930,118
KCPL-MO	8,330	15,899,824
MPS	18,303	40,793,920
SJLP	3,962	12,767,553
All Systems	40,879	87,391,415

3.3 Customer Electric Meters

Losses occur in each customer meter. KCPL provided the customer meter inventory of single and three-phase meters, mechanical and electronic. Both the mechanical and electronic meters require very little energy to operate, with electronic meters being considerably more efficient.

The meter losses were quantified as no-load losses. The non-coincident and coincident peak demand losses of no-load losses are equal. The demand loss for electric meters was calculated by multiplying the number of meters by the loss of each meter type. The energy losses for each meter type were calculated by multiplying the corresponding demand losses by 8,760, the number of hours in 2013.

The allocated peak demand and energy losses are summarized in Table 3-5 below. The detailed calculated losses are presented in Appendix F.

Table 3-5. Allocated Customer Meter Losses

Region	Non-Coincident Peak Demand Losses - kW	Energy Losses kWh
KCPL-KS	58	514,114
KCPL-MO	61	538,141
MPS	229	2,005,517
SJLP	37	326,552
All Systems	385	3,384,324

3.4 Non-Technical Losses

The two main components that make up the energy and demand that is unaccounted for are the Energy Diversion and Company Unmetered Use. In the KCPL system, the unmetered company use is comprised of the light and power used by substations.

3.4.1 Energy Diversion

Energy diversion is the term used to describe energy that is stolen by customers tampering with the meter or bypassing the meter. Energy diversion in the United States is very small. Consistent with previous studies, KCPL estimated the energy diversion as 0.002% of the sales to ultimate customers. Siemens PTI calculated the non-coincident and coincident peak demand losses from the estimated energy diversion losses and the load and loss factors at the residential level. The load and loss factors were determined from load research data.

The allocated energy diversion losses are summarized in Table 3-6 below. The calculated diversion losses are documented in the tables included in Appendix A.

Table 3-6. Allocated Energy Diversion Losses

Region	Non-Coincident Peak Demand Losses - kW	Energy Losses kWh
KCPL-KS	17	56,411
KCPL-MO	15	47,436
MPS	19	64,976
SJLP	3	11,468
All Systems	54	180,291

3.5 Unaccounted Substation Station Light & Power

The only company unmetered use that is not in the calculated losses is the electric energy consumed by light and power service at the substations. Siemens PTI calculated the company unmetered use based on the number of substations and an estimated average non-coincident peak load consumption of 40 kW per substation. The coincident peak load consumption was calculated using the residential coincident factor determined from load research data. The energy consumption was calculated for a load factor of 60%.

The allocated Substation Station Light & Power consumption is summarized in Table 3-7 below. The calculated Station Light & Power consumption is documented in Appendix F.

Table 3-7. Allocated Company Unmetered Use

Region	Number of Substations	Energy Consumption kWh
KCPL-KS	1,467	7,709,250
KCPL-MO	2,921	15,355,100
MPS	4,370	22,966,390
SJLP	977	5,134,289
All Systems	9,735	51,165,029

Section

4

Allocation Procedure and Loss Multipliers

Siemens PTI calculated the technical losses for the following categories: transmission lines and transformers, transmission corona, primary distribution transformers (substation transformers), distribution to distribution transformers, primary distribution lines, secondary distribution transformers, secondary lines, service drops, and customer electric meters. Adding the calculated energy losses of these categories should approximate the total recorded energy losses determined by taking the difference between the input to the systems and the sales. As it has been discussed in this report, the calculation methods use statistical approaches for the calculation of the losses of these subsystems. This approach usually results in differences between the recorded annual energy losses and the annual calculated values. Therefore, the loss difference needs to be allocated back to the calculated values so that the sum of the losses in these categories is equal to the recorded losses. The allocated losses for every region are included in the Executive Summary of this report. The calculated losses are documented in Appendix A.

Once the sum of the calculated losses was allocated to match the FERC reported losses, the demand and energy loss multipliers were determined. Loss multipliers are used to allocate losses to customers as a function of the service level. As an example, if a residential customer required one kWh of energy, the generation system would have to provide 1.061288 kWh to cover one kWh load plus the associated energy loss. Similarly, if the same residential customer placed a demand requirement of one kW, the generation system would have to provide, for example, 1.080868 kW to cover one kW load and the associated demand loss. The two numbers above are examples of demand and energy multipliers. Therefore, transmission customers are only responsible for their share of losses that result from their service on the transmission system. Primary service customers are responsible for losses resulting from their load on the primary system, and the transmission system. Secondary customers are responsible for losses that their load creates on all systems.

Siemens PTI calculated the demand and energy multipliers (also known as "loss factors") for each service level based on the loss results. The loss multipliers are organized as a function of where customers can be connected to a designated voltage service level such as transmission, primary distribution and secondary distribution.

The Loss Multipliers for the KCP&L-KS, KCPL-MO, MPS, SJLP, and the combined regions are included in Appendix B.

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Appendix

A

Calculated Losses

A.1 KCPL – Kansas

A.2 KCPL – Missouri

A.3 KCPL – KS + MO

A.4 MPS

A.5 SJLP

A.6 All Systems

Table A-01

KCPL-KANSAS CALCULATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	28,043	28,043	156,520,001
Line Corona	4,988	56	1,056,876
Transformer No-Load	874	874	7,655,636
Generator Step-Up No-Load	1,197	1,197	8,097,581
Sum	35,102	30,170	173,330,094
SUBSTATION SYSTEM			
Transmission to Distribution Load	9,204	9,155	24,625,361
Transmission to Distribution No-Load	3,694	3,694	32,121,833
Sum	12,898	12,849	56,747,194
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	342	340	908,787
Distribution to Distribution No-Load	349	349	3,095,570
Primary Lines	42,703	42,474	98,740,415
Sum	43,394	42,703	102,744,772
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	4,356	4,309	7,594,848
Transformer No-Load	7,779	7,779	68,144,313
Lines and Service Drops	10,377	10,264	18,092,064
Customer Meters	59	59	518,758
Sum	22,571	22,411	94,349,983
NON-TECHNICAL LOSSES			
Substation Station Light & Power	1,480	1,464	7,778,880
Energy Diversion	17	16	56,921
Sum	1,497	1,480	7,835,801
Total	115,462	109,613	435,007,844
TOTAL REPORTED FERC FORM 1 LOSSES			431,114,000
LOSSES ADJUSTMENT NECESSARY			-3,893,844

Table A-02

KCPL-MISSOURI CALCULATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	39,075	39,075	174,518,410
Line Corona	4,489	51	952,854
Transformer No-Load	653	653	5,716,163
Generator Step-Up No-Load	2,077	2,077	13,426,263
Sum	46,294	41,856	194,613,690
SUBSTATION SYSTEM			
Transmission to Distribution Load	10,834	10,603	28,998,301
Transmission to Distribution No-Load	4,446	4,446	38,800,099
Sum	15,280	15,049	67,798,400
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	124	121	333,946
Distribution to Distribution No-Load	212	212	1,873,039
Primary Lines	57,480	54,159	165,773,836
Sum	57,816	54,492	167,980,821
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	3,448	3,080	6,580,805
Transformer No-Load	7,874	7,874	68,972,029
Lines and Service Drops	9,124	8,150	17,415,864
Customer Meters	67	67	589,452
Sum	20,513	19,171	93,558,150
NON-TECHNICAL LOSSES			
Substation Station Light & Power	3,200	2,858	16,819,200
Energy Diversion	16	13	51,959
Sum	3,216	2,871	16,871,159
Total	143,119	133,439	540,822,220
TOTAL REPORTED FERC FORM 1 LOSSES			493,744,000
LOSSES ADJUSTMENT NECESSARY			-47,078,220

Table A-03

KCPL-KS & MO TOTAL CALCULATED LOSSES	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Line	67,118	67,118	331,038,411
Line Corona	9,477	107	2,009,730
Transformer No-Load	1,527	1,527	13,371,799
Generator Step-Up No-Load	3,274	3,274	21,523,844
Sum	81,396	72,026	367,943,784
SUBSTATION SYSTEM			
Transmission to Distribution Load	20,038	19,758	53,623,662
Transmission to Distribution No-Load	8,140	8,140	70,921,932
Sum	28,178	27,898	124,545,594
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	466	461	1,242,733
Distribution to distribution No-Load	561	561	4,968,609
Primary Lines	100,183	96,633	264,514,251
Sum	101,210	97,655	270,725,593
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	7,804	7,389	14,175,653
Transformer No-Load	15,653	15,653	137,116,342
Lines and Service Drops	19,501	18,414	35,507,928
Customer Meters	126	126	1,108,210
Sum	43,084	41,582	187,908,133
NON-TECHNICAL LOSSES			
Substation Station Light & Power	4,680	4,322	24,598,080
Energy Diversion	33	29	108,880
Sum	4,713	4,351	24,706,960
Total	258,581	243,512	975,830,064
TOTAL REPORTED FERC FORM 1 LOSSES			924,858,000
LOSSES ADJUSTMENT NECESSARY			-50,972,064

Table A-04

MPS CALCULATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	20,854	20,854	68,110,586
Line Corona	2,007	23	427,059
Transformer No-Load	1,362	1,362	11,967,023
Generator Step-Up No-Load	1,184	1,184	10,401,592
Sum	25,407	23,423	90,906,260
SUBSTATION SYSTEM			
Transmission to Distrbution Load	2,408	2,408	5,662,622
Transmission to Distribution No-Load	3,479	3,479	30,304,958
Sum	5,887	5,887	35,967,580
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	108	108	255,302
Distribution to Distribution No-Load	259	259	2,253,677
Primary Lines	47,394	47,385	111,424,980
Sum	47,761	47,752	113,933,959
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	6,603	6,603	14,750,134
Transformer No-Load	9,141	9,141	80,259,792
Lines and Service Drops	15,750	15,750	35,103,135
Customer Meters	197	197	1,725,746
Sum	31,691	31,691	131,838,807
NON-TECHNICAL LOSSES			
Substation Station Light & Power	3,760	3,760	19,762,560
Energy Diversion	16	15	55,912
Sum	3,776	3,775	19,818,472
Total	114,522	112,528	392,465,078
TOTAL REPORTED FERC FORM 1 LOSSES			456,090,000
LOSSES ADJUSTMENT NECESSARY			63,624,922

Table A-05

SJLP CALCULATED LOSSES			
	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	8,354	8,354	35,518,854
Line Corona	3,140	35	665,406
Transformer No-Load	306	306	2,688,782
Generator Step-Up No-Load	102	102	895,968
Sum	11,902	8,797	39,769,010
SUBSTATION SYSTEM			
Transmission to Distrbution Load	852	819	2,771,939
Transmission to Distribution No-Load	2,646	2,646	23,190,671
Sum	3,498	3,465	25,962,610
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	197	189	643,047
Distribution to Distribution No-Load	965	965	8,449,409
Primary Lines	14,213	13,661	46,270,359
Sum	15,375	14,815	55,362,815
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	1,513	1,458	3,276,614
Transformer No-Load	2,717	2,717	23,802,284
Lines and Service Drops	5,354	5,160	17,252,684
Customer Meters	50	50	441,267
Sum	9,634	9,385	44,772,849
NON-TECHNICAL LOSSES			
Substation Station Light & Power	1,320	1,272	6,937,920
Energy Diversion	4	4	15,496
Sum	1,324	1,276	6,953,416
Total	41,733	37,738	172,820,700
TOTAL REPORTED FERC FORM 1 LOSSES			127,893,000
LOSSES ADJUSTMENT NECESSARY			-44,927,700

Table A-06

KCPL-TOTAL SYSTEM CALCULATED LOSSES	NON-COINCIDENT PEAK LOSSES KW	COINCIDENT PEAK LOSSES KW	ENERGY LOSSES KWH
TRANSMISSION SYSTEM			
Transmission Line	96,326	96,326	434,667,851
Line Corona	14,624	165	3,102,195
Transformer No-Load	3,195	3,195	28,027,604
Generator Step-Up No-Load	4,560	4,560	32,821,404
Sum	118,705	104,246	498,619,054
SUBSTATION SYSTEM			
Transmission to Distrbution Load	23,298	22,985	62,058,223
Transmission to Distribution No-Load	14,265	14,265	124,417,561
Sum	37,563	37,250	186,475,784
PRIMARY DISTRIBUTION SYSTEM			
Disribution to Distribution Load	771	758	2,141,082
Distribution to distribution No-Load	1,785	1,785	15,671,695
Primary Lines	161,790	157,679	422,209,590
Sum	164,346	160,222	440,022,367
DISTRIBUTION SECONDARY SYSTEM			
Transformer Load	15,920	15,450	32,202,401
Transformer No-Load	27,511	27,511	241,178,418
Lines and Service Drops	40,605	39,324	87,863,748
Customer Meters	373	373	3,275,223
Sum	84,409	82,658	364,519,790
NON-TECHNICAL LOSSES			
Substation Station Light & Power	9,760	9,354	51,298,560
Energy Diversion	53	48	180,288
Sum	9,813	9,402	51,478,848
Total	414,836	393,777	1,541,115,843
TOTAL REPORTED FERC FORM 1 LOSSES			1,508,841,000
LOSSES ADJUSTMENT NECESSARY			-32,274,843

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Appendix B

Loss Multipliers

B.1 KCPL – Kansas – Energy

B.2 KCPL – Missouri – Energy

B.3 KCPL – KS + MO – Energy

B.4 MPS – Energy Loss

B.5 SJLP – Energy Loss

B.6 All Systems – Energy

B.7 KCPL – Kansas – Demand

B.8 KCPL – Missouri – Demand

B.9 KCPL – KS + MO – Demand

B.10 MPS – Demand

B.11 SJLP – Demand

B.12 All Systems - Demand

Table B-01

KCPL-KANSAS ENERGY LOSS MULTIPLIERS

SERVICE LEVEL	Total System kWh	Total System Multiplier	Secondary Service kWh	Secondary Service Cumulative Multiplier	Primary Service kWh	Primary Service Cumulative Multiplier	Substation Service kWh	Substation Service Cumulative Multiplier	Transmission Service kWh	Transmission Service Cumulative Multiplier
Secondary		1.025713								
Sales	3,938,498,757		3,938,498,757							
Losses + Diversion	101,271,097		101,271,097							
Input to Primary	4,039,769,854		4,039,769,854	1.025713						
Primary		1.024859	4,039,769,854							
Primary Sales	2,318,755,819				2,318,755,819					
Primary Losses	158,064,320		100,423,197		57,641,123					
Input to Transmission	6,516,589,993		4,140,193,051	1.024859	2,376,396,942	1.024859				
			4,140,193,051		2,376,396,942					
Transmission		1.024842								
Transmission Sales	398,279,904								398,279,904	
Losses	171,778,582		102,850,307		59,034,241				9,894,034	
System Input	7,086,648,479		4,243,043,358	1.077325	2,435,431,183	1.050318			408,173,938	1.024842
Losses + Diversion	431,113,999		304,544,601		116,675,364				9,894,034	

Table B-02

KCPL- MISSOURI ENERGY LOSS MULTIPLIERS

SERVICE LEVEL	Total System		Secondary Service		Primary Service		Substation Service		Transmission Service	
	kWh	Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier
Secondary		1.024411								
Sales	4,130,000,658		4,130,000,658							
Losses + Diversion	100,816,510		100,816,510							
Input to Primary	4,230,817,168		4,230,817,168	1.024411						
Primary		1.025166	4,230,817,168							
Primary Sales	4,322,598,972				4,322,598,972					
Primary Losses	215,254,794		106,472,509		108,782,285					
put toTransmission	8,768,670,934		4,337,289,677	1.050191	4,431,381,257	1.025166				
			4,337,289,677		4,431,381,257					
Transmission		1.033429								
Transmission Sales	325,885,489								325,885,489	
Losses	177,672,697		84,733,979		86,572,167				6,366,551	
System Input	9,272,229,120		4,422,023,656	1.070708	4,517,953,424	1.045194			332,252,040	1.019536
Losses + Diversion	493,744,001		292,022,998		195,354,452				6,366,551	

Table B-03

KCPL-KS & MO TOTAL COINCIDENT ENERGY LOSS MULTIPLIERS

SERVICE LEVEL	Total System kWh	Total System Multiplier	Secondary Service kWh	Secondary Service Cumulative Multiplier	Primary Service kWh	Primary Service Cumulative Multiplier	Substation Service kWh	Substation Service Cumulative Multiplier	Transmission Service kWh	Transmission Service Cumulative Multiplier
Secondary		1.025046								
Sales	8,068,499,416		8,068,499,416							
Losses + Diversion	202,087,607		202,087,607							
Input to Primary	8,270,587,023		8,270,587,023	1.025046						
Primary		1.025035	8,270,587,023							
Primary Sales	6,641,354,790				6,641,354,790					
Primary Losses	373,319,114		207,053,398		166,265,716					
Input to Substation	15,285,260,927		8,477,640,420	1.025035	6,807,620,507	1.025035				
			8,477,640,420		6,807,620,507					
Transmission		1.021828								
Transmission Sales	724,165,393								724,165,393	
Losses	349,451,279		185,048,623		148,595,686				15,806,970	
System Input	16,358,877,599		8,662,689,043	1.073643	6,956,216,193	1.047409			739,972,363	1.021828
Losses + Diversion	924,858,000		594,189,627		314,861,403				15,806,970	

Table B-04

MPS ENERGY LOSS MULTIPLIERS

SERVICE LEVEL	Total System kWh	Total System Multiplier	Secondary Service kWh	Secondary Service Cumulative Multiplier	Primary Service kWh	Primary Service Cumulative Multiplier	Substation Service kWh	Substation Service Cumulative Multiplier	Transmission Service kWh	Transmission Service Cumulative Multiplier
Secondary		1.034093								
Sales	5,169,442,854		5,169,442,854							
Losses + Diversion	176,243,371		176,243,371							
Input to Primary	5,345,686,226		5,345,686,226	1.034093						
Primary		1.022808	5,345,686,226							
Primary Sales	459,421,984				459,421,984					
Primary Losses	132,404,492		121,925,870		10,478,622					
Input to Substation	5,937,512,701		5,467,612,096	1.057679	469,900,606	1.022808				
Substations			5,467,612,096		469,900,606					
Substation Sales	392,406,491						392,406,491			
Substation Losses	41,798,505		36,104,412		3,102,906		2,591,187			
put to Transmission	6,371,717,698		5,503,716,508	1.064663	473,003,512	1.029562	394,997,678	1.006603		
Transmission		1.016522	5,503,716,508		473,003,512		394,997,678			
ransmission Sales	22,442,016								22,442,016	
Losses	105,643,632		90,931,823		7,814,914		6,526,110		370,785	
System Input	6,499,803,346		5,594,648,331	1.082254	480,818,426	1.046573	401,523,788	1.023234	22,812,801	1.016522
Losses + Diversion	456,090,000		425,205,477		21,396,442		9,117,297		370,785	

Table B-05

SJLP ENERGY LOSS MULTIPLIERS

	Total System		Secondary Service		Primary Service		Substation Service		Transmission Service	
SERVICE LEVEL	kWh	Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier
Secondary		1.020675								
Sales	1,851,435,944		1,851,435,944							
Losses + Diversion	38,279,137		38,279,137							
Input to Primary	1,889,715,082		1,889,715,082	1.020675						
Primary		1.020115	1,889,715,082							
Primary Sales	147,131,728				147,131,728					
Primary Losses	40,970,303		38,010,811		2,959,492					
Input to Substation	2,077,817,113		1,927,725,893	1.041206	150,091,220	1.020115				
Substations		1.008904	1,927,725,893		150,091,220					
Substation Sales	80,099,832						80,099,832			
Substation Losses	19,213,185		17,163,661		1,336,349		713,175			
Input to Transmission	2,177,130,130		1,944,889,554	1.050476	151,427,569	1.029197	80,813,007	1.008904		
Transmission		1.013096	1,944,889,554		151,427,569		80,813,007			
Transmission Sales	70,218,894								70,218,894	
Losses	29,430,375		25,469,488		1,983,034		1,058,294		919,558	
System Input	2,276,779,398		1,970,359,041	1.064233	153,410,603	1.042675	81,871,302	1.022116	71,138,452	1.013096
Losses + Diversion	127,893,000		118,923,097		6,278,875		1,771,470		919,558	

Table B-06

KCPL- TOTAL SYSTEM ENERGY LOSS MULTIPLIERS

SERVICE LEVEL	Total System		Secondary Service		Primary Service		Substation Service		Transmission Service	
	kWh	Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier	kWh	Cumulative Multiplier
Secondary		1.027609								
Sales	15,089,378,214		15,089,378,214							
Losses + Diversion	416,610,116		416,610,116							
Input to Primary	15,505,988,330		15,505,988,330	1.027609						
Primary		1.018834	15,505,988,330							
Primary Sales	7,247,908,502				7,247,908,502					
Primary Losses	428,558,077		292,047,406		136,510,671					
Input to Transmission	23,182,454,909		15,798,035,736	1.046964	7,384,419,173	1.018834				
Substations		1.007573	15,798,035,736		7,384,419,173					
Substation Sales	472,506,323		0				472,506,323			
Substation Losses	179,147,522		119,644,202		55,924,860		3,578,460			
Input to Transmission	23,834,108,754		15,917,679,937	1.054893	7,440,344,034	1.026550	476,084,783	1.007573		
Transmission		1.019655	15,917,679,937		7,440,344,034		476,084,783			
Transmission Sales	816,826,303								816,826,303	
Losses	484,525,286		312,869,204		146,243,330		9,357,662		16,055,091	
System Input	25,135,460,343		16,230,549,141	1.075627	7,586,587,363	1.046728	485,442,445	1.027378	832,881,393	1.019655
Losses + Diversion	1,508,841,001		1,141,170,927		338,678,861		12,936,122		16,055,091	

Table B-07

KCPL-KANSAS COINCIDENT DEMAND LOSS MULTIPLIERS

SERVICE LEVEL	Total System		Secondary Service		Primary Service		Substation Service		Transmission Service	
	kW	Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier
Secondary		1.022545								
Sales	1,050,156		1,050,156							
Losses + Diversion	23,676		23,676							
Input to Primary	1,073,832		1,073,832	1.022545						
Primary		1.038189	1,073,832							
Primary Sales	379,773				379,773					
Primary Losses	55,511		41,008		14,503					
Input to Transmission	1,509,116		1,114,840	1.038189	394,276	1.038189				
			1,114,840		394,276					
Transmission		1.018689								
Transmission Sales	90,669								90,669	
Losses	29,899		20,836		7,369				1,695	
System Input	1,629,683		1,135,676	1.081435	401,644	1.057592			92,363	1.018689
Losses + Diversion	109,086		85,520		21,872				1,695	

Table B-08

KCPL- MISSOURI COINCIDENT DEMAND LOSS MULTIPLIERS

SERVICE LEVEL	Total System kW	Total System Multiplier	Secondary Service kW	Secondary Service Cumulative Multiplier	Primary Service kW	Primary Service Cumulative Multiplier	Substation Service kW	Substation Service Cumulative Multiplier	Transmission Service kW	Transmission Service Cumulative Multiplier
Secondary		1.021357								
Sales	942,208		942,208							
Losses + Diversion	20,123		20,123							
Input to Primary	962,331		962,331	1.021357						
Primary		1.038790	962,331							
Primary Sales	674,372				674,372					
Primary Losses	63,487		37,328		26,159					
Input to Transmission	1,700,190		999,659	1.060975	700,531	1.038790				
			999,659		700,531					
Transmission		1.021612								
Transmission Sales	67,979								67,979	
Losses	38,213		21,604		15,140				1,469	
System Input	106,192		1,021,263	1.083905	715,671	1.061239			69,448	1.021612
Losses + Diversion	121,823		79,056		41,298				1,469	

Table B-09

KCPL-KS & MO TOTAL COINCIDENT DEMAND LOSS MULTIPLIERS

SERVICE LEVEL	Total System		Secondary Service		Primary Service		Substation Service		Transmission Service	
	kW	Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier	kW	Cumulative Multiplier
Secondary		1.021688								
Sales	2,019,465		2,019,465							
Losses + Diversion	43,799		43,799							
Input to Primary	2,063,264		2,063,264	1.021688						
Primary		1.038458	2,063,264							
Primary Sales	1,030,943				1,030,943					
Primary Losses	118,998		79,350		39,648					
Input to Transmission	3,213,205		2,142,614	1.038458	1,070,591	1.038458				
			2,142,614		1,070,591					
		1.000170								
Transmission Sales	398,279,904								398,279,904	
Losses	68,112		363		182				67,567	
System Input	401,561,221		2,142,977	1.061161	1,070,773	1.038634			398,347,471	1.000170
Losses + Diversion	230,909		123,512		39,830				67,567	

Table B-10

MPS COINCIDENT DEMAND LOSS MULTIPLIERS

SERVICE LEVEL	Total System kW	Total System Multiplier	Secondary Service kW	Secondary Service Cumulative Multiplier	Primary Service kW	Primary Service Cumulative Multiplier	Substation Service kW	Substation Service Cumulative Multiplier	Transmission Service kW	Transmission Service Cumulative Multiplier
Secondary		1.034018								
Sales	1,211,550		1,211,550							
Losses + Diversion	41,215		41,215							
Input to Primary	1,252,765		1,252,765	1.034018						
Primary		1.042014	1,252,765							
Primary Sales	68,091				68,091					
Primary Losses	55,494		52,633		2,861					
Input to Substation	1,376,350		1,305,398	1.077461	70,952	1.042014				
Substations			1,305,398		70,952					
Substation Sales	61,002						61,002			
Substation Losses	6,841		6,213		338		290			
put to Transmission	1,444,192		1,311,611	1.082589	71,290	1.046973	61,292	1.004759		
Transmission		1.018830	1,311,611		71,290		61,292			
Transmission Sales	1,392								1,392	
Losses	27,220		24,697		1,342		1,154		26	
System Input	1,472,804		1,336,308	1.102974	72,632	1.066687	62,446	1.023679	1,418	1.018830
Losses + Diversion	130,770		124,759		4,541		1,444		26	

Table B-11

SJLP COINCIDENT DEMAND LOSS MULTIPLIERS

SERVICE LEVEL	Total System kW	Total System Multiplier	Secondary Service kW	Secondary Service Cumulative Multiplier	Primary Service kW	Primary Service Cumulative Multiplier	Substation Service kW	Substation Service Cumulative Multiplier	Transmission Service kW	Transmission Service Cumulative Multiplier
Secondary		1.022936								
Sales	343,995		343,995							
Losses + Diversion	7,890		7,890							
Input to Primary	351,885		351,885	1.022936						
Primary		1.029188	351,885							
Primary Sales	23,743				23,743					
Primary Losses	10,964		10,271		693					
Input to Substation	386,592		362,156	1.052794	24,436	1.029188				
Substations		1.006454	362,156		24,436					
Substation Sales	10,702						10,702			
Substation Losses	2,564		2,337		158		69			
nput to Transmission	399,857		364,493	1.059589	24,593	1.035831	10,771	1.006454		
Transmission		1.015876	364,493		24,593		10,771			
Transmission Sales	10,142								10,142	
Losses	6,509		5,787		390		171		161	
System Input	416,508		370,280	1.076410	24,984	1.052275	10,942	1.022432	10,303	1.015876
Losses + Diversion	27,927		26,285		1,241		240		161	

Table B-12										
KCPL- TOTAL SYSTEM COINCIDENT DEMAND LOSS MULTIPLIERS										
	Total System		**Secondary Service**		**Primary Service**		**Substation Service**		**Transmission Service**	
SERVICE LEVEL	**kW**	**Multiplier**	**kW**	**Cumulative Multiplier**	**kW**	**Cumulative Multiplier**	**kW**	**Cumulative Multiplier**	**kW**	**Cumulative Multiplier**
Secondary		1.026186								
Sales	3,547,908		3,547,908							
Losses + Diversion	92,904		92,904							
Input to Primary	3,640,812		3,640,812	1.026186						
Primary		1.033213	3,640,812							
Primary Sales	1,145,979				1,145,979					
Primary Losses	158,983		120,922		38,061					
Input to Transmission	4,945,774		3,761,734	1.060268	1,184,040	1.033213				
Substations			3,761,734		1,184,040					
Substation Sales	71,703						71,703			
Substation Losses	35,878		26,899		8,467		513			
Input to Transmission	5,053,355		3,788,633	1.067850	1,192,507	1.040601	72,216	1.007151		
Transmission		1.019497	3,788,633		1,192,507		72,216			
Transmission Sales	170,182								170,182	
Losses	101,841		73,865		23,250		1,408		3,318	
System Input	5,325,378		3,862,498	1.088669	1,215,756	1.060889	73,624	1.026787	173,499	1.019497
Losses + Diversion	389,606		314,590		69,778		1,921		3,318	

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Appendix

C

Corona Losses

Table C-1

KCPL-MO CORONA LOSSES

		LOSS			DEMAND LOSSES		ENERGY LOSSES		TOTAL LOSSES	
VOLTAGE	LENGTH OF CIRCUITS	NO RAIN	WITH RAIN	HOURS OF RAIN	COINCIDENT WITH NO RAIN	NON-COINCIDENT WITH RAIN	NO RAIN	RAIN	COINCIDENT DEMAND	ENERGY
KV	MILES	KW/MILE	KW/MILE	HOURS	KW	KW	KWH	KWH	KW	KWH
Kansas										
69		0	0.008	115	0.0	-	0	0	0.0	0
161	310.68	0.01	0.837	115	3.1	260.0	26,800	29,900	3.1	56,700
345	168.25	0.314	28.101	115	52.8	4,728.0	456,456	543,720	52.8	1,000,176
				SUBTOTAL	55.9	4,988.0	483,256	573,620	55.9	1,056,876
Missouri										
69	73.07	0	0.008	115	0.0	0.6	0	69	0.0	69
161	585.00	0.01	0.837	115	5.8	489.6	50,141	56,304	5.8	106,445
345	142.31	0.314	28.101	115	44.7	3,999.2	386,432	459,908	44.7	846,340
Total Kansas and Missouri										
				SUBTOTAL	50.5	4,489.4	436,573	516,281	50.5	952,854
69	73.07	0	0.008	115	0.0	0.6	0	69	0.0	69
161	895.68	0.01	0.837	115	9.0	749.7	77,805	86,216	9.0	164,021
345	310.57	0.314	28.101	115	97.5	8,727.2	842,888	1,003,628	97.5	1,846,516
				TOTALS	106.5	9,477.5	920,693	1,089,913	106.5	2,010,606

Table C-2

MPS and SJLP CORONA LOSSES

VOLTAGE	LENGTH OF CIRCUITS	LOSSES NO RAIN	LOSSES WITH RAIN	HOURS OF RAIN	DEMAND LOSSES COINCIDENT WITH NO RAIN	DEMAND LOSSES NON-COINCIDENT WITH RAIN	ENERGY LOSSES NO RAIN	ENERGY LOSSES RAIN	TOTAL LOSSES COINCIDENT DEMAND	TOTAL LOSSES ENERGY
KV	MILES	KW/MILE	KW/MILE	HOURS	KW	KW	KWH	KWH	KW	KWH
MPS Corona Losses										
69	422.79	0	0.008	115	0.0	3.4	0	391	0.0	391
161	459.02	0.01	0.837	115	4.6	384.2	39,767	44,183	4.6	83,950
345	57.63	0.314	28.101	115	18.1	1,619.5	156,475	186,243	18.1	342,718
				SUBTOTAL	22.7	2,007.1	196,242	230,817	22.7	427,059
						No-coincident Demand			2,007.1	
SJLP Corona Losses										
69	122.18	0	0.008	115	0.0	1.0	0	115	0.0	115
161	106.25	0.01	0.837	115	1.1	88.9	9,510	10,224	1.1	19,734
345	108.54	0.314	28.101	115	34.1	3,050.1	294,795	350,762	34.1	645,557
				SUBTOTAL	35.2	3,140.0	304,305	361,101	35.2	665,406
						No-coincident Demand			3,140.0	
MPS + SJPL TOTAL									57.9	1,092,465

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Appendix

D

Transformer Losses

Table D-01					
KCPL TRANSMISSION TRANSFORMER NO-LOAD LOSSES					
	VOLTAGE				
SUBSTATION	**HIGH SIDE**	**LOW SIDE**	**OA/FA/FOA**	**NO-LOAD LOSSES**	**ENERGY NO-LOAD LOSSES**
	KV	**KV**	**MVA**	**WATTS**	**KWH**
Kansas					
CRAIG 7	345	161	330/440/550	79,267	694,379
CRAIG 7	345	161	330/440/551	186,840	1,636,718
CRAIG 7	345	161	240/320/400	140,986	1,235,037
ODESSA	161	69	20	40,500	354,780
STILWEL7	345	161	330/440/550	177,663	1,556,328
STILWEL7	345	161	330/440/550	73,448	643,404
W.GRDNR7	345	161	240/320/400	175,227	1,534,989
Total Kansas				873,931	7,655,636
Missouri					
DUNCAN 5	161	69	36/48/60	28,656	251,027
HAWTH 7	345	161	300/400/500	211,000	1,848,360
HAWTH 7	345	161	330/440/550	80,018	700,958
HAWTHRN5	161	69	30	53,200	466,032
HAWTHRN5	161	69	30	44,230	387,455
IATAN 11	345/161	13.8	390/520/650	112,206	982,925
LBRTYST5	161	69	36/48/61	22,090	193,508
Liberty South	161	69	60	60,630	531,119
SWAVRLY5	161	69	20	40,500	354,780
Total Missouri				652,530	5,716,163
TOTAL				1,526,461	13,371,798
ESTIMATED					

Table D-02

MPS & SJLP TRANSMISSION TRANSFORMERS NO-LOAD LOSSES

Substation	High Side Voltage KV	Low Side Voltage KV	Rating OA/FA/FA/FOA MVA	No-Load Demand Loss KW	No-Load Energy Loss KWH
MPS Transmission Transformers					
Nevada 161-69	161	69	30/40/50	44.9	394,226
Nevada 161-69	161	69	30/40/50	45.0	395,280
South Harper	161	69	30/40/50	28.4	249,466
North Warsaw	161	69	30/40/50	44.9	394,402
Belton South	161	69	60/80/100	31.3	274,939
Liberty South	161	69	60	60.6	532,574
Clinton	161	69	50	69.3	608,731
Clinton	161	69	50	38.2	335,549
Harrisonville	161	69	30/40/50	44.9	394,226
Lexington	161	69	30/50	20.2	176,998
Roanridge	161	69	30/40/50	46.8	410,916
Odessa	161	69	20/27/33	40.0	351,360
Warrensburg East	161	69	50	78.8	692,179
Pleasant Hill 345	345	161	240/320/400	87.5	768,512
Pleasant Hill 345	161	69	60/80/100	78.8	692,179
Longview	161	69	60/80/100	71.8	630,691
Martin City	161	69	30/40/50	39.8	349,603
Sedalia West	161	69	100	58.8	516,763
Sedalia West	161	69	100	44.9	394,753
Sibley	161	69	100	106.5	935,724
Sibley	161	345	400	85.9	754,106
Peculiar 345	161	345	400	85.9	754,546
Stranger Creek	345	161	214/285/357/400	109.2	959,301
			Subtotal	1,362.4	11,967,023
SJLP Transmission Transformers					
Lake road	161	35	67	44.8	393,435
Lake road	161	35	67	44.8	393,435
Maryville	161	69	30/40/50	32.4	284,602
Maryville	161	69	30/40/50	32.9	288,994
Midway	161	69	30/40/50/56	14.47	127,104
St Joseph	345	161	336	67.5	592,920
St Joseph	345	161	336	69.3	608,292
			Subtotal	306.1	2,688,782
KCP&L GMOC Total				1,668.5	14,655,805
Note:		Values are estimated			

1 of 1

Table D-03							
KCPL GSU TRANSFORMER NO-LOAD LOSSES							
	VOLTAGE						
SUBSTATION	**LOW SIDE**	**HIGH SIDE**	**RATE A**	**RATE B**	**DEMAND NO-LOAD LOSSES**	**PLANT HOURS OF OPERATION**	**ENERGY NO-LOAD LOSSES**
	kV	**kV**	**MVA**	**MVA**	**WATTS**	**HOURS**	**KWH**
Missouri							
HAW G5 1	22.0	161	650	650	238,000	7921	1,885,198
HAW G9 1	13.8	161	147	147	161,000	7921	1,275,281
HAWCT6 1	16.0	161	200	200	70,144	7921	555,611
HAWCT7 1	13.8	161	100	100	36,176	232	8,393
HAWCT8 1	13.8	161	100	100	35,444	232	8,223
IAT G1 1	24.0	345	724	724	392,977	7753	3,046,751
IAT G2 1	25.0	345	1000	1000	409,959	7753	3,178,412
MONTG1 1	22.0	161	195	195	143,170	8416	1,204,919
MONTG2 1	22.0	161	195	195	143,720	8416	1,209,548
MONTG3 1	18.0	161	175	175	120,857	8416	1,017,133
NE CT1112	13.8	161	107		73,720	113	8,330
NE CT1314	13.8	161	140		81,380	113	9,196
NE CT1516	13.8	161	140		83,519	113	9,438
NE CT1718	13.8	161	120		87,010	113	9,832
Total Missouri					**2,077,076**		**13,426,263**
Kansas							
LAC G1 1	22.0	345	870	870	532,029	8077	4,297,198
LAC G2 1	24.0	345	724	724	468,572	8077	3,784,656
OSAWACT1	13.8	161	100	100	40,600	31	1,259
WG CT 1	13.8	161	100	100	38,554	93	3,586
WG CT 2	13.8	161	100	100	39,135	93	3,640
WG CT 3	13.8	161	100	100	38,752	93	3,604
WG CT 4	13.8	161	100	100	39,133	93	3,639
Total Kansas					**1,196,775**		**8,097,581**
TOTAL KS & MO					**3,273,851**		**21,523,844**
Estimated as same as IATAN G1 unit							

Table D-04

MPS-SJLP GSU TRANSFORMERS NO-LOAD LOSSES

Plant	High Side Voltage KV	Low Side Voltage KV	Rating OA/FA/FA/FOA MVA	No-Load Demand Losses KW	No-Load Energy Losses KWH
MPS GSU Transformers					
S.HARP#1	161	18	270	88.6	778,262
ARIESCT2	161	18	200	96.1	844,415
ARIESCT1	161	18	200	99.7	875,484
ARIESSTG	161	18	300	158.7	1,394,258
TWA 1	161	13	25	66.1	580,543
TWA 2	161	13	25	65.7	577,082
NEVADA#1	69	13.2	25	21.0	184,025
GRNWD#3&#4	161	13.2	70	108.2	950,429
GRDWD#1&#2	161	13.2	70	82.2	722,045
RGREEN#3	69	13.2	100	65.7	577,109
SIBLEY#1	69	13.2	45/60	46.9	411,970
SIBLEY#2	69	13.2	45/60	65.2	572,717
SIBLEY#3	161	22	450	220.1	1,933,253
			Sub Total	1,184.2	10,401,592
SJLP GSU Transformers					
LAKE RD 4	161	13.8	60/80/100/112	20.6	180,950
LAKE RD 1	34.5	13.2	18/24/30	12.3	108,043
LAKE RD 2	34.4	13.2	33	15.9	139,666
LAKE RD 3	34.5	13.2	12/16/20	10.4	91,354
LAKE RD 5	34.5	13.2	45/60/75/84	18.2	159,869
LAKE RD 6	34.5	13.8	18/24/30	12.3	108,043
LAKE RD 7	34.5	13.8	18/24/30	12.3	108,043
			Sub Total	102.0	895,968
KCP&L GMOC Total				1,286.2	11,297,560
		Values are estimated			
Note:		Values are from PSS/E Ratings			

Table D-05

KCPL KANSAS SUBSTATION TRANSFORMERS

Substation	Voltage	OA Rating	Peak Load	Transformer Rated No-load Loss	Transformer Rated Load Loss	No-load Peak Loss	No-load Energy Loss	Load Non-coincident Peak Loss	Load Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Antioch	161/12	18	13.352	30,728	74,005	31	269,177	41	108,875
Antioch	161/12	18	9.758	30,728	74,005	31	269,177	22	58,151
BNSF	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Brookridge	161/12	30	34.081	51,213	123,342	51	448,626	159	425,610
Brookridge	161/12	30	36.734	51,213	123,342	51	448,626	185	494,452
Brookridge	161/12	30	31.568	51,213	123,342	51	448,626	137	365,159
Brookridge	161/12	30	30.282	51,213	123,342	51	448,626	126	336,013
Brookridge	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Brookridge	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Brookridge	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Brookridge	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Bucyrus	161/12	18	4.454	30,728	74,005	31	269,177	5	12,115
Bucyrus	161/12	18	4.470	30,728	74,005	31	269,177	5	12,203
Cedar Creek	161/12	18	16.576	30,728	74,005	31	269,177	63	167,801
Cedar Creek	161/12	18	25.040	30,728	74,005	31	269,177	143	382,916
Cedar Niles	161/12	18	7.047	30,728	74,005	31	269,177	11	30,328
Cedar Niles	161/12	18	2.632	30,728	74,005	31	269,177	2	4,231
Centennial	161/12	18	9.614	30,728	74,005	31	269,177	21	56,447
Centennial	161/12	18	17.100	30,728	74,005	31	269,177	67	178,578
Centerville	161/34	15	13.000	25,607	61,671	26	224,317	46	123,852
Centerville	161/35	15	13.000	25,607	61,671	26	224,317	46	123,852
College	161/12	18	14.233	30,728	74,005	31	269,177	46	123,717
College	161/12	18	18.460	30,728	74,005	31	269,177	78	208,113
College	161/12	18	24.977	30,728	74,005	31	269,177	142	380,992

Table D-05

KCPL KANSAS SUBSTATION TRANSFORMERS

				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
College	161/12	18	20.843	30,728	74,005	31	269,177	99	265,311
Greenwood	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Greenwood	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Greenwood	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Kenilworth	161/12	30	36.333	51,213	123,342	51	448,626	181	483,716
Kenilworth	161/12	30	33.616	51,213	123,342	51	448,626	155	414,076
Kenilworth	161/12	30	27.697	51,213	123,342	51	448,626	105	281,095
Kenilworth	161/12	30	32.637	51,213	123,342	51	448,626	146	390,308
Kenilworth	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Kenilworth	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Kenilworth	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Kenilworth	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Lackman	161/12	18	7.143	30,728	74,005	31	269,177	12	31,160
Lenexa	161/12	18	5.250	30,728	74,005	31	269,177	6	16,833
Lenexa	161/12	15	16.541	25,607	61,671	26	224,317	75	200,512
Lenexa	161/12	30	34.138	51,213	123,342	51	448,626	160	427,035
Lenexa	161/12	15	23.516	25,607	61,671	26	224,317	152	405,270
Lenexa	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Louisburg	161/13	6	5.000	10,243	24,668	10	89,729	17	45,803
Merriam	161/12	30	31.793	51,213	123,342	51	448,626	139	370,383
Merriam	161/12	30	44.557	51,213	123,342	51	448,626	272	727,477
Merriam	161/12	30	31.857	51,213	123,342	51	448,626	139	371,875
Merriam	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Merriam	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Merriam	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852

Table D-05

KCPL KANSAS SUBSTATION TRANSFORMERS

Substation	Voltage	OA Rating	Peak Load	Transformer Rated No-load Loss	Transformer Rated Load Loss	No-load Peak Loss	No-load Energy Loss	Load Non-coincident Peak Loss	Load Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Moonlight	161/12	18	13.074	30,728	74,005	31	269,177	39	104,388
Moonlight	161/12	18	17.403	30,728	74,005	31	269,177	69	184,962
Mur-Len	161/12	18	23.281	30,728	74,005	31	269,177	124	331,008
Mur-Len	161/12	18	24.195	30,728	74,005	31	269,177	134	357,508
Mur-Len	161/12	18	21.167	30,728	74,005	31	269,177	102	273,624
Murlen	161/12	18	16.000	30,728	74,005	31	269,177	58	156,342
North Louisburg	161/12	18	16.404	30,728	74,005	31	269,177	61	164,337
North Louisburg	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Olathe	161/12	18	27.312	30,728	74,005	31	269,177	170	455,556
Olathe	161/12	18	22.792	30,728	74,005	31	269,177	119	317,249
Olathe	161/12	18	27.547	30,728	74,005	31	269,177	173	463,430
Olathe	161/12	15	21.592	25,607	61,671	26	224,317	128	341,667
Olathe	161/12	15	15.409	25,607	61,671	26	224,317	65	174,007
Olathe	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Olathe	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Overland Park	161/12	15	22.717	25,607	61,671	26	224,317	141	378,198
Overland Park	161/12	18	18.819	30,728	74,005	31	269,177	81	216,286
Overland Park	161/12	18	17.868	30,728	74,005	31	269,177	73	194,979
Oxford	161/12	18	18.255	30,728	74,005	31	269,177	76	203,516
Oxford	161/12	18	30.811	30,728	74,005	31	269,177	217	579,758
Oxford	161/12	18	23.593	30,728	74,005	31	269,177	127	339,939
Paola	161/34	18	10.649	30,728	74,005	31	269,177	26	69,255
Paola	161/34	18	10.198	30,728	74,005	31	269,177	24	63,513
Pflumm	161/12	18	18.919	30,728	74,005	31	269,177	82	218,591
Pflumm	161/12	18	10.264	30,728	74,005	31	269,177	24	64,338

Table D-05

KCPL KANSAS SUBSTATION TRANSFORMERS

Substation	Voltage	OA Rating	Peak Load	Transformer Rated No-load Loss	Transformer Rated Load Loss	No-load Peak Loss	No-load Energy Loss	Load Non-coincident Peak Loss	Load Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Pleasant Valley	161/34	18	8.062	30,728	74,005	31	269,177	15	39,694
Quarry	161/12	18	16.448	30,728	74,005	31	269,177	62	165,220
Quarry	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Randolph	161/12	18	17.671	30,728	74,005	31	269,177	71	190,703
Randolph	161/12	18	12.423	30,728	74,005	31	269,177	35	94,251
Redel	161/12	18	16.716	30,728	74,005	31	269,177	64	170,647
Redel	161/12	18	13.069	30,728	74,005	31	269,177	39	104,309
Reeder	161/12	18	17.602	30,728	74,005	31	269,177	71	189,217
Reeder	161/12	18	21.989	30,728	74,005	31	269,177	110	295,288
Riley	161/12	18	23.191	30,728	74,005	31	269,177	123	328,454
Riley	161/12	18	27.683	30,728	74,005	31	269,177	175	468,017
Riley	161/12	18	26.698	30,728	74,005	31	269,177	163	435,304
Riley	161/12	18	18.457	30,728	74,005	31	269,177	78	208,045
Riley	161/12	24	30.170	40,970	98,674	41	358,897	156	416,917
Roeland Park	161/12	30	36.298	51,213	123,342	51	448,626	181	482,784
Roeland Park	161/12	30	29.343	51,213	123,342	51	448,626	118	315,498
Roeland Park	161/12	15	19.693	25,607	61,671	26	224,317	106	284,211
Roeland Park	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Roeland Park	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Shawnee	161/12	15	13.899	25,607	61,671	26	224,317	53	141,574
Shawnee	161/12	15	16.569	25,607	61,671	26	224,317	75	201,192
Shawnee Mission	161/12	18	16.398	30,728	74,005	31	269,177	61	164,217
Shawnee Mission	161/12	18	19.779	30,728	74,005	31	269,177	89	238,915
Shawnee Mission	161/12	18	15.528	30,728	74,005	31	269,177	55	147,254
South Ottawa	161/34	18	20.810	30,728	74,005	31	269,177	99	264,472

Table D-05

KCPL KANSAS SUBSTATION TRANSFORMERS

Substation	Voltage	OA Rating	Peak Load	Transformer Rated No-load Loss	Transformer Rated Load Loss	No-load Peak Loss	No-load Energy Loss	Load Non-coincident Peak Loss	Load Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
South Ottawa	161/34	18	11.404	30,728	74,005	31	269,177	30	79,424
South Ottawa	161/34	18	11.404	30,728	74,005	31	269,177	30	79,424
Sprint	161/13	24	21.000	40,970	98,674	41	358,897	76	201,994
Sprint	161/13	24	21.000	40,970	98,674	41	358,897	76	201,994
Stilwell	161/12	18	9.663	30,728	74,005	31	269,177	21	57,024
Switzer	161/12	18	23.918	30,728	74,005	31	269,177	131	349,369
Switzer	161/12	18	13.729	30,728	74,005	31	269,177	43	115,110
Switzer	161/12	18	19.034	30,728	74,005	31	269,177	83	221,256
Switzer	161/12	18	21.823	30,728	74,005	31	269,177	109	290,847
Tomahawk	161/12	18	16.446	30,728	74,005	31	269,177	62	165,179
Tomahawk	161/12	15	22.832	25,607	61,671	26	224,317	143	382,037
Tomahawk	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Tomahawk	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Tomahawk	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Wagstaff	161/34	15	5.385	25,607	61,671	26	224,317	8	21,251
West Gardner	161/12	15	14.130	25,607	61,671	26	224,317	55	146,319
Total		2,148	2,099			3,694	32,121,833	9,204	24,625,361
Coincident Peak								9,155	

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Allied Signal	161/13/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Allied Signal	161/13/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Avondale	161/12	18	10.931	30,728	74,005	31	269,177	27	72,972
Avondale	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Avondale	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Avondale	161/12/13	30	28.442	51,213	123,342	51	448,626	111	296,420
Avondale	161/12/13	30	42.921	51,213	123,342	51	448,626	252	675,036
Avondale	161/12/13	30	31.096	51,213	123,342	51	448,626	133	354,321
Barry	161/12	18	15.124	30,728	74,005	31	269,177	52	139,691
Barry	161/12	18	12.228	30,728	74,005	31	269,177	34	91,316
Barry	161/12	18	17.621	30,728	74,005	31	269,177	71	189,625
Birmingham	161/12	12	15.775	20,485	49,337	20	179,449	85	227,965
Blue Mills	161/12	12	6.459	20,485	49,337	20	179,449	14	38,217
Blue Mills	161/12	12	8.231	20,485	49,337	20	179,449	23	62,063
Blue Springs	69/12	3.33	2.169	5,685	13,691	6	49,801	6	15,530
Blue Valley	161/13	36	10.128	61,456	148,010	61	538,355	12	31,322
Blue Valley	161/13	15	19.597	25,607	61,671	26	224,317	105	281,447
Blue Valley	161/13	36	36.480	61,456	148,010	61	538,355	152	406,364
Blue Valley	161/13	36	31.000	61,456	148,010	61	538,355	110	293,446
Blue Valley	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Brunswick	161/34	10	7.850	17,071	41,114	17	149,542	25	67,740
Bunker Ridge	161/12	12	15.076	20,485	49,337	20	179,449	78	208,210
Bunker Ridge	161/12	12	4.143	20,485	49,337	20	179,449	6	15,724
Carrollton	161/34	18	12.374	30,728	74,005	31	269,177	35	93,509

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Carrollton	161/34	18	19.454	30,728	74,005	31	269,177	86	231,128
Chouteau	161/13	18	19.192	30,728	74,005	31	269,177	84	224,945
Claycomo	161/12	30	32.345	51,213	123,342	51	448,626	143	383,356
Claycomo	161/12	30	27.127	51,213	123,342	51	448,626	101	269,644
Claycomo	161/12	18	4.100	30,728	74,005	31	269,177	4	10,266
Claycomo	161/13/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Claycomo		30	26.000	51,213	123,342	51	448,626	93	247,705
Corder	69/12	7.5	2.507	12,803	30,836	13	112,154	3	9,212
Courtney	161/12	7.5	6.000	12,803	30,836	13	112,154	20	52,766
Courtney	69/12	7.5	8.200	12,803	30,836	13	112,154	37	98,556
Crosstown	161/13	30	35.492	51,213	123,342	51	448,626	173	461,582
Crosstown	161/13	30	33.461	51,213	123,342	51	448,626	153	410,266
Crosstown	161/13	30	35.101	51,213	123,342	51	448,626	169	451,468
Crosstown	161/13	30	29.284	51,213	123,342	51	448,626	118	314,231
Crosstown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Crosstown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Crosstown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Crosstown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Grandview West	69/8	12	9.089	20,485	49,337	20	179,449	28	75,677
Green Street	69/12	15	16.200	25,607	61,671	26	224,317	72	192,330
Forest	161/13	30	32.342	51,213	123,342	51	448,626	143	383,285
Forest	161/13	30	41.298	51,213	123,342	51	448,626	234	624,950
Forest	161/13	15	25.253	25,607	61,671	26	224,317	175	467,351
Forest	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Gladstone	161/12	30	44.628	51,213	123,342	51	448,626	273	729,798

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Gladstone	161/12	30	28.503	51,213	123,342	51	448,626	111	297,693
Gladstone	161/12	30	39.819	51,213	123,342	51	448,626	217	580,989
Gladstone	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Gladstone	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Gladstone	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Grand Avenue	161/13	24	22.301	40,970	98,674	41	358,897	85	227,797
Grand Avenue	161/13	24	23.843	40,970	98,674	41	358,897	97	260,388
Grand Avenue	161/13	24	18.113	40,970	98,674	41	358,897	56	150,273
Grand Avenue	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Grand Avenue	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Grand Avenue	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Hawthorn	161/13	40	12.223	68,284	164,456	68	598,168	15	41,059
Hawthorn	161/13	40	18.803	68,284	164,456	68	598,168	36	97,163
Hickman	161/12	18	23.766	30,728	74,005	31	269,177	129	344,943
Hickman	161/12	18	18.659	30,728	74,005	31	269,177	80	212,624
Hickman	161/12	15	15.796	25,607	61,671	26	224,317	68	182,857
Higginsville	69/12	2	0.313	3,414	8,223	3	29,907	-	538
Higginsville		15	13.000	25,607	61,671	26	224,317	46	123,852
Leeds	161/13	30	36.502	51,213	123,342	51	448,626	183	488,226
Leeds	161/13	15	24.909	25,607	61,671	26	224,317	170	454,705
Leeds	161/13	30	34.158	51,213	123,342	51	448,626	160	427,536
Leeds	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Leeds	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Leeds	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Line Creek	161/12	18	10.781	30,728	74,005	31	269,177	27	70,983

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Line Creek	161/12	18	25.269	30,728	74,005	31	269,177	146	389,952
Line Creek	161/12	18	14.427	30,728	74,005	31	269,177	48	127,112
Loma Vista	161/12	18	15.085	30,728	74,005	31	269,177	52	138,972
Loma Vista	161/12	18	29.546	30,728	74,005	31	269,177	199	533,129
Loma Vista	161/12	15	10.628	25,607	61,671	26	224,317	31	82,779
Loma Vista	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Malta Bend	161/12	48	7.182	81,941	197,347	82	717,803	4	11,813
Martin City	161/12	18	15.894	30,728	74,005	31	269,177	58	154,277
Martin City	161/12	18	22.255	30,728	74,005	31	269,177	113	302,476
Martin City	161/12	18	16.727	30,728	74,005	31	269,177	64	170,872
Midtown	161/13	25	32.234	42,678	102,785	43	373,859	171	456,875
Midtown	161/13	30	38.118	51,213	123,342	51	448,626	199	532,412
Midtown	161/13	30	33.062	51,213	123,342	51	448,626	150	400,540
Midtown	161/13	30	51.363	51,213	123,342	51	448,626	362	966,692
Midtown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Midtown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Midtown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Navy	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
North Kansas City	161/13	18	9.330	30,728	74,005	31	269,177	20	53,162
North Kansas City	161/13	18	17.072	30,728	74,005	31	269,177	67	177,993
North Kansas City	161/13	18	14.365	30,728	74,005	31	269,177	47	126,022
North Kansas City	161/13	15	17.343	25,607	61,671	26	224,317	82	220,428
Northeast	161/13	30	42.610	51,213	123,342	51	448,626	249	665,289
Northeast	161/13	30	31.035	51,213	123,342	51	448,626	132	352,932
Northeast	161/13	25	10.206	42,678	102,785	43	373,859	17	45,802

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Northeast	161/13	18	23.159	30,728	74,005	31	269,177	123	327,548
Northeast	161/13	25	27.426	42,678	102,785	43	373,859	124	330,745
Norton	161/34	10	12.026	17,071	41,114	17	149,542	59	158,983
Riverside	161/12	12	16.925	20,485	49,337	20	179,449	98	262,414
Riverside	161/12	18	19.239	30,728	74,005	31	269,177	85	226,048
Salisbury	161/34	10	10.824	17,071	41,114	17	149,542	48	128,791
Salisbury	161/34	18	17.109	30,728	74,005	31	269,177	67	178,766
Shoal Creek	161/12	18	19.882	30,728	74,005	31	269,177	90	241,410
Shoal Creek	161/12	18	18.521	30,728	74,005	31	269,177	78	209,490
South Waverly	161/34	15	11.930	25,607	61,671	26	224,317	39	104,303
Southtown	161/13	25	17.789	42,678	102,785	43	373,859	52	139,146
Southtown	161/13	15	18.985	25,607	61,671	26	224,317	99	264,143
Southtown	161/13	25	20.224	42,678	102,785	43	373,859	67	179,847
Southtown	161/13	18	16.293	30,728	74,005	31	269,177	61	162,120
Southtown	161/13	30	35.843	51,213	123,342	51	448,626	176	470,756
Southtown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Southtown	161/13	15	13.000	25,607	61,671	26	224,317	46	123,852
Sugar Creek	69/4	3.75	1.600	6,402	15,418	6	56,082	3	7,505
Sugar Creek	69/4	1.5	0.770	2,561	6,167	3	22,434	2	4,345
Sugar Creek	69/4	3.75	3.130	6,402	15,418	6	56,082	11	28,719
Swope	161/12	18	11.453	30,728	74,005	31	269,177	30	80,108
Swope	161/12	18	11.731	30,728	74,005	31	269,177	31	84,044
Terrace	161/13	18	17.890	30,728	74,005	31	269,177	73	195,459
Terrace	161/13	18	19.438	30,728	74,005	31	269,177	86	230,748
Terrace	161/13	18	8.684	30,728	74,005	31	269,177	17	46,055

Table D-06

KCPL MISSOURI SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	**Voltage**	**OA Rating**	**Peak Load**	**Rated No-load Loss**	**Rated Load Loss**	**Peak Loss**	**Energy Loss**	**Non-coincident Peak Loss**	**Energy Loss**
	kV	**MVA**	**MVA**	**Watt**	**Watt**	**kW**	**kWh**	**kW**	**kWh**
Tiffany Springs	161/12	15	14.336	25,607	61,671	26	224,317	56	150,617
Tiffany Springs	161/12	18	12.504	30,728	74,005	31	269,177	36	95,485
Tiffany Springs	161/12	18	11.744	30,728	74,005	31	269,177	32	84,230
Tomahawk	161/12	18	40.582	30,728	74,005	31	269,177	376	1,005,778
Troost	161/13	18	16.000	30,728	74,005	31	269,177	58	156,342
Weatherby	161/12	18	12.968	30,728	74,005	31	269,177	38	102,703
Weatherby	161/12	15	14.269	25,607	61,671	26	224,317	56	149,212
Weatherby	161/12	30	35.555	51,213	123,342	51	448,626	173	463,222
Weatherby	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
Weatherby	161/12	15	13.000	25,607	61,671	26	224,317	46	123,852
West Higginsville	69/12	3.75	0.814	6,402	15,418	6	56,082	1	1,942
		2,595	2,473			4,446	38,800,099	10,834	28,998,301
Coincident Demand						4,446		10,603	

Table D-07

MPS SUBSTATION TRANSFORMERS

				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Adrian	161/12	10	2.216	17,071	41,114	17	149,542	1	1,971
Adrian	161/25	18	5.001	30,728	74,005	74	648,284	2	5,576
Amoco (Service Pipel	69/2.4	3	2.340	5,121	12,334	5	44,860	3	7,325
Amoco (Service Pipel	69/2.4	3	0.180	5,121	12,334	5	44,860	-	43
Appleton City	69/12	7.5	2.976	12,803	30,836	13	112,154	2	4,739
Appleton City	69/34	3	1.438	5,121	12,334	5	44,860	1	2,766
Belton City	69/4	3.75	2.868	6,402	15,418	6	56,082	4	8,803
Belton South	161/12	18	8.223	30,728	74,005	31	269,177	6	15,077
Belton South	69/12	15	12.669	25,607	61,671	26	224,317	18	42,944
Belton South	69/12	15	18.254	25,607	61,671	26	224,317	38	89,154
Blue Ridge	69/12	7.5	2.752	12,803	30,836	13	112,154	2	4,053
Blue Springs East	161/12	15	12.871	25,607	61,671	26	224,317	19	44,325
Blue Springs East	161/12	15	16.440	25,607	61,671	26	224,317	31	72,315
Blue Springs East	161/12	15	14.188	25,607	61,671	26	224,317	23	53,860
Blue Springs South	161/12	18	11.761	30,728	74,005	31	269,177	13	30,841
Blue Springs South	161/12	18	0.779	30,728	74,005	31	269,177	-	135
Blue Springs West	161/12	15	17.832	25,607	61,671	26	224,317	36	85,079
Blue Springs West	161/12	15	17.825	25,607	61,671	26	224,317	36	85,012
Blythedale/Eagleville	34/12	3.75	1.528	6,402	15,418	6	56,082	1	2,499
Centerview	69/12	3	1.800	5,121	12,334	5	44,860	2	4,334
Clinton Plant	69/12	15	13.932	25,607	61,671	26	224,317	22	51,934
Clinton Plant	69/13	15	11.000	25,607	61,671	26	224,317	14	32,375
Clinton Plant	69/34/2.4	12.5	9.000	21,339	51,393	21	186,930	11	26,007
Cole Camp Jct	69/34	11.2	7.127	19,120	46,048	19	167,491	8	18,202
Concordia 69	69/12	15	6.283	25,607	61,671	26	224,317	4	10,562

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Concordia 69	69/12	5	2.812	8,536	20,557	9	74,775	3	6,347
Concordia 69	69/34	6	2.615	10,243	24,668	10	89,729	2	4,574
Duncan Road	161/12	18	20.079	30,728	74,005	31	269,177	38	89,893
Duncan Road	161/12	18	21.847	30,728	74,005	31	269,177	45	106,420
Elm	69/12	5.6	4.139	9,560	23,024	10	83,746	5	12,278
Ferrelview	161/25	30	13.830	51,213	123,342	51	448,626	11	25,588
Ferrelview	161/25	30	25.596	51,213	123,342	51	448,626	37	87,647
Frost Road	161/12	25	15.358	42,678	102,785	43	373,859	16	37,865
Frost Road	161/12	25	20.319	42,678	102,785	43	373,859	28	66,279
Grain Valley	161/12	18	18.796	30,728	74,005	31	269,177	34	78,772
Grandview City	69/8	7.5	6.469	12,803	30,836	13	112,154	10	22,394
Grandview City	69/8	7.5	6.198	12,803	30,836	13	112,154	9	20,557
Grandview East	161/12	15	14.861	25,607	61,671	26	224,317	25	59,091
Grandview East	161/12	18	11.108	30,728	74,005	31	269,177	12	27,511
Grandview West	69/8	12	11.590	20,485	49,337	20	179,449	19	44,926
Grandview West	69/8	12	9.089	20,485	49,337	20	179,449	12	27,629
Green Street	69/12	15	16.200	25,607	61,671	26	224,317	30	70,219
Hallmark	161/12.47	15	15.553	25,607	61,671	26	224,317	28	64,722
Hallmark	161/12.47	15	1.655	25,607	61,671	26	224,317	-	733
Harris Road	161/12	15	5.835	25,607	61,671	26	224,317	4	9,110
Harrisonville Anacond	69/4	1.5	1.728	2,561	6,167	3	22,434	3	7,989
Harrisonville West	69/12	7.5	1.870	12,803	30,836	13	112,154	1	1,871
Holden	69/4	7.5	5.376	12,803	30,836	13	112,154	7	15,466
Honeywell	161/12	18	4.305	30,728	74,005	31	269,177	2	4,132
Honeywell	161/12	18	4.202	30,728	74,005	31	269,177	2	3,937
Hook Road	161/12	15	14.321	25,607	61,671	26	224,317	23	54,874

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Hook Road	161/12	18	18.750	30,728	74,005	31	269,177	33	78,387
Hwy 13 & 40 Jct.	69/12	1.5	1.255	2,561	6,167	3	22,434	2	4,214
Jamesport	69/12	7.5	2.528	12,803	30,836	13	112,154	1	3,420
KC South	161/12	15	12.224	25,607	61,671	26	224,317	17	39,981
KC South	161/12	18	4.633	30,728	74,005	31	269,177	2	4,786
KCI	161/12	15	4.766	25,607	61,671	26	224,317	3	6,078
KCI	161/12	15	7.434	25,607	61,671	26	224,317	6	14,787
Kelsey Hayes	69/4	7.5	3.961	12,803	30,836	13	112,154	4	8,396
Kelsey Hayes	69/4	3.5	2.798	5,975	14,390	6	52,341	4	8,977
Kelsey Hayes	69/4	3.5	3.342	5,975	14,390	6	52,341	5	12,807
Kelsey Hayes	69/4	3.5	1.777	5,975	14,390	6	52,341	2	3,621
Kelsey Hayes	69/4	3.5	1.777	5,975	14,390	6	52,341	2	3,621
Kingsville	69/12	3.75	5.328	6,402	15,418	6	56,082	13	30,382
Knob Noster	69/12	7.5	8.496	12,803	30,836	13	112,154	16	38,626
Lake Winnebago	161/12	15	7.228	25,607	61,671	26	224,317	6	13,978
Lake Winnebago	161/12	15	16.299	25,607	61,671	26	224,317	30	71,080
Lakewood	161/12	15	17.298	25,607	61,671	26	224,317	34	80,060
Lakewood	161/12	15	14.846	25,607	61,671	26	224,317	25	58,971
Lamar	69/34	3	3.729	5,121	12,334	5	44,860	8	18,603
Lamonte	69/12	5	1.656	8,536	20,557	9	74,775	1	2,201
Laredo	69/12	7.5	1.835	12,803	30,836	13	112,154	1	1,802
Lees Summit East	161/12	18	24.556	30,728	74,005	31	269,177	57	134,449
Lees Summit East	161/12	18	20.716	30,728	74,005	31	269,177	41	95,687
Lees Summit East	161/12	18	7.930	30,728	74,005	31	269,177	6	14,021
Lexington	69/12	12	17.723	20,485	49,337	20	179,449	45	105,053
Lexington	69/13	12	9.000	20,485	49,337	20	179,449	12	27,091

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Liberty Moss St	69/12	12	10.073	20,485	49,337	20	179,449	14	33,935
Liberty Moss St	69/12	12	11.698	20,485	49,337	20	179,449	19	45,767
Liberty Moss St	69/12	12	11.094	20,485	49,337	20	179,449	18	41,163
Liberty South	161/12	15	10.740	25,607	61,671	26	224,317	13	30,863
Liberty South	161/12	18	5.757	30,728	74,005	31	269,177	3	7,390
Liberty West	161/12	15	18.760	25,607	61,671	26	224,317	40	94,165
Liberty West	161/12	18	21.964	30,728	74,005	31	269,177	46	107,563
Liberty West	161/12	18	3.035	30,728	74,005	31	269,177	1	2,054
Longview	161/12	15	13.596	25,607	61,671	26	224,317	21	49,459
Longview	161/12	15	17.357	25,607	61,671	26	224,317	34	80,607
Metz	69/34	10	1.148	17,071	41,114	17	149,542	-	529
Nevada 3M	69/12	12	13.106	20,485	49,337	20	179,449	24	57,448
Nevada 3M	69/12	12	13.515	20,485	49,337	20	179,449	26	61,089
Nevada Plant	69/12	12	0.004	20,485	49,337	20	179,449	-	-
Nevada Plant	69/12	15	14.115	25,607	61,671	26	224,317	23	53,307
Oak Grove	161/12	15	14.316	25,607	61,671	26	224,317	23	54,836
Oak Grove	161/12	15	3.387	25,607	61,671	26	224,317	1	3,069
Orrick	161/12	7.5	3.824	12,803	30,836	13	112,154	3	7,825
Osceola 161	161/34	18	5.649	30,728	74,005	31	269,177	3	7,115
Peculiar	161/12	18	9.523	30,728	74,005	31	269,177	9	20,220
Platte City	161/25	18	27.066	30,728	74,005	31	269,177	69	163,339
Platte City	161/25	18	13.000	30,728	74,005	31	269,177	16	37,681
Pope Lane	161/13.8	12	9.327	20,485	49,337	20	179,449	12	29,095
Pope Lane	161/25	30	1.586	51,213	123,342	51	448,626	-	337
Post Oak 69/34kV	69/34	10	4.899	17,071	41,114	17	149,542	4	9,632
Prairie Lee	161/12	15	6.890	25,607	61,671	26	224,317	5	12,702

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Prairie Lee	161/12	15	15.841	25,607	61,671	26	224,317	29	67,141
Ralph Green	69/12	10	12.928	17,071	41,114	17	149,542	29	67,077
Ralph Green	69/12	15	7.935	25,607	61,671	26	224,317	7	16,847
Ralph Green	69/34	12	4.107	20,485	49,337	20	179,449	2	5,641
Raymore	69/12	15	13.638	25,607	61,671	26	224,317	21	49,765
Raymore	69/12	15	18.143	25,607	61,671	26	224,317	37	88,073
Raymore North	161/12	18	6.141	30,728	74,005	31	269,177	4	8,409
Raytown No. 1	161/12	21	18.108	35,849	86,339	36	314,037	27	62,667
Raytown No. 1	161/12	21	18.769	35,849	86,339	36	314,037	29	67,325
Rich Hill	69/12	3.75	2.481	6,402	15,418	6	56,082	3	6,588
Richard Gebaur	69/4	3.75	3.858	6,402	15,418	6	56,082	7	15,930
Richard Gebaur	69/4	3.75	3.000	6,402	15,418	6	56,082	4	9,632
Richmond	161/12	15	9.327	25,607	61,671	26	224,317	10	23,276
Richmond	161/12	15	12.046	25,607	61,671	26	224,317	17	38,825
Sedalia East	161/12	15	11.329	25,607	61,671	26	224,317	15	34,340
Sedalia East	161/12	15	10.727	25,607	61,671	26	224,317	13	30,788
Sedalia Pittsburg-Cor	69/12	5.6	4.248	9,560	23,024	10	83,746	6	12,933
Sedalia Plant, 9th & I	69/12	12	14.930	20,485	49,337	20	179,449	32	74,551
Sedalia West	161/12	15	16.078	25,607	61,671	26	224,317	29	69,165
Sedalia West	161/12	15	15.449	25,607	61,671	26	224,317	27	63,859
Sedalia West	161/12	18	21.693	30,728	74,005	31	269,177	45	104,925
Service Pipe Line	69/2.4	3.75	2.340	6,402	15,418	6	56,082	2	5,860
Service Pipe Line	69/2.4	1.5	0.180	2,561	6,167	3	22,434	-	87
Sheldon	69/12	1.5	1.692	2,561	6,167	3	22,434	3	7,660
Sibley	69/12	12	8.212	20,485	49,337	20	179,449	10	22,554
Smithville	161/13.8	12	11.061	20,485	49,337	20	179,449	17	40,919

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Staley Road	69/12	15	16.111	25,607	61,671	26	224,317	30	69,449
Staley Road	69/12	15	14.059	25,607	61,671	26	224,317	22	52,885
Strother Road	161/12	15	18.475	25,607	61,671	26	224,317	39	91,325
Strother Road	161/12	18	13.000	30,728	74,005	31	269,177	16	37,681
Trenton	69/12	3.75	2.082	6,402	15,418	6	56,082	2	4,639
Trenton	69/34	7.5	0.813	12,803	30,836	13	112,154	-	354
Trenton	69/4	3.75	1.225	6,402	15,418	6	56,082	1	1,606
Turner Road	161/12	18	7.937	30,728	74,005	31	269,177	6	14,046
Turner Road	161/12	18	9.884	30,728	74,005	31	269,177	9	21,782
TWA	161/12	15	3.336	25,607	61,671	26	224,317	1	2,978
TWA	161/12	15	2.814	25,607	61,671	26	224,317	1	2,119
Urich	69/12	3.75	2.700	6,402	15,418	6	56,082	3	7,802
Warrensburg East	161/12	18	22.361	30,728	74,005	31	269,177	47	111,487
Warrensburg East	69/12	12	14.135	20,485	49,337	20	179,449	28	66,823
Warrensburg Plant	69/12	12	13.255	20,485	49,337	20	179,449	25	58,761
Warrensburg Plant	69/12	12	13.016	20,485	49,337	20	179,449	24	56,661
Warrensburg Plant	69/4	3.75	1.595	6,402	15,418	6	56,082	1	2,723
Warsaw	69/12	7.5	3.370	12,803	30,836	13	112,154	3	6,077
Warsaw	69/12	7.5	5.766	12,803	30,836	13	112,154	8	17,791
Western Electric	161/12	18	27.057	30,728	74,005	31	269,177	69	163,230
Western Electric	161/12	18	26.606	30,728	74,005	31	269,177	67	157,834
Western Electric	161/12	18	18.759	30,728	74,005	31	269,177	33	78,462
Western Electric	161/12	25	19.340	42,678	102,785	43	373,859	26	60,046
Whiteman AFB East	161/12	25	12.982	42,678	102,785	43	373,859	12	27,056
Whiteman AFB West	161/12	15	3.372	25,607	61,671	26	224,317	1	3,042
Windsor	161/12	18	6.028	30,728	74,005	31	269,177	3	8,102

Table D-07

MPS SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Total		1,994				3,479	30,304,958	2,408	5,662,622
Coincident Demad						3,479		2,408	

Table D-08

SJLP SUBSTATION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Alabama Street	161/12	18	11.906	30,728	74,005	74	648,284	13	43,766
Alabama Street	161/12	18	12.613	30,728	74,005	74	648,284	15	49,118
Brown's Curve	69/12	1.5	0.785	2,561	6,167	6	54,023	1	2,283
Brown's Curve	69/34	7.5	6.371	12,803	30,836	31	270,123	9	30,077
Burlington Junction	69/12	2.5	2.798	4,268	10,279	10	90,044	5	17,403
Cook Road	161/12	18	20.411	30,728	74,005	74	648,284	40	128,628
Cook Road	161/12	18	21.438	30,728	74,005	74	648,284	44	141,898
East Side	161/12	15	18.357	25,607	61,671	62	540,238	38	124,851
East Side	161/12	15	18.832	25,607	61,671	62	540,238	40	131,396
East Side	161/34	36	25.209	61,456	148,010	148	1,296,568	30	98,104
East Side	161/34	36	49.094	61,456	148,010	148	1,296,568	114	372,078
Edmond Street	161/12	18	9.369	30,728	74,005	74	648,284	8	27,101
Edmond Street	161/12	40	7.116	68,284	164,456	164	1,440,635	2	7,035
Edmond Street	161/34	18	2.971	30,728	74,005	74	648,284	1	2,725
Edmond Street	161/69	30	13.796	51,213	123,342	123	1,080,476	11	35,259
Fairfax	69/12	2.5	2.512	4,268	10,279	10	90,044	4	14,027
Fillmore Street	69/12	5	6.788	8,536	20,557	21	180,079	16	51,214
Fillmore Street	69/12	7.5	0.624	12,803	30,836	31	270,123	-	289
Fillmore Street	69/12	7.5	5.935	12,803	30,836	31	270,123	8	26,101
Fillmore Street	69/12	7.5	0.707	12,803	30,836	31	270,123	-	371
Industrial Park	161/34	20	20.694	34,142	82,228	82	720,317	37	118,998
Industrial Park	161/34	20	27.863	34,142	82,228	82	720,317	66	215,727
Kellog	69/12	7.5	3.237	12,803	30,836	31	270,123	2	7,764
Kellog	69/34	7.5	3.645	12,803	30,836	31	270,123	3	9,845
Lake Road	161/34	40	46.520	68,284	164,456	164	1,440,635	92	300,676
Lake Road	161/34	40	44.584	68,284	164,456	164	1,440,635	85	276,171
Maryville	161/12	18	8.069	30,728	74,005	74	648,284	6	20,102

Table D-08

SJLP SUBSTATION TRANSFORMERS

				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Maryville	161/69/13	30	19.000	51,213	123,342	123	1,080,476	21	66,875
Maryville	161/69/13	30	19.000	51,213	123,342	123	1,080,476	21	66,875
Maryville	69/12	8.4	5.067	14,340	34,536	35	302,535	5	16,986
Maryville	69/13	7.5	5.000	12,803	30,836	31	270,123	6	18,525
Maryville	69/34	7.5	4.766	12,803	30,836	31	270,123	5	16,832
Maryville	69/34	7.5	2.018	12,803	30,836	31	270,123	1	3,018
Mound City	69/12	3.75	2.829	6,402	15,418	15	135,062	4	11,861
Mound City	69/12	3.75	1.953	6,402	15,418	15	135,062	2	5,653
Nodaway	69/12	7.5	3.912	12,803	30,836	31	270,123	3	11,340
Nodaway	69/12	7.5	8.412	12,803	30,836	31	270,123	16	52,434
North Ward (Craig)	69/12	1.5	0.833	2,561	6,167	6	54,023	1	2,571
Pickering	69/12	1.5	1.924	2,561	6,167	6	54,023	4	13,715
Savannah	69/12	7.5	7.381	12,803	30,836	31	270,123	12	40,369
Savannah	69/12	7.5	3.354	12,803	30,836	31	270,123	3	8,336
Savannah	69/12	7.5	4.515	12,803	30,836	31	270,123	5	15,105
Tarkio	69/12	3.75	1.873	6,402	15,418	15	135,062	2	5,199
Tarkio	69/12	5	4.102	8,536	20,557	21	180,079	6	18,703
Woodbine	161/12	18	21.188	30,728	74,005	74	648,284	43	138,607
Woodbine		3.75	2.000	6,402	15,418	15	135,062	2	5,928
		644				2,646	23,190,671	852	2,771,939
Coincident Demand						2,646		819	

Table D-09

KCPL KANSAS DISTRIBUTION TO DISTRIBUTION TRANSFORMERS

				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Baldwin	34/12	7.5	3.585	12,803	30,836	13	112,154	7	18,838
Baldwin	34/12	3.75	2.959	6,402	15,418	6	56,082	10	25,667
Beagle	34/12	1.5	1.224	2,561	6,167	3	22,434	4	10,979
Beagle	34/12	1.5	1.188	2,561	6,167	3	22,434	4	10,343
Beagle	34/12	1.5	1.000	2,561	6,167	3	22,434	3	7,328
Bush City	34/12	3.75	2.700	6,402	15,418	6	56,082	8	21,370
Center Street	34/12	3	2.800	5,121	12,334	5	44,860	11	28,727
Chiles	34/12	7.5	3.931	12,803	30,836	13	112,154	8	22,650
Chiles	34/12	7.5	3.845	12,803	30,836	13	112,154	8	21,669
Drexel Corners	34/12	3	1.188	5,121	12,334	5	44,860	2	5,171
Drexel Corners	34/12	3	0.302	5,121	12,334	5	44,860	-	334
Edgerton	34/12	3.75	3.121	6,402	15,418	6	56,082	11	28,554
Edgerton	34/12	3.75	1.979	6,402	15,418	6	56,082	4	11,481
Greeley	34/12	3	2.973	5,121	12,334	5	44,860	12	32,387
Holly Street	34/12	3	2.532	5,121	12,334	5	44,860	9	23,491
Lakeview	34/13	7.5	6.000	12,803	30,836	13	112,154	20	52,766
Lakeview	34/13	7.5	6.000	12,803	30,836	13	112,154	20	52,766
Lane	34/12	7.5	2.642	12,803	30,836	13	112,154	4	10,231
Linn Valley	34/12	7.5	2.984	12,803	30,836	13	112,154	5	13,051
Linn Valley	34/12	7.5	2.984	12,803	30,836	13	112,154	5	13,051
Michigan Valley	34/12	7.5	6.696	12,803	30,836	13	112,154	25	65,718
Michigan Valley	34/13	6	5.000	10,243	24,668	10	89,729	17	45,803
Mound City	34/12	3.75	2.970	6,402	15,418	6	56,082	10	25,858
Parker	34/12	3.75	0.962	6,402	15,418	6	56,082	1	2,713

Table D-09

KCPL KANSAS DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Parker	34/12	3.75	0.962	6,402	15,418	6	56,082	1	2,713
Prescott	34/12	3.75	0.608	6,402	15,418	6	56,082	-	1,084
Prescott	34/12	3.75	0.608	6,402	15,418	6	56,082	-	1,084
Pressonville	34/12	3.75	5.400	6,402	15,418	6	56,082	32	85,481
Ransomville	34/12	1.5	1.080	2,561	6,167	3	22,434	3	8,548
Richland	34/12	1.5	1.476	2,561	6,167	3	22,434	6	15,966
Richland	34/12	1.5	1.476	2,561	6,167	3	22,434	6	15,966
Rock Creek	34/12	3.75	2.800	6,402	15,418	6	56,082	9	22,983
Rock Creek	34/12	3.75	0.900	6,402	15,418	6	56,082	1	2,374
Sand Creek	34/12	12	2.527	20,485	49,337	20	179,449	2	5,850
Sand Creek	34/12	3.75	2.160	6,402	15,418	6	56,082	5	13,677
Six Mile	34/12	3.75	2.916	6,402	15,418	6	56,082	9	24,926
Six Mile	34/12	3.75	3.672	6,402	15,418	6	56,082	15	39,527
South Ottawa	34/12	7.5	1.000	12,803	30,836	13	112,154	1	1,466
South Ottawa	34/12	3.75	1.000	6,402	15,418	6	56,082	1	2,931
South Wellsville	34/12	3.75	2.484	6,402	15,418	6	56,082	7	18,088
Walmart	34/12	7.5	2.417	12,803	30,836	13	112,154	3	8,563
Walmart	34/12	7.5	4.482	12,803	30,836	13	112,154	11	29,444
Welda	34/12	3.75	1.512	6,402	15,418	6	56,082	3	6,702
Wellsville	34/12	3.75	3.240	6,402	15,418	6	56,082	12	30,773
Wellsville	34/12	3.75	2.592	6,402	15,418	6	56,082	7	19,695
Total		207	117			349	3,095,570	342	908,787
Coincident Peak								340	

Table D-10

KCPL MISSOURI DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Blackburn	34/12	3.75	0.816	6,402	15,418	6	56,082	1	1,952
Bogard	34/12	3.75	2.073	6,402	15,418	6	56,082	5	12,597
Bowdry	34/12	3.75	0.101	6,402	15,418	6	56,082	-	30
Brunswick	34/12	7.5	2.238	12,803	30,836	13	112,154	3	7,341
Carrollton	34/12	3	0.730	5,121	12,334	5	44,860	1	1,953
Carrollton	34/4	3	2.158	5,121	12,334	5	44,860	6	17,064
Carrollton	34/4	18	10.727	30,728	74,005	31	269,177	26	70,274
Chariton	34/12	3.75	1.870	6,402	15,418	6	56,082	4	10,251
City of Lacygne	34/12	1.5	1.000	2,561	6,167	3	22,434	3	7,328
Gilliam	34/12	3.75	1.719	6,402	15,418	6	56,082	3	8,662
Gilliam	34/12	3.75	1.782	6,402	15,418	6	56,082	3	9,309
Glasgow	34/12	7.5	1.646	12,803	30,836	13	112,154	1	3,971
Glasgow	34/12	7.5	2.782	12,803	30,836	13	112,154	4	11,344
Keytesville	34/12	3	1.289	5,121	12,334	5	44,860	2	6,088
Leta	34/12	3.75	1.864	6,402	15,418	6	56,082	4	10,185
Moss Creek	19.9/7.2	3.75	0.241	6,402	15,418	6	56,082	-	170
Mt. Leonard	34/12	7.5	1.517	12,803	30,836	13	112,154	1	3,373
Orange Street	34/12	3.75	2.232	6,402	15,418	6	56,082	5	14,604
Show Me	34/12	7.5	5.417	12,803	30,836	13	112,154	16	43,010
Sweet Springs	34/12	7.5	3.881	12,803	30,836	13	112,154	8	22,077
Sweet Springs	34/12	7.5	2.551	12,803	30,836	13	112,154	4	9,538

Table D-10

KCPL MISSOURI DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Waverly	34/12	1.5	2.464	2,561	6,167	3	22,434	17	44,493
Waverly	34/12	1.5	1.000	2,561	6,167	3	22,434	3	7,328
West Marshall	34/12	3.75	1.816	6,402	15,418	6	56,082	4	9,668
West Marshall	34/12	3.75	0.675	6,402	15,418	6	56,082	-	1,336
Total		125	55			212	1,873,039	124	333,946
Coincident Demand						212		121	

Table D-11

MPS DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Archie	25/12	3	2.030	5,121	12,334	5	44,860	2	5,513
Blairstown	34/12	1.5	1.008	2,561	6,167	3	22,434	1	2,719
Brownington	34/12	2.5	0.312	4,268	10,279	4	37,388	-	156
Calhoun	34/12	2.5	1.296	4,268	10,279	4	37,388	1	2,696
Cole Camp City	34/4	3.75	3.105	6,402	15,418	6	56,082	4	10,318
Cole Camp Jct	34/2.4	5	0.142	8,536	20,557	9	74,775	-	16
Concordia 34/4	34/4	3.75	2.560	6,402	15,418	6	56,082	3	7,014
Deepwater	34/12	1.5	0.768	2,561	6,167	3	22,434	1	1,578
East Lynn	34/12	1.5	1.608	2,561	6,167	3	22,434	3	6,918
Cainsville	34/4	1.5	0.553	2,561	6,167	3	22,434	-	818
Garden City	34/12	10	3.216	17,071	41,114	17	149,542	2	4,151
Gilman City	12/4	2.5	0.592	4,268	10,279	4	37,388	-	563
Greenridge	34/12	1.5	1.260	2,561	6,167	3	22,434	2	4,248
Harrisonville Lake	34/12	1.5	1.813	2,561	6,167	3	22,434	4	8,795
Harwood	34/12	0.45	0.112	768	1,850	1	6,728	-	112
Hume	12/4	1.5	0.568	2,561	6,167	3	22,434	-	863
Hwy 92	25/12	1.5	1.200	2,561	6,167	3	22,434	2	3,853
Iantha	34/2.4	0.5	0.162	854	2,056	1	7,481	-	211
Keystone-Salisbury	34/4	12	9.000	20,485	49,337	20	179,449	12	27,091
Keystone-Salisbury	34/4	12	9.000	20,485	49,337	20	179,449	12	27,091
Keystone-Tina	34/4	12	9.000	20,485	49,337	20	179,449	12	27,091
Lakeland School	34/12	0.75	0.300	1,280	3,084	1	11,213	-	482

Table D-11

MPS DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Lamar	34/12	1.5	0.192	2,561	6,167	3	22,434	-	99
Leeton	34/12	2	1.464	3,414	8,223	3	29,907	2	4,301
Liberal	12/4	1.5	0.449	2,561	6,167	3	22,434	-	539
Liberal	34/4	2.5	1.728	4,268	10,279	4	37,388	2	4,794
Lincoln	34/12	3.75	2.784	6,402	15,418	6	56,082	4	8,295
Lowry City	34/12	2.5	0.984	4,268	10,279	4	37,388	1	1,554
Merwin Corners	25/12	7.5	6.000	12,803	30,836	13	112,154	8	19,264
Modena	34/2.4	3.75	0.088	6,402	15,418	6	56,082	-	8
Montrose City	34/12	1.5	1.008	2,561	6,167	3	22,434	1	2,719
Mt. Moriah	34/4	3.75	0.156	6,402	15,418	6	56,082	-	26
New Hampton	13.2/2.4	3.75	0.319	6,402	15,418	6	56,082	-	109
Norborne	34/12	1.5	1.825	2,561	6,167	3	22,434	4	8,911
Osceola	34/12	7.5	6.382	12,803	30,836	13	112,154	9	21,795
Post Oak Rural	34/12	0.75	0.418	1,280	3,084	1	11,213	-	935
Raytown No. 2	12/4	1.5	1.344	2,561	6,167	3	22,434	2	4,833
Ridgeway	34/2.4	5	0.612	8,536	20,557	9	74,775	-	301
Rockville	34/4	1.5	0.424	2,561	6,167	3	22,434	-	481
Schell City	34/12	0.75	0.591	1,280	3,084	1	11,213	1	1,869
Sedalia 10th & Porter	12/4	1.5	1.944	2,561	6,167	3	22,434	4	10,111
Sedalia 11th & Grand	12/4	1.5	0.840	2,561	6,167	3	22,434	1	1,888
Sedalia 6th & Kentucl	12/4	1.5	1.926	2,561	6,167	3	22,434	4	9,925

Table D-11

MPS DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Spickard	34/4	3.75	0.504	6,402	15,418	6	56,082	-	272
Strasburg	34/12	2.5	2.208	4,268	10,279	4	37,388	3	7,827
Tindall	34/2.4	3.75	0.252	6,402	15,418	6	56,082	-	68
Walker	34/12	1	0.720	1,707	4,111	2	14,953	1	2,081
Total		151	85			259	2,253,677	108	255,302
Coincident Demand						259		108	

Table D-12

SJLP DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Ajax	34/12	7.5	4.851	12,803	30,836	31	270,123	5	17,437
Ajax	34/12	8.4	5.537	14,340	34,536	35	302,535	6	20,284
Ajax	34/12	7.5	7.447	12,803	30,836	31	270,123	13	41,094
Ajax	34/12	7.5	3.944	12,803	30,836	31	270,123	4	11,526
Belt Junction	34/12	7.5	3.285	12,803	30,836	31	270,123	2	7,996
Belt Junction	34/12	7.5	9.881	12,803	30,836	31	270,123	22	72,347
Belt Junction	34/12	7.5	5.270	12,803	30,836	31	270,123	6	20,580
Belt Junction	34/12	7.5	1.843	12,803	30,836	31	270,123	1	2,517
Belt Junction	34/12	7.5	2.699	12,803	30,836	31	270,123	2	5,398
Gower	34/12	7.5	1.741	12,803	30,836	31	270,123	1	2,246
Gower	34/12	3.75	3.169	6,402	15,418	15	135,062	5	14,883
Grant City	34/12	2.5	2.417	4,268	10,279	10	90,044	4	12,987
Hwy 48	34/12	1.5	1.213	2,561	6,167	6	54,023	2	5,451
Industrial Park	34/12	7.5	8.415	12,803	30,836	31	270,123	16	52,472
Industrial Park	34/12	7.5	3.130	12,803	30,836	31	270,123	2	7,259
King City	34/12	12	2.383	20,485	49,337	49	432,192	1	2,630
Lake Road	34/12	7.5	3.590	12,803	30,836	31	270,123	3	9,550
Maitland	34/12	7.5	2.358	12,803	30,836	31	270,123	1	4,120
Messanie Street	34/12	5	5.794	8,536	20,557	21	180,079	11	37,314
Messanie Street	34/12	5	3.705	8,536	20,557	21	180,079	5	15,258
Messanie Street	34/12	5	4.636	8,536	20,557	21	180,079	7	23,889
Messanie Street	34/12	5	5.014	8,536	20,557	21	180,079	9	27,943
Muddy Creek	34/12	5	3.858	8,536	20,557	21	180,079	5	16,544

Table D-12

SJLP DISTRIBUTION TO DISTRIBUTION TRANSFORMERS									
				Transformer		No-load		Load	
Substation	Voltage	OA Rating	Peak Load	Rated No-load Loss	Rated Load Loss	Peak Loss	Energy Loss	Non-coincident Peak Loss	Energy Loss
	kV	MVA	MVA	Watt	Watt	kW	kWh	kW	kWh
Oak Street	34/12	3.75	3.235	6,402	15,418	15	135,062	5	15,509
Oak Street	34/12	3.75	1.889	6,402	15,418	15	135,062	2	5,288
Oak Street	34/12	5	3.919	8,536	20,557	21	180,079	5	17,071
Oak Street	34/12	7.5	7.319	12,803	30,836	31	270,123	12	39,694
Oregon	34/12	3.75	2.182	6,402	15,418	15	135,062	2	7,056
Oregon	34/12	3.75	2.258	6,402	15,418	15	135,062	2	7,556
Parnell	34/12	1	0.765	1,707	4,111	4	36,012	1	3,252
Quaker Oats	34/12	5.6	7.506	9,560	23,024	23	201,690	17	55,912
Quaker Oats	34/12	5.6	4.764	9,560	23,024	23	201,690	7	22,523
Ravenwood	34/12	1.5	1.864	2,561	6,167	6	54,023	4	12,873
Rochester	34/12	1.5	1.250	2,561	6,167	6	54,023	2	5,789
Rosecrans	34/12	3.75	0.309	6,402	15,418	15	135,062	-	142
Rosecrans	34/12	3.75	1.795	6,402	15,418	15	135,062	1	4,775
Rushville	34/12	3.75	1.932	6,402	15,418	15	135,062	2	5,532
Snow Creek	34/12	7.5	0.694	12,803	30,836	31	270,123	-	357
Wire Rope	34/4	10	1.231	17,071	41,114	41	360,159	-	842
Wire Rope	34/4	5	0.962	8,536	20,557	21	180,079	-	1,029
Worth	34/12	3.75	0.362	6,402	15,418	15	135,062	-	194
Worth	34/12	3.75	2.000	6,402	15,418	15	135,062	2	5,928
Total		235	142			965	8,449,409	197	643,047
Coincident Demand						965		189	

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Overhead (OH) Units								
0.5	26	13	9	0.23	2	9	0.03	53
1	3	3	14	0.04	368	17	0.01	12
2	24	48	21	0.50	4,415	31	0.10	169
3	94	282	26	2.44	21,409	44	0.54	938
5	125	625	35	4.38	38,325	67	1.09	1,899
6	1	6	39	0.04	342	79	0.01	18
7	23	161	43	0.99	8,664	90	0.27	469
8		-	47	-	0	101	-	-
9	1	9	50	0.05	438	111	0.01	25
10	5,792	57,920	53	306.98	2,689,110	122	91.90	160,227
15	1,854	27,810	67	124.22	1,088,150	172	41.47	72,308
20	62	1,240	80	4.96	43,450	220	1.77	3,093
22	2	44	84	0.17	1,472	239	0.06	108
23		-	87	-	0	248	-	-
25	10,304	257,600	91	937.66	8,213,937	266	356.47	621,491
30	212	6,360	101	21.41	187,569	311	8.57	14,950
35	7	245	111	0.78	6,807	355	0.32	563
37	1,467	54,279	115	168.71	1,477,856	372	70.97	123,743
38	38	1,444	116	4.41	38,614	381	1.88	3,283
40		-	120	-	0	398	-	-

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
45	140	6,300	128	17.92	156,979	440	8.01	13,968
50	6,186	309,300	137	847.48	7,423,942	481	386.98	674,687
55	5	275	145	0.73	6,351	522	0.34	592
60		-	152	-	0	562	-	-
65	1	65	159	0.16	1,393	602	0.08	137
67	1	67	162	0.16	1,419	618	0.08	140
70	3	210	167	0.50	4,389	641	0.25	436
75	1,452	108,900	173	251.20	2,200,477	680	128.41	223,884
80	3	240	180	0.54	4,730	718	0.28	488
87	2	174	189	0.38	3,311	772	0.20	350
90		-	193	-	0	794	-	-
95	1	95	199	0.20	1,743	832	0.11	189
100	240	24,000	205	49.20	430,992	869	27.12	47,291
105		-	211	-	0	906	-	-
112	30	3,360	220	6.60	57,816	957	3.73	6,510
113	3	339	221	0.66	5,808	964	0.38	656
124		-	233	-	0	1,044	-	-
125	13	1,625	234	3.04	26,648	1,051	1.78	3,098
137		-	247	-	0	1,137	-	-
150	432	64,800	261	112.75	987,708	1,228	68.99	120,290
167	51	8,517	278	14.18	124,199	1,346	8.93	15,565
175	8	1,400	286	2.29	20,043	1,401	1.46	2,541

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
200	6	1,200	309	1.85	16,241	1,570	1.23	2,136
204		-	312	-	0	1,596	-	-
225	128	28,800	331	42.37	371,144	1,735	28.88	50,357
250	1	250	352	0.35	3,084	1,899	0.25	431
270		-	368	-	0	2,027	-	-
275		-	372	-	0	2,059	-	-
300	78	23,400	392	30.58	267,846	2,218	22.50	39,229
333	1	333	417	0.42	3,653	2,425	0.32	550
334		-	418	-	0	2,431	-	-
337		-	420	-	0	2,449	-	-
338		-	420	-	0	2,456	-	-
350		-	429	-	0	2,530	-	-
351		-	430	-	0	2,536	-	-
367	1	367	441	0.44	3,863	2,634	0.34	597
450		-	498	-	0	3,135	-	-
500	40	20,000	529	21.16	185,362	3,429	17.84	31,101
750	9	6,750	672	6.05	52,980	4,846	5.67	9,889
801		-	698	-	0	5,126	-	-
900		-	748	-	0	5,662	-	-
1000	3	3,000	796	2.39	20,919	6,194	2.42	4,213
1500	1	1,500	1,010	1.01	8,848	8,754	1.14	1,985
2000	2	4,000	1,196	2.39	20,954	11,189	2.91	5,074

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
2500	1	2,500	1,364	1.36	11,949	13,534	1.76	3,069
3000	1	3,000	1,518	1.52	13,298	15,812	2.06	3,585
3828		-	1,752	-	0	19,466	-	-
4160		-	1,840	-	0	20,897	-	-
4350		-	1,889	-	0	21,708	-	-
4500		-	1,927	-	0	22,345	-	-
4950		-	2,038	-	0	24,238	-	-
5000		-	2,050	-	0	24,447	-	-
6500		-	2,392	-	0	30,578	-	-
7500		-	2,602	-	0	34,548	-	-
8400		-	2,781	-	0	38,055	-	-
34500	10	345,000	6,382	63.82	559,063	126,986	165.15	287,941
Total OH	28,888	1,377,856		3,061.66	26,818,080		1,465	2,554,328

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Underground (UG) Units								
5	3	15	35	0.11	920	67	0.03	46
10	9	90	53	0.48	4,179	122	0.14	249
15	2	30	67	0.13	1,174	172	0.04	78
23	1	23	87	0.09	762	248	0.03	56
25	3,658	91,450	91	332.88	2,916,011	266	126.55	220,634
30	1	30	101	0.10	885	311	0.04	71
37	104	3,848	115	11.96	104,770	372	5.03	8,773
38	7	266	116	0.81	7,113	381	0.35	605
45	5	225	128	0.64	5,606	440	0.29	499
50	10,670	533,500	137	1,461.79	12,805,280	481	667.48	1,163,742
75	4,887	366,525	173	845.45	7,406,151	680	432.20	753,527
100	1,748	174,800	205	358.34	3,139,058	869	197.56	344,436
112	360	40,320	220	79.20	693,792	957	44.81	78,120
113	1	113	221	0.22	1,936	964	0.13	219
150	627	94,050	261	163.65	1,433,548	1,228	100.14	174,588
167	930	155,310	278	258.54	2,264,810	1,346	162.80	283,841
200		-	309	-	0	1,570	-	-
225	473	106,425	331	156.56	1,371,492	1,735	106.73	186,084
250		-	352	-	0	1,899	-	-
300	392	117,600	392	153.66	1,346,097	2,218	113.08	197,149

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
333	1	333	417	0.42	3,653	2,425	0.32	550
334		-	418	-	0	2,431	-	-
336		-	419	-	0	2,443	-	-
338	3	1,014	420	1.26	11,038	2,456	0.96	1,671
400	1	400	464	0.46	4,065	2,835	0.37	643
450	8	3,600	498	3.98	34,900	3,135	3.26	5,687
500	480	240,000	529	253.92	2,224,339	3,429	214.06	373,212
559		-	565	-	0	3,772	-	-
647		-	616	-	0	4,273	-	-
667	1	667	627	0.63	5,493	4,385	0.57	994
675	1	675	631	0.63	5,528	4,430	0.58	1,005
750	270	202,500	672	181.44	1,589,414	4,846	170.17	296,684
850		-	723	-	0	5,393	-	-
900		-	748	-	0	5,662	-	-
975		-	784	-	0	6,062	-	-
1000	161	161,000	796	128.16	1,122,647	6,194	129.70	226,123
1050	2	2,100	819	1.64	14,349	6,458	1.68	2,929
1071		-	828	-	0	6,568	-	-
1083		-	834	-	0	6,630	-	-
1100		-	842	-	0	6,719	-	-
1300		-	928	-	0	7,748	-	-
1375		-	959	-	0	8,128	-	-

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
1500	133	199,500	1,010	134.33	1,176,731	8,754	151.42	264,001
1533		-	1,023	-	0	8,918	-	-
2000	36	72,000	1,196	43.06	377,171	11,189	52.39	91,336
2150		-	1,248	-	0	11,901	-	-
2250	2	4,500	1,282	2.56	22,461	12,371	3.22	5,610
2471		-	1,354	-	0	13,400	-	-
2500	65	162,500	1,364	88.66	776,662	13,534	114.41	199,474
2502		-	1,364	-	0	13,544	-	-
2600		-	1,395	-	0	13,995	-	-
2661		-	1,415	-	0	14,274	-	-
2750		-	1,442	-	0	14,681	-	-
2900		-	1,488	-	0	15,361	-	-
3000	5	15,000	1,518	7.59	66,488	15,812	10.28	17,927
3003		-	1,519	-	0	15,825	-	-
3200		-	1,577	-	0	16,707	-	-
3250		-	1,591	-	0	16,929	-	-
3360		-	1,623	-	0	17,417	-	-
3500		-	1,662	-	0	18,034	-	-
3552		-	1,676	-	0	18,262	-	-
3750	3	11,250	1,731	5.19	45,491	19,127	7.46	13,011
3800		-	1,744	-	0	19,344	-	-
4000		-	1,798	-	0	20,209	-	-

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
4002	1	4,002	1,798	1.80	15,750	20,218	2.63	4,584
4500		-	1,927	-	0	22,345	-	-
4950	2	9,900	2,038	4.08	35,706	24,238	6.30	10,992
5000		-	2,050	-	0	24,447	-	-
5250		-	2,109	-	0	25,485	-	-
5320		-	2,126	-	0	25,775	-	-
5500		-	2,168	-	0	26,517	-	-
5502	2	11,004	2,168	4.34	37,983	26,525	6.90	12,029
5750		-	2,225	-	0	27,542	-	-
6000	2	12,000	2,282	4.56	39,981	28,560	7.43	12,952
6050		-	2,293	-	0	28,763	-	-
6333		-	2,355	-	0	29,907	-	-
7100		-	2,519	-	0	32,970	-	-
7500	1	7,500	2,602	2.60	22,794	34,548	4.49	7,834
8000	1	8,000	2,702	2.70	23,670	36,503	4.75	8,277
8001	1	8,001	2,703	2.70	23,678	36,507	4.75	8,278
8500		-	2,800	-	0	38,441	-	-
8750		-	2,849	-	0	39,403	-	-
9000		-	2,896	-	0	40,361	-	-
9374		-	2,966	-	0	41,788	-	-
10000		-	3,081	-	0	44,157	-	-
10500	1	10,500	3,171	3.17	27,778	46,033	5.99	10,438

Table D-13

KCPL-KS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
11000		-	3,259	-	0	47,897	-	-
11250	1	11,250	3,302	3.30	28,926	48,824	6.35	11,071
11575		-	3,358	-	0	50,024	-	-
11725		-	3,383	-	0	50,577	-	-
12000	1	12,000	3,430	3.43	30,047	51,587	6.71	11,697
12250		-	3,472	-	0	52,502	-	-
12525		-	3,517	-	0	53,506	-	-
12918		-	3,582	-	0	54,935	-	-
16250		-	4,099	-	0	66,812	-	-
17000		-	4,209	-	0	69,433	-	-
34500	1	34,500	6,382	6.38	55,906	126,986	16.52	28,794
Total UG	25,064	2,890,316		4,717.61	41,326,233		2,891	5,040,520
Total	53,952	4,268,172		7,779.00	68,144,313		4,356	7,594,848
Coincident Demand							4,309	

Note: Numbers may be rounded to nearest 1kW, kWh, kVA or value.

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Overhead (OH) Units								
0.5	16	8	9	0.14	1	9	0.01	25
1		-	14	-	0	17	-	-
2	17	34	21	0.36	3,127	31	0.05	93
3	60	180	26	1.56	13,666	44	0.24	463
5	100	500	35	3.50	30,660	67	0.62	1,176
6		-	39	-	0	79	-	-
7	60	420	43	2.58	22,601	90	0.50	948
8	4	32	47	0.19	1,647	101	0.04	71
9		-	50	-	0	111	-	-
10	3,498	34,980	53	185.39	1,624,051	122	39.24	74,906
15	2,501	37,515	67	167.57	1,467,887	172	39.56	75,505
20	65	1,300	80	5.20	45,552	220	1.31	2,510
22		-	84	-	0	239	-	-
23	1	23	87	0.09	762	248	0.02	44
25	8,167	204,175	91	743.20	6,510,406	266	199.77	381,311
30	268	8,040	101	27.07	237,116	311	7.66	14,630
35	4	140	111	0.44	3,889	355	0.13	249
37	2,935	108,595	115	337.53	2,956,719	372	100.40	191,640
38	51	1,938	116	5.92	51,824	381	1.79	3,411
40	4	160	120	0.48	4,205	398	0.15	279

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
45	441	19,845	128	56.45	494,484	440	17.84	34,059
50	9,476	473,800	137	1,298.21	11,372,337	481	419.13	800,029
55	7	385	145	1.02	8,891	522	0.34	641
60	2	120	152	0.30	2,663	562	0.10	197
65		-	159	-	0	602	-	-
67		-	162	-	0	618	-	-
70	1	70	167	0.17	1,463	641	0.06	113
75	3,162	237,150	173	547.03	4,791,948	680	197.72	377,404
80	1	80	180	0.18	1,577	718	0.07	126
87	3	261	189	0.57	4,967	772	0.21	407
90	4	360	193	0.77	6,763	794	0.29	557
95		-	199	-	0	832	-	-
100	591	59,100	205	121.16	1,061,318	869	47.23	90,145
105	2	210	211	0.42	3,697	906	0.17	318
112	129	14,448	220	28.38	248,609	957	11.35	21,669
113	10	1,130	221	2.21	19,360	964	0.89	1,692
124	1	124	233	0.23	2,041	1,044	0.10	183
125	15	1,875	234	3.51	30,748	1,051	1.45	2,767
137	3	411	247	0.74	6,491	1,137	0.31	599
150	1,119	167,850	261	292.06	2,558,437	1,228	126.36	241,193
167	192	32,064	278	53.38	467,574	1,346	23.76	45,361
175	9	1,575	286	2.57	22,548	1,401	1.16	2,213
200	5	1,000	309	1.55	13,534	1,570	0.72	1,378

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
204	1	204	312	0.31	2,733	1,596	0.15	280
225	453	101,925	331	149.94	1,313,501	1,735	72.27	137,954
250	23	5,750	352	8.10	70,921	1,899	4.02	7,666
270	1	270	368	0.37	3,224	2,027	0.19	356
275	2	550	372	0.74	6,517	2,059	0.38	723
300	270	81,000	392	105.84	927,158	2,218	55.07	105,114
333	4	1,332	417	1.67	14,612	2,425	0.89	1,703
334	3	1,002	418	1.25	10,985	2,431	0.67	1,280
337	2	674	420	0.84	7,358	2,449	0.45	860
338	2	676	420	0.84	7,358	2,456	0.45	862
350	1	350	429	0.43	3,758	2,530	0.23	444
351	1	351	430	0.43	3,767	2,536	0.23	445
367		-	441	-	0	2,634	-	-
450	5	2,250	498	2.49	21,812	3,135	1.44	2,751
500	166	83,000	529	87.81	769,251	3,429	52.34	99,910
750	46	34,500	672	30.91	270,789	4,846	20.50	39,127
801	1	801	698	0.70	6,114	5,126	0.47	900
900	1	900	748	0.75	6,552	5,662	0.52	994
1000	22	22,000	796	17.51	153,405	6,194	12.53	23,918
1500	5	7,500	1,010	5.05	44,238	8,754	4.02	7,683
2000	2	4,000	1,196	2.39	20,954	11,189	2.06	3,928
2500	2	5,000	1,364	2.73	23,897	13,534	2.49	4,751
3000		-	1,518	-	0	15,812	-	-

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
3828	2	7,656	1,752	3.50	30,695	19,466	3.58	6,833
4160	3	12,480	1,840	5.52	48,355	20,897	5.76	11,004
4350	1	4,350	1,889	1.89	16,548	21,708	2.00	3,810
4500	1	4,500	1,927	1.93	16,881	22,345	2.05	3,922
4950	1	4,950	2,038	2.04	17,853	24,238	2.23	4,254
5000	3	15,000	2,050	6.15	53,874	24,447	6.74	12,873
6500	1	6,500	2,392	2.39	20,954	30,578	2.81	5,367
7500	1	7,500	2,602	2.60	22,794	34,548	3.18	6,064
8400	1	8,400	2,781	2.78	24,362	38,055	3.50	6,680
34500	3	103,500	6,382	19.15	167,719	126,986	35.03	66,867
Total OH	33,954	1,938,769		4,361.16	38,202,502		1,539	2,937,635

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Underground (UG) Units								
5	1	5	35	0.04	307	67	0.01	12
10	1	10	53	0.05	464	122	0.01	21
15	5	75	67	0.34	2,935	172	0.08	151
23	1	23	87	0.09	762	248	0.02	44
25	1,206	30,150	91	109.75	961,375	266	29.50	56,307
30	1	30	101	0.10	885	311	0.03	55
37	122	4,514	115	14.03	122,903	372	4.17	7,966
38	7	266	116	0.81	7,113	381	0.25	468
45	1	45	128	0.13	1,121	440	0.04	77
50	4,944	247,200	137	677.33	5,933,393	481	218.68	417,406
75	2,641	198,075	173	456.89	4,002,383	680	165.14	315,219
100	1,019	101,900	205	208.90	1,829,920	869	81.43	155,428
112	198	22,176	220	43.56	381,586	957	17.42	33,259
113	3	339	221	0.66	5,808	964	0.27	508
150	456	68,400	261	119.02	1,042,580	1,228	51.49	98,288
167	523	87,341	278	145.39	1,273,651	1,346	64.73	123,561
200	4	800	309	1.24	10,827	1,570	0.58	1,102
225	404	90,900	331	133.72	1,171,422	1,735	64.46	123,032
250	12	3,000	352	4.22	37,002	1,899	2.10	4,000
300	405	121,500	392	158.76	1,390,738	2,218	82.60	157,671
333	3	999	417	1.25	10,959	2,425	0.67	1,277

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
334	2	668	418	0.84	7,323	2,431	0.45	853
336	2	672	419	0.84	7,341	2,443	0.45	858
338	2	676	420	0.84	7,358	2,456	0.45	862
400	5	2,000	464	2.32	20,323	2,835	1.30	2,488
450	566	254,700	498	281.87	2,469,164	3,135	163.17	311,451
500	1	500	529	0.53	4,634	3,429	0.32	602
559	1	559	565	0.57	4,949	3,772	0.35	662
647	2	1,294	616	1.23	10,792	4,273	0.79	1,500
667	1	667	627	0.63	5,493	4,385	0.40	770
675	347	234,225	631	218.96	1,918,063	4,430	141.35	269,817
750	1	750	672	0.67	5,887	4,846	0.45	851
850	5	4,250	723	3.62	31,667	5,393	2.48	4,733
900	1	900	748	0.75	6,552	5,662	0.52	994
975	241	234,975	784	188.94	1,655,149	6,062	134.34	256,430
1000	1	1,000	796	0.80	6,973	6,194	0.57	1,087
1050	1	1,050	819	0.82	7,174	6,458	0.59	1,134
1071	1	1,071	828	0.83	7,253	6,568	0.60	1,153
1083	1	1,083	834	0.83	7,306	6,630	0.61	1,164
1100	1	1,100	842	0.84	7,376	6,719	0.62	1,179
1300	194	252,200	928	180.03	1,577,080	7,748	138.22	263,832
1375	1	1,375	959	0.96	8,401	8,128	0.75	1,427
1500	74	111,000	1,010	74.74	654,722	8,754	59.57	113,703
1533	1	1,533	1,023	1.02	8,961	8,918	0.82	1,565

Table D-14								
KCPL-MO SECONDARY TRANSFORMERS								
KVA	**Number of Units**	**Total kVA**	**Unit No-Load Demand Losses Watt**	**No-Load Demand Losses kW**	**No-Load Energy Losses kWh**	**Unit Load Demand Losses Watt**	**Non-coincident Load Demand Losses kW**	**Load Energy Losses kWh**
2000	6	12,000	1,196	7.18	62,862	11,189	6.17	11,784
2150	1	2,150	1,248	1.25	10,932	11,901	1.09	2,089
2250	171	384,750	1,282	219.22	1,920,385	12,371	194.53	371,310
2471	3	7,413	1,354	4.06	35,583	13,400	3.70	7,056
2500	1	2,500	1,364	1.36	11,949	13,534	1.24	2,376
2502	4	10,008	1,364	5.46	47,795	13,544	4.98	9,509
2600	2	5,200	1,395	2.79	24,440	13,995	2.57	4,913
2661	1	2,661	1,415	1.42	12,395	14,274	1.31	2,505
2750	10	27,500	1,442	14.42	126,319	14,681	13.50	25,769
2900	1	2,900	1,488	1.49	13,035	15,361	1.41	2,696
3000	1	3,000	1,518	1.52	13,298	15,812	1.45	2,775
3003	2	6,006	1,519	3.04	26,613	15,825	2.91	5,555
3200	1	3,200	1,577	1.58	13,815	16,707	1.54	2,932
3250	2	6,500	1,591	3.18	27,874	16,929	3.11	5,943
3360	1	3,360	1,623	1.62	14,217	17,417	1.60	3,057
3500	6	21,000	1,662	9.97	87,355	18,034	9.95	18,992
3552	2	7,104	1,676	3.35	29,364	18,262	3.36	6,411
3750	5	18,750	1,731	8.66	75,818	19,127	8.79	16,786
3800	2	7,600	1,744	3.49	30,555	19,344	3.56	6,791
4000	5	20,000	1,798	8.99	78,752	20,209	9.29	17,736
4002	8	32,016	1,798	14.38	126,004	20,218	14.87	28,390
4500	1	4,500	1,927	1.93	16,881	22,345	2.05	3,922
4950	2	9,900	2,038	4.08	35,706	24,238	4.46	8,509

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
5000	2	10,000	2,050	4.10	35,916	24,447	4.50	8,582
5250	5	26,250	2,109	10.55	92,374	25,485	11.72	22,366
5320	10	53,200	2,126	21.26	186,238	25,775	23.70	45,241
5500	1	5,500	2,168	2.17	18,992	26,517	2.44	4,654
5502	1	5,502	2,168	2.17	18,992	26,525	2.44	4,656
5750	1	5,750	2,225	2.23	19,491	27,542	2.53	4,834
6000	13	78,000	2,282	29.67	259,874	28,560	34.14	65,168
6050	1	6,050	2,293	2.29	20,087	28,763	2.64	5,049
6333	2	12,666	2,355	4.71	41,260	29,907	5.50	10,499
7100	1	7,100	2,519	2.52	22,066	32,970	3.03	5,787
7500	1	7,500	2,602	2.60	22,794	34,548	3.18	6,064
8000	7	56,000	2,702	18.91	165,687	36,503	23.50	44,850
8001	2	16,002	2,703	5.41	47,357	36,507	6.71	12,816
8500	1	8,500	2,800	2.80	24,528	38,441	3.53	6,747
8750	1	8,750	2,849	2.85	24,957	39,403	3.62	6,916

Table D-14

KCPL-MO SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
9000	2	18,000	2,896	5.79	50,738	40,361	7.42	14,169
9374	3	28,122	2,966	8.90	77,946	41,788	11.53	22,004
10000	1	10,000	3,081	3.08	26,990	44,157	4.06	7,751
10500	1	10,500	3,171	3.17	27,778	46,033	4.23	8,080
11000	2	22,000	3,259	6.52	57,098	47,897	8.81	16,814
11250	1	11,250	3,302	3.30	28,926	48,824	4.49	8,570
11575	1	11,575	3,358	3.36	29,416	50,024	4.60	8,780
11725		-	3,383	-	0	50,577	-	-
12000		-	3,430	-	0	51,587	-	-
12250		-	3,472	-	0	52,502	-	-
12525		-	3,517	-	0	53,506	-	-
12918		-	3,582	-	0	54,935	-	-
16250		-	4,099	-	0	66,812	-	-
17000		-	4,209	-	0	69,433	-	-
34500		-	6,382	-	0	126,986	-	-
Total UG	13,707	3,104,231		3,512.50	30,769,527		1,909	3,643,170
Total	47,661	5,043,000		7,873.66	68,972,029		3,448	6,580,805
Coincident Demand							3,080	

Note: Numbers may be rounded to nearest 1kW, kWh, kVA or value.

Table D-15								
MPS SECONDARY TRANSFORMERS								
KVA	**Number of Units**	**Total kVA**	**Unit No-Load Demand Losses Watt**	**No-Load Demand Losses kW**	**No-Load Energy Losses kWh**	**Unit Load Demand Losses Watt**	**Non-coincident Load Demand Losses kW**	**Load Energy Losses kWh**
Overhead (OH) Units								
1	3	3	14	0.04	369	17	0.01	21
3	47	141	26	1.22	10,729	44	0.39	871
5	751	3,755	35	26.29	230,782	67	9.49	21,202
7	17	119	43	0.73	6,418	90	0.29	645
8	7	56	47	0.33	2,889	101	0.13	298
10	5,911	59,110	53	313.28	2,750,625	122	136.03	303,871
15	7,965	119,475	67	533.66	4,685,491	172	258.42	577,275
17	1	17	72	0.07	632	192	0.04	81
20	71	1,420	80	5.68	49,870	220	2.95	6,582
25	14,693	367,325	91	1,337.06	11,739,413	266	737.24	1,646,874
30	167	5,010	101	16.87	148,092	311	9.80	21,885
35	103	3,605	111	11.43	100,382	355	6.90	15,408
37	1,588	58,756	115	182.62	1,603,404	372	111.43	248,921
38	724	27,512	116	83.98	737,380	381	52.03	116,234
40	109	4,360	120	13.08	114,842	398	8.18	18,280
42	2	84	123	0.25	2,160	415	0.16	350
43	1	43	125	0.13	1,098	423	0.08	178
45	279	12,555	128	35.71	313,551	440	23.16	51,728

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
47	4	188	132	0.53	4,636	456	0.34	769
48	3	144	133	0.40	3,503	465	0.26	588
50	4,647	232,350	137	636.64	5,589,690	481	421.63	941,859
52	4	208	140	0.56	4,917	497	0.38	838
53	5	265	141	0.71	6,190	506	0.48	1,066
55	142	7,810	145	20.59	180,780	522	13.98	31,234
57	3	171	148	0.44	3,898	538	0.30	680
58	2	116	149	0.30	2,616	546	0.21	460
60	17	1,020	152	2.58	22,688	562	1.80	4,026
62	15	930	155	2.33	20,414	578	1.64	3,653
63	8	504	157	1.26	11,028	586	0.88	1,975
65	51	3,315	159	8.11	71,197	602	5.79	12,937
67	14	938	162	2.27	19,913	618	1.63	3,646
68	14	952	164	2.30	20,159	625	1.65	3,687
70	8	560	167	1.34	11,730	641	0.97	2,161
75	1,375	103,125	173	237.88	2,088,543	680	176.37	393,985
80	51	4,080	180	9.18	80,600	718	6.91	15,430
85	6	510	187	1.12	9,851	756	0.86	1,911
87	38	3,306	189	7.18	63,058	772	5.53	12,361
88	34	2,992	191	6.49	57,017	779	5.00	11,161

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
90	4	360	193	0.77	6,778	794	0.60	1,338
95	1	95	199	0.20	1,747	832	0.16	351
100	499	49,900	205	102.30	898,150	869	81.80	182,721
105	1	105	211	0.21	1,853	906	0.17	382
110	2	220	217	0.43	3,811	943	0.36	795
112	116	12,992	220	25.52	224,066	957	20.94	46,778
113	90	10,170	221	19.89	174,634	964	16.37	36,558
115	2	230	223	0.45	3,916	979	0.37	825
124	1	124	233	0.23	2,046	1,044	0.20	440
125	79	9,875	234	18.49	162,307	1,051	15.66	34,986
130	3	390	240	0.72	6,322	1,087	0.62	1,374
137	2	274	247	0.49	4,337	1,137	0.43	958
138	2	276	248	0.50	4,355	1,144	0.43	964
145	1	145	256	0.26	2,248	1,193	0.23	503
150	627	94,050	261	163.65	1,436,821	1,228	145.24	324,440
163	1	163	274	0.27	2,406	1,318	0.25	555
167	31	5,177	278	8.62	75,666	1,346	7.87	17,582
175	80	14,000	286	22.88	200,886	1,401	21.14	47,228
182	1	182	292	0.29	2,564	1,448	0.27	610
200	69	13,800	309	21.32	187,198	1,570	20.43	45,647

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
225	251	56,475	331	83.08	729,451	1,735	82.15	183,502
250	30	7,500	352	10.56	92,717	1,899	10.75	24,006
267	4	1,068	366	1.46	12,854	2,008	1.52	3,384
275	4	1,100	372	1.49	13,065	2,059	1.55	3,470
300	200	60,000	392	78.40	688,352	2,218	83.68	186,922
317	6	1,902	405	2.43	21,335	2,325	2.63	5,878
333	1	333	417	0.42	3,661	2,425	0.46	1,022
367	14	5,138	441	6.17	54,208	2,634	6.96	15,539
375	1	375	447	0.45	3,925	2,683	0.51	1,131
384	1	384	453	0.45	3,977	2,738	0.52	1,154
434	1	434	487	0.49	4,276	3,039	0.57	1,281
500	101	50,500	529	53.43	469,107	3,429	65.33	145,934
584	3	1,752	580	1.74	15,277	3,915	2.22	4,949
750	16	12,000	672	10.75	94,403	4,846	14.63	32,672
1000	9	9,000	796	7.16	62,900	6,194	10.52	23,490
1142	2	2,284	860	1.72	15,102	6,937	2.62	5,846
1500	8	12,000	1,010	8.08	70,942	8,754	13.21	29,510
2250	1	2,250	1,282	1.28	11,256	12,371	2.33	5,213
12480	1	12,480	3,510	3.51	30,818	53,342	10.06	22,477

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Total OH	41,146	1,476,333		4,165.18	36,570,292		2,649.05	5,917,546

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Underground (UG) Units								
3	1	3	26	0.03	228	44	0.01	19
5	5	25	35	0.18	1,537	67	0.06	141
7	1	7	43	0.04	378	90	0.02	38
8	1	8	47	0.05	413	101	0.02	43
10	19	190	53	1.01	8,841	122	0.44	977
15	20	300	67	1.34	11,765	172	0.65	1,450
25	14,667	366,675	91	1,334.70	11,718,640	266	735.93	1,643,960
30	13	390	101	1.31	11,528	311	0.76	1,704
37	2,886	106,782	115	331.89	2,913,994	372	202.51	452,384
38	298	11,324	116	34.57	303,507	381	21.42	47,842
45	3	135	128	0.38	3,372	440	0.25	556
50	9,847	492,350	137	1,349.04	11,844,562	481	893.44	1,995,801
75	2,495	187,125	173	431.64	3,789,755	680	320.03	714,904
100	1,011	101,100	205	207.26	1,819,699	869	165.72	370,202
112	136	15,232	220	29.92	262,698	957	24.55	54,843
113	14	1,582	221	3.09	27,165	964	2.55	5,687
125	1	125	234	0.23	2,055	1,051	0.20	443
150	574	86,100	261	149.81	1,315,367	1,228	132.96	297,015

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
167	293	48,931	278	81.45	715,166	1,346	74.39	166,181
200	1	200	309	0.31	2,713	1,570	0.30	662
225	302	67,950	331	99.96	877,666	1,735	98.84	220,788
250	21	5,250	352	7.39	64,902	1,899	7.52	16,804
300	424	127,200	392	166.21	1,459,306	2,218	177.40	396,274
337	11	3,707	420	4.62	40,564	2,449	5.08	11,351
350	1	350	429	0.43	3,767	2,530	0.48	1,066
375	2	750	447	0.89	7,849	2,683	1.01	2,261
450	20	9,000	498	9.96	87,449	3,135	11.83	26,420
500	412	206,000	529	217.95	1,913,583	3,429	266.49	595,296
525	1	525	545	0.55	4,785	3,575	0.67	1,506
550	1	550	560	0.56	4,917	3,720	0.70	1,568
667	1	667	627	0.63	5,505	4,385	0.83	1,848
675	14	9,450	631	8.83	77,563	4,430	11.70	26,134
750	209	156,750	672	140.45	1,233,133	4,846	191.05	426,774
834	1	834	715	0.72	6,278	5,306	1.00	2,236
900	9	8,100	748	6.73	59,107	5,662	9.61	21,472
1000	110	110,000	796	87.56	768,777	6,194	128.52	287,099
1100	1	1,100	842	0.84	7,393	6,719	1.27	2,831
1500	139	208,500	1,010	140.39	1,232,624	8,754	229.53	512,731

Table D-15

MPS SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
2000	46	92,000	1,196	55.02	483,040	11,189	97.09	216,879
2250	3	6,750	1,282	3.85	33,768	12,371	7.00	15,638
2363	1	2,363	1,319	1.32	11,581	12,899	2.43	5,435
2500	20	50,000	1,364	27.28	239,518	13,534	51.06	114,058
3000	13	39,000	1,518	19.73	173,265	15,812	38.77	86,616
3750	2	7,500	1,731	3.46	30,396	19,127	7.22	16,119
5000	1	5,000	2,050	2.05	17,999	24,447	4.61	10,301
7500	4	30,000	2,602	10.41	91,382	34,548	26.07	58,231
Total UG	34,055	2,567,880		4,976.03	43,689,500		3,953.99	8,832,588
Total	75,201	4,044,213		9,141.21	80,259,792		6,603.04	14,750,134
Coincident Demand							6,603.04	

Note: Numbers may be rounded to nearest 1kW, kWh, kVA or value.

Table D-16								
SJLP SECONDARY TRANSFORMERS								
KVA	**Number of Units**	**Total kVA**	**Unit No-Load Demand Losses Watt**	**No-Load Demand Losses kW**	**No-Load Energy Losses kWh**	**Unit Load Demand Losses Watt**	**Non-coincident Load Demand Losses kW**	**Load Energy Losses kWh**
Overhead (OH) Units								
0.5	23	12	9	0.21	1,813	9	0.03	60
2	9	18	21	0.19	1,656	31	0.04	81
3	85	255	26	2.21	19,360	44	0.50	1,083
5	337	1,685	35	11.80	103,324	67	3.02	6,537
6	1	6	39	0.04	342	79	0.01	23
7	1	7	43	0.04	377	90	0.01	26
8	11	88	47	0.52	4,529	101	0.15	322
9	2	18	50	0.10	876	111	0.03	64
10	2,584	25,840	53	136.95	1,199,700	122	42.13	91,268
15	3,983	59,745	67	266.86	2,337,702	172	91.55	198,337
16	1	16	70	0.07	613	182	0.02	53
20	49	980	80	3.92	34,339	220	1.44	3,121
21	1	21	82	0.08	718	230	0.03	67
25	6,053	151,325	91	550.82	4,825,209	266	215.17	466,141
30	208	6,240	101	21.01	184,030	311	8.64	18,728
35	23	805	111	2.55	22,364	355	1.09	2,364
37	6	222	115	0.69	6,044	372	0.30	646
38	108	4,104	116	12.53	109,745	381	5.50	11,913

Table D-16

SJLP SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
40	16	640	120	1.92	16,819	398	0.85	1,844
45	224	10,080	128	28.67	251,167	440	13.17	28,534
50	2,914	145,700	137	399.22	3,497,150	481	187.31	405,789
53	2	106	141	0.28	2,470	506	0.14	293
55	25	1,375	145	3.63	31,755	522	1.74	3,778
56	1	56	146	0.15	1,279	530	0.07	153
60	8	480	152	1.22	10,652	562	0.60	1,302
65	4	260	159	0.64	5,571	602	0.32	697
70	5	350	167	0.84	7,315	641	0.43	928
75	565	42,375	173	97.75	856,246	680	51.34	111,230
80	20	1,600	180	3.60	31,536	718	1.92	4,157
88	3	264	191	0.57	5,019	779	0.31	677
90	1	90	193	0.19	1,691	794	0.11	230
95	1	95	199	0.20	1,743	832	0.11	241
100	99	9,900	205	20.30	177,784	869	11.50	24,907
113	5	565	221	1.11	9,680	964	0.64	1,395
115	1	115	223	0.22	1,953	979	0.13	283
125	11	1,375	234	2.57	22,548	1,051	1.55	3,347
130	1	130	240	0.24	2,102	1,087	0.15	315
150	367	55,050	261	95.79	839,094	1,228	60.23	130,476

Table D-16

SJLP SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
167	3	501	278	0.83	7,306	1,346	0.54	1,169
175	9	1,575	286	2.57	22,548	1,401	1.69	3,650
200	8	1,600	309	2.47	21,655	1,570	1.68	3,636
225	66	14,850	331	21.85	191,371	1,735	15.30	33,152
300	48	14,400	392	18.82	164,828	2,218	14.23	30,823
317	1	317	405	0.41	3,548	2,325	0.31	673
367	1	367	441	0.44	3,863	2,634	0.35	763
500	15	7,500	529	7.94	69,511	3,429	6.87	14,891
750	4	3,000	672	2.69	23,547	4,846	2.59	5,612
833	1	833	715	0.72	6,263	5,300	0.71	1,534
4000	1	4,000	1,798	1.80	15,750	20,209	2.70	5,851
7500	1	7,500	2,602	2.60	22,794	34,548	4.62	10,002
Total OH	17,916	578,436		1,732.80	15,179,299		753.88	1,633,166

Table D-16

SJLP SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
Underground (UG) Units								
15	135	2,025	67	9.05	79,234	172	3.10	6,722
25	1,286	32,150	91	117.03	1,025,148	266	45.72	99,035
37	4	148	115	0.46	4,030	372	0.20	431
50	1,427	71,350	137	195.50	1,712,571	481	91.73	198,717
75	457	34,275	173	79.06	692,574	680	41.53	89,969
100	129	12,900	205	26.45	231,658	869	14.98	32,454
112	42	4,704	220	9.24	80,942	957	5.37	11,637
113	2	226	221	0.44	3,872	964	0.26	558
150	145	21,750	261	37.85	331,522	1,228	23.80	51,550
167	30	5,010	278	8.34	73,058	1,346	5.40	11,690
225	96	21,600	331	31.78	278,358	1,735	22.26	48,221
250	1	250	352	0.35	3,084	1,899	0.25	550
300	127	38,100	392	49.78	436,108	2,218	37.64	81,551
500	174	87,000	529	92.05	806,323	3,429	79.74	172,736
750	93	69,750	672	62.50	547,465	4,846	60.23	130,476
1000	31	31,000	796	24.68	216,162	6,194	25.66	55,590
1500	119	178,500	1,010	120.19	1,052,864	8,754	139.22	301,591
2000	21	42,000	1,196	25.12	220,016	11,189	31.40	68,026

Table D-16

SJLP SECONDARY TRANSFORMERS

KVA	Number of Units	Total kVA	Unit No-Load Demand Losses Watt	No-Load Demand Losses kW	No-Load Energy Losses kWh	Unit Load Demand Losses Watt	Non-coincident Load Demand Losses kW	Load Energy Losses kWh
2500	53	132,500	1,364	72.29	633,278	13,534	95.86	207,667
3000	1	3,000	1,518	1.52	13,298	15,812	2.11	4,578
3750	9	33,750	1,731	15.58	136,472	19,127	23.01	49,837
5000	1	5,000	2,050	2.05	17,958	24,447	3.27	7,078
10000	1	10,000	3,081	3.08	26,990	44,157	5.90	12,784
Total UG	4,384	836,988		984.36	8,622,985		758.63	1,643,448
Total	22,300	1,415,424		2,717.16	23,802,284		1,512.51	3,276,614
Coincident Demand							1,457.79	

Note: Numbers may be rounded to nearest 1kW, kWh, kVA or value.

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Appendix

E

Primary Distribution Circuit Losses

Table E-1 KCPL-Kansas Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
6511	KCPL-KS	Southland	Antioch	Distribution Feeder	12.47	6798	169	389,979
6512	KCPL-KS	Southland	Antioch	Distribution Feeder	12.47	6753	166	384,789
6541	KCPL-KS	Southland	Antioch	Distribution Feeder	12.47	9904	428	990,104
1211	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	4778	92	212,761
1212	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	3642	65	151,283
1213	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	6081	136	314,449
1214	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	3868	70	161,911
1222	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	4311	80	184,954
1223	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5747	123	284,476
1224	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	6164	139	322,399
1231	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	3349	60	138,582
1232	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	2008	40	92,660
1233	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	8526	283	654,795
1234	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5399	111	256,343
1241	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	6525	155	359,310
1242	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	1003	30	68,545
1243	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	6906	174	402,771
1244	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	3568	64	147,957
1252	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5289	107	247,975
1253	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5318	108	250,174
1254	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	2049	41	93,824
1261	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	8710	299	692,105
1262	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5202	104	241,565
1263	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5472	113	261,945
1271	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	7499	208	481,299
1272	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5319	108	250,250
1273	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	5549	116	268,090
1281	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	1096	30	70,493
1282	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	9222	349	806,898
1283	KCPL-KS	JOCO	Brookridge	Distribution Feeder	12.47	6636	161	371,435
11722	KCPL-KS	South District	Bucyrus	Distribution Feeder	12.47	6340	147	339,881
11731	KCPL-KS	South District	Bucyrus	Distribution Feeder	12.47	3049	55	126,633
11733	KCPL-KS	South District	Bucyrus	Distribution Feeder	12.47	2656	49	112,561
5111	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	2632	48	111,742
5112	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	8210	258	595,635
5113	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	2977	54	123,948
5114	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	3205	57	132,717
5141	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	6964	177	409,822
5142	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	9297	357	825,285
5143	KCPL-KS	JOCO	Cedar Creek	Distribution Feeder	12.47	9154	342	790,604
13211	KCPL-KS	South District	Cedar Niles	Distribution Feeder	12.47	2709	49	114,369
13213	KCPL-KS	South District	Cedar Niles	Distribution Feeder	12.47	5989	132	305,917
13232	KCPL-KS	South District	Cedar Niles	Distribution Feeder	12.47	2671	49	113,076
7313	KCPL-KS	South District	Centennial	Distribution Feeder	12.47	6508	155	357,455
7314	KCPL-KS	South District	Centennial	Distribution Feeder	12.47	4066	74	171,844
7321	KCPL-KS	South District	Centennial	Distribution Feeder	12.47	7480	207	478,523
7323	KCPL-KS	South District	Centennial	Distribution Feeder	12.47	7741	224	517,551
7324	KCPL-KS	South District	Centennial	Distribution Feeder	12.47	3383	61	139,995
9011	KCPL-KS	JOCO	College	Distribution Feeder	12.47	5026	99	229,170
9012	KCPL-KS	JOCO	College	Distribution Feeder	12.47	7528	210	485,420
9021	KCPL-KS	JOCO	College	Distribution Feeder	12.47	6921	175	404,614
9022	KCPL-KS	JOCO	College	Distribution Feeder	12.47	2042	40	93,624
9023	KCPL-KS	JOCO	College	Distribution Feeder	12.47	4916	96	221,757
9031	KCPL-KS	JOCO	College	Distribution Feeder	12.47	7789	227	524,931
9032	KCPL-KS	JOCO	College	Distribution Feeder	12.47	10367	492	1,137,575
9033	KCPL-KS	JOCO	College	Distribution Feeder	12.47	7408	203	468,298
9041	KCPL-KS	JOCO	College	Distribution Feeder	12.47	5990	132	306,042
9042	KCPL-KS	JOCO	College	Distribution Feeder	12.47	10155	462	1,067,438
9043	KCPL-KS	JOCO	College	Distribution Feeder	12.47	3426	61	141,826
5011	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	4099	75	173,551
5013	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6671	162	375,415
5015	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	5192	104	240,904
5021	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6066	135	313,112
5022	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6701	164	378,744
5023	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	3637	65	151,053

Table E-1 KCPL-Kansas Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
5024	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	4509	85	196,268
5031	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	7603	215	496,482
5033	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	3034	55	126,061
5034	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	4500	85	195,731
5041	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	7471	206	477,214
5042	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6165	139	322,497
5044	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	5346	109	252,239
5051	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	5649	119	276,281
5052	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6707	164	379,437
5053	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	2166	42	97,167
5054	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	3404	61	140,879
5062	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	3919	71	164,395
5063	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	4224	78	180,174
5064	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	2042	40	93,624
5071	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	5881	128	296,142
5072	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	4339	81	186,481
5073	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	6104	137	316,659
5081	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	7139	187	431,988
5082	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	5876	128	295,692
5083	KCPL-KS	JOCO	Kenilworth	Distribution Feeder	12.47	3787	68	158,015
2913	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	5328	109	250,937
2921	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	5556	116	268,649
2922	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	4443	83	192,422
2923	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	4186	77	178,101
2924	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	2603	48	110,793
2931	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	4183	77	177,939
2932	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	8090	249	574,614
2933	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	4262	79	182,215
2941	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	9434	372	859,916
2942	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	8680	297	685,812
2961	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	7300	196	453,416
2962	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	1070	30	69,937
2963	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	7214	191	441,832
2964	KCPL-KS	JOCO	Lenexa	Distribution Feeder	12.47	8283	263	608,837
9111	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	4435	83	191,954
9112	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	2134	42	96,254
9113	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	6506	154	357,238
9114	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	8144	253	583,962
9122	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	574	26	60,280
9123	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	5472	113	261,945
9125	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	5003	98	227,571
9131	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	10314	484	1,119,705
9132	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	5114	102	235,322
9133	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	5409	111	257,046
9134	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	2521	47	108,083
9141	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	7454	205	474,750
9142	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	7355	199	460,933
9143	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	7126	186	430,282
9151	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	2749	50	115,759
9152	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	2674	49	113,180
9153	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	6998	179	414,087
9154	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	4358	81	187,563
9161	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	10137	459	1,061,850
9162	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	2798	51	117,463
9163	KCPL-KS	JOCO	Merriam	Distribution Feeder	12.47	3021	54	125,601
6911	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	3663	66	152,253
6912	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	6927	175	405,354
6914	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	2679	49	113,352
6941	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	9913	429	992,821
6942	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	6364	148	342,329
6943	KCPL-KS	JOCO	Moonlight	Distribution Feeder	12.47	1386	33	76,906
8211	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	6591	159	366,492
8212	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	8915	318	736,010

Table E-1 KCPL-Kansas Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
8213	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	8123	251	580,240
8221	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	7096	184	426,499
8222	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	8529	283	655,393
8223	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	8931	320	739,604
8241	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	5959	131	303,167
8242	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	7114	185	428,712
8243	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	3676	66	152,857
8244	KCPL-KS	Southland	Mur-Len	Distribution Feeder	12.47	4735	91	209,994
12111	KCPL-KS	South District	North Louisburg	Distribution Feeder	12.47	2194	42	97,999
12112	KCPL-KS	South District	North Louisburg	Distribution Feeder	12.47	5096	101	234,036
12113	KCPL-KS	South District	North Louisburg	Distribution Feeder	12.47	9359	364	840,757
4111	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	4087	75	172,918
4112	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	7395	202	466,439
4113	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	8082	248	573,216
4114	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	8156	253	586,100
4121	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	8088	248	574,264
4122	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	5699	121	280,434
4123	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	9346	362	837,435
4131	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	5334	109	251,319
4132	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	1888	39	89,402
4141	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	5781	124	287,436
4142	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	7648	218	503,178
4143	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	7761	225	520,633
4152	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	5881	128	296,142
4153	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	6243	143	330,148
4154	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	9791	414	957,200
4171	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	8791	307	709,171
4172	KCPL-KS	Southland	Olathe	Distribution Feeder	12.47	6848	171	395,841
4711	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	6753	166	384,789
4712	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	6736	166	382,802
4713	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	9567	387	894,908
4731	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	7589	214	494,370
4732	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	4953	97	224,201
4733	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	6559	157	362,939
4751	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	9100	336	777,948
4752	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	7004	179	414,844
4753	KCPL-KS	JOCO	Overland Park	Distribution Feeder	12.47	2031	40	93,311
3811	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	5179	104	239,953
3813	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	6176	140	323,579
3814	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	7173	189	436,351
3821	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	7563	212	490,630
3822	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	8867	314	725,331
3823	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	7233	192	444,396
3824	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	8605	290	670,532
3831	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	7070	183	423,136
3832	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	6843	171	395,238
3833	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	4263	79	182,271
3834	KCPL-KS	Southland	Oxford	Distribution Feeder	12.47	7533	210	486,231
12521	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	10962	588	1,360,198
12522	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	4034	74	170,202
12523	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	4205	77	179,135
12531	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	5273	107	246,769
12533	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	3873	70	162,158
12534	KCPL-KS	JOCO	Pflumm	Distribution Feeder	12.47	1280	32	74,480
12831	KCPL-KS	JOCO	Quarry	Distribution Feeder	12.47	6245	143	330,349
12833	KCPL-KS	JOCO	Quarry	Distribution Feeder	12.47	5222	105	243,041
12834	KCPL-KS	JOCO	Quarry	Distribution Feeder	12.47	5227	105	243,411
11521	KCPL-KS	Southland	Redel	Distribution Feeder	12.47	7918	236	545,628
11522	KCPL-KS	Southland	Redel	Distribution Feeder	12.47	9048	331	765,961
11531	KCPL-KS	Southland	Redel	Distribution Feeder	12.47	3221	58	133,366
11532	KCPL-KS	Southland	Redel	Distribution Feeder	12.47	10043	446	1,032,279
2012	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	4037	74	170,357
2013	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	5096	101	234,036
2014	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	8732	301	696,545
2021	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	8508	282	651,414

Table E-1 KCPL-Kansas Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
2022	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	5423	112	258,144
2023	KCPL-KS	JOCO	Reeder	Distribution Feeder	12.47	8386	272	628,042
1911	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7183	189	437,681
1913	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	8082	248	573,216
1914	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	8273	263	606,986
1931	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7218	191	442,371
1932	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	6921	175	404,614
1933	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7899	235	542,645
1934	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	6058	135	312,350
1941	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7031	181	418,141
1942	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	8873	314	726,657
1943	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7218	191	442,371
1944	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	3976	72	167,222
1952	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	9842	420	971,884
1954	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	8891	316	730,651
1961	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	4589	87	201,024
1962	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	8699	298	689,791
1963	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	7695	221	510,431
1964	KCPL-KS	Southland	Riley	Distribution Feeder	12.47	10331	487	1,125,516
6811	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	9422	371	856,779
6812	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	4116	75	174,399
6813	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	6775	167	387,257
6821	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	5013	99	228,265
6823	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	4474	84	194,188
6824	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	7042	181	419,544
6831	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	6366	148	342,538
6832	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	2927	53	122,094
6833	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	3944	72	165,651
6841	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	4035	74	170,254
6843	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	6652	161	373,249
6844	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	5857	127	294,075
6852	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	5844	127	292,914
6853	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	5961	131	303,352
6854	KCPL-KS	JOCO	Roeland Park	Distribution Feeder	12.47	8182	255	590,758
1321	KCPL-KS	JOCO	Shawnee	Distribution Feeder	12.47	7423	203	470,433
1322	KCPL-KS	JOCO	Shawnee	Distribution Feeder	12.47	6683	163	376,789
1331	KCPL-KS	JOCO	Shawnee	Distribution Feeder	12.47	6971	178	410,696
1332	KCPL-KS	JOCO	Shawnee	Distribution Feeder	12.47	3967	72	166,816
1333	KCPL-KS	JOCO	Shawnee	Distribution Feeder	12.47	5879	128	295,962
9322	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	6422	151	348,323
9323	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	3031	54	125,946
9324	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	7191	190	438,749
9341	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	5290	107	248,050
9342	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	6828	170	393,437
9343	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	7957	239	552,145
9362	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	6748	166	384,204
9363	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	5646	119	276,028
9364	KCPL-KS	JOCO	Shawnee Mission	Distribution Feeder	12.47	3366	60	139,258
1621	KCPL-KS	Southland	Stilwell	Distribution Feeder	12.47	5140	103	237,139
1622	KCPL-KS	Southland	Stilwell	Distribution Feeder	12.47	6314	146	337,260
2211	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	7613	215	497,996
2212	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	7530	210	485,716
2213	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	9132	340	785,565
2221	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	7982	241	556,195
2222	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	5953	131	302,614
2232	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	7658	218	504,713
2233	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	11661	725	1,677,181
2241	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	7672	219	506,869
2242	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	8601	290	669,716
2243	KCPL-KS	Southland	Switzer	Distribution Feeder	12.47	5877	128	295,782
11421	KCPL-KS	Southland	Lackman	Distribution Feeder	12.47	2784	51	116,964
11422	KCPL-KS	Southland	Lackman	Distribution Feeder	12.47	4466	84	193,715
114B2	KCPL-KS	Southland	Lackman	Distribution Feeder	12.47	7250	193	446,566
114T2	KCPL-KS	Southland	Lackman	Distribution Feeder	12.47	7250	193	446,566
						TOTAL Loss	42,703	98,740,415

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
479	KCPL-MO	East Jackson	Sugar Creek	Distribution Feeder	4.16	795	5	15,170
568	KCPL-MO	East Jackson	Sugar Creek	Distribution Feeder	4.16	1653	89	256,984
578	KCPL-MO	East Jackson	Sugar Creek	Distribution Feeder	4.16	1963	98	283,052
579	KCPL-MO	East Jackson	Sugar Creek	Distribution Feeder	4.16	1271	25	72,791
10912	KCPL-MO	East District	Moss Creek	Distribution Feeder	7.2	25	1	3,598
10913	KCPL-MO	East District	Moss Creek	Distribution Feeder	7.2	225	8	22,130
2721	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	4330	80	231,968
2722	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	5175	104	298,898
2723	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	1478	34	98,589
2724	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	4962	97	280,374
2731	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	2523	47	134,888
2732	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	13193	1149	3,312,689
2733	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	3541	63	183,106
2734	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	2293	44	125,914
2761	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	4548	86	247,670
2762	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	5958	131	378,044
2764	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	2044	41	116,841
2771	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	10227	472	1,360,556
2772	KCPL-MO	Northland	Avondale	Distribution Feeder	12.47	935	29	83,767
1111	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	7678	220	633,327
1112	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	2814	51	147,189
1114	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	4839	94	270,262
1142	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	4541	86	247,101
1144	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	7929	237	682,837
1161	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	10512	514	1,482,305
1162	KCPL-MO	Northland	Barry	Distribution Feeder	12.47	7274	195	561,116
1011	KCPL-MO	Northland	Birmingham	Distribution Feeder	12.47	5657	120	345,449
1012	KCPL-MO	Northland	Birmingham	Distribution Feeder	12.47	8331	267	770,410
1013	KCPL-MO	Northland	Birmingham	Distribution Feeder	12.47	2936	53	152,706
2611	KCPL-MO	East District	Blackburn	Distribution Feeder	12.47	204	23	67,273
2612	KCPL-MO	East District	Blackburn	Distribution Feeder	12.47	368	25	70,670
2613	KCPL-MO	East District	Blackburn	Distribution Feeder	12.47	273	14	39,381
7911	KCPL-MO	East Jackson	Blue Mills	Distribution Feeder	12.47	4000	73	210,120
7912	KCPL-MO	East Jackson	Blue Mills	Distribution Feeder	12.47	3104	56	160,569
7931	KCPL-MO	East Jackson	Blue Mills	Distribution Feeder	12.47	12344	890	2,567,979
8613	KCPL-MO	East Jackson	Blue Springs	Distribution Feeder	12.47	2245	43	124,122
11611	KCPL-MO	East District	Bogard	Distribution Feeder	12.47	1626	36	103,068
11612	KCPL-MO	East District	Bogard	Distribution Feeder	12.47	399	25	71,333
10011	KCPL-MO	East District	Bowdry	Distribution Feeder	12.47	71	4	10,183
10012	KCPL-MO	East District	Bowdry	Distribution Feeder	12.47	34	2	4,894
4221	KCPL-MO	East District	Brunswick	Distribution Feeder	12.47	2553	47	136,116
4222	KCPL-MO	East District	Brunswick	Distribution Feeder	12.47	283	24	68,901
8411	KCPL-MO	Dodson	Bunker Ridge	Distribution Feeder	12.47	2288	44	125,712
8412	KCPL-MO	Dodson	Bunker Ridge	Distribution Feeder	12.47	6834	170	491,622
8441	KCPL-MO	Dodson	Bunker Ridge	Distribution Feeder	12.47	1470	34	98,361
8442	KCPL-MO	Dodson	Bunker Ridge	Distribution Feeder	12.47	4884	95	273,939
10431	KCPL-MO	East District	Carrollton	Distribution Feeder	12.47	1048	30	86,655
6011	KCPL-MO	East District	Chariton	Distribution Feeder	12.47	1148	31	89,309
6012	KCPL-MO	East District	Chariton	Distribution Feeder	12.47	788	28	80,153
5251	KCPL-MO	Northland	Claycomo	Distribution Feeder	12.47	5145	103	296,201
5252	KCPL-MO	Northland	Claycomo	Distribution Feeder	12.47	5117	102	293,775
5261	KCPL-MO	Northland	Claycomo	Distribution Feeder	12.47	8137	252	726,904
5262	KCPL-MO	Northland	Claycomo	Distribution Feeder	12.47	5636	119	343,194
5263	KCPL-MO	Northland	Claycomo	Distribution Feeder	12.47	8024	244	702,540
3411	KCPL-MO	East District	Corder	Distribution Feeder	12.47	65	3	9,407
3412	KCPL-MO	East District	Corder	Distribution Feeder	12.47	1670	36	104,436
3413	KCPL-MO	East District	Corder	Distribution Feeder	12.47	668	27	77,320
5712	KCPL-MO	East Jackson	Courtney	Distribution Feeder	12.47	4410	82	237,618
5713	KCPL-MO	East Jackson	Courtney	Distribution Feeder	12.47	4110	75	217,153
5911	KCPL-MO	East District	Gilliam	Distribution Feeder	12.47	2069	41	117,713
5912	KCPL-MO	East District	Gilliam	Distribution Feeder	12.47	1780	37	107,933
7811	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6544	156	450,747
7812	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6515	155	446,832
7813	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	7762	225	649,604
7821	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	2593	48	137,749

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
7822	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	7011	180	518,442
7823	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	8878	315	907,841
7824	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6863	172	496,009
7831	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6141	138	399,402
7832	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6453	152	438,582
7834	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	2698	49	142,174
7841	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	4708	90	259,823
7842	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	8328	267	769,657
7843	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	2138	42	120,188
7844	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	4998	98	283,481
7851	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	8715	300	864,579
7852	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	7652	218	628,506
7853	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	3464	62	178,921
7861	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	6967	177	511,651
7862	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	7405	202	583,503
7863	KCPL-MO	Northland	Gladstone	Distribution Feeder	12.47	7926	237	682,335
2511	KCPL-MO	East District	Glasgow	Distribution Feeder	12.47	1704	37	105,513
2521	KCPL-MO	East District	Glasgow	Distribution Feeder	12.47	1445	34	97,632
2522	KCPL-MO	East District	Glasgow	Distribution Feeder	12.47	1463	34	98,144
5612	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	6100	137	394,459
5614	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	4848	94	270,978
5621	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	7396	202	581,930
5623	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	3802	69	198,019
5624	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	4450	83	240,514
5641	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	5769	124	357,253
5642	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	7418	203	585,919
5644	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	6372	148	428,031
5661	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	5259	106	306,535
5663	KCPL-MO	Dodson	Hickman	Distribution Feeder	12.47	8231	259	747,683
11012	KCPL-MO	East District	Higginsville	Distribution Feeder	12.47	406	25	71,480
2111	KCPL-MO	East District	Keytesville	Distribution Feeder	12.47	193	10	27,863
2112	KCPL-MO	East District	Keytesville	Distribution Feeder	12.47	1141	31	89,121
1811	KCPL-MO	East District	Leta	Distribution Feeder	12.47	452	25	72,467
1812	KCPL-MO	East District	Leta	Distribution Feeder	12.47	888	29	82,602
1813	KCPL-MO	East District	Leta	Distribution Feeder	12.47	466	25	72,775
6311	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	5545	116	333,989
6312	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	5379	110	317,785
6331	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	8928	320	921,568
6332	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	9920	430	1,240,799
6333	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	8678	296	854,827
6341	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	8899	317	913,566
6342	KCPL-MO	Northland	Line Creek	Distribution Feeder	12.47	5909	129	372,519
3511	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	4695	90	258,804
3512	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	5631	119	342,690
3513	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	5400	111	319,760
3514	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	203	10	29,259
3531	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	4536	86	246,794
3532	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	7226	192	553,032
3533	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	1444	34	97,600
3542	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	6428	151	435,270
3543	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	3938	72	206,241
3544	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	7491	208	598,797
3551	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	2958	53	153,690
3552	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	6925	175	505,243
3553	KCPL-MO	Dodson	Loma Vista	Distribution Feeder	12.47	1298	32	93,419
13611	KCPL-MO	East District	Malta Bend	Distribution Feeder	12.47	7435	204	588,838
6613	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	11140	620	1,789,482
6614	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	5895	129	370,934
6621	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	8021	243	702,000
6623	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	7384	201	579,945
6624	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	7601	215	618,837
6631	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	3314	59	171,018
6632	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	6689	163	470,704
6634	KCPL-MO	Dodson	Martin City	Distribution Feeder	12.47	7367	200	576,891
3211	KCPL-MO	East District	Mt. Leonard	Distribution Feeder	12.47	830	28	81,182

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
3212	KCPL-MO	East District	Mt. Leonard	Distribution Feeder	12.47	326	16	47,066
3213	KCPL-MO	East District	Mt. Leonard	Distribution Feeder	12.47	263	24	68,470
3611	KCPL-MO	East District	Orange Street	Distribution Feeder	12.47	1698	37	105,334
3612	KCPL-MO	East District	Orange Street	Distribution Feeder	12.47	298	15	42,951
3613	KCPL-MO	East District	Orange Street	Distribution Feeder	12.47	314	16	45,344
7111	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	10439	503	1,450,023
7112	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	4342	81	232,817
7113	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	1437	34	97,384
7114	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	4132	76	218,604
7141	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	3755	68	195,243
7142	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	8859	313	902,571
7143	KCPL-MO	Northland	Randolph	Distribution Feeder	12.47	167	8	24,099
9812	KCPL-MO	Northland	Riverside	Distribution Feeder	12.47	5138	102	295,594
9813	KCPL-MO	Northland	Riverside	Distribution Feeder	12.47	9563	387	1,114,828
9841	KCPL-MO	Northland	Riverside	Distribution Feeder	12.47	9526	382	1,102,468
9842	KCPL-MO	Northland	Riverside	Distribution Feeder	12.47	10194	467	1,347,398
7041	KCPL-MO	Northland	Shoal Creek	Distribution Feeder	12.47	7835	230	663,894
7042	KCPL-MO	Northland	Shoal Creek	Distribution Feeder	12.47	12272	871	2,512,991
7043	KCPL-MO	Northland	Shoal Creek	Distribution Feeder	12.47	1368	33	95,394
7051	KCPL-MO	Northland	Shoal Creek	Distribution Feeder	12.47	10824	564	1,627,597
7052	KCPL-MO	Northland	Shoal Creek	Distribution Feeder	12.47	8766	304	877,774
14011	KCPL-MO	East District	Show Me	Distribution Feeder	12.47	3450	62	178,146
14012	KCPL-MO	East District	Show Me	Distribution Feeder	12.47	2158	42	120,908
2811	KCPL-MO	East District	Sweet Springs	Distribution Feeder	12.47	1507	34	99,445
2812	KCPL-MO	East District	Sweet Springs	Distribution Feeder	12.47	2398	45	129,948
2821	KCPL-MO	East District	Sweet Springs	Distribution Feeder	12.47	2049	41	117,014
2822	KCPL-MO	East District	Sweet Springs	Distribution Feeder	12.47	530	26	74,188
3011	KCPL-MO	Dodson	Swope	Distribution Feeder	12.47	4112	75	217,287
3012	KCPL-MO	Dodson	Swope	Distribution Feeder	12.47	7526	210	605,153
3021	KCPL-MO	Dodson	Swope	Distribution Feeder	12.47	5780	124	358,364
3022	KCPL-MO	Dodson	Swope	Distribution Feeder	12.47	7093	184	531,479
3911	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	6267	144	414,836
3912	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	461	25	72,660
3913	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	8244	260	750,648
3931	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	9168	343	990,443
3932	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	4741	91	262,404
3941	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	8879	315	908,054
3942	KCPL-MO	Northland	Tiffany Springs	Distribution Feeder	12.47	2853	52	148,957
4811	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	6646	161	464,749
4812	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	9777	412	1,188,754
4813	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	7117	186	535,289
4822	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	4299	80	229,852
4823	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	7116	186	535,122
4824	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	8449	277	798,072
4841	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	9242	351	1,012,417
4842	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	8198	257	740,289
4851	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	2945	53	153,118
4852	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	3744	67	194,604
4853	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	7151	188	540,803
4854	KCPL-MO	Dodson	Tomahawk	Distribution Feeder	12.47	6857	172	495,146
12211	KCPL-MO	East District	Waverly	Distribution Feeder	12.47	1829	38	109,542
12212	KCPL-MO	East District	Waverly	Distribution Feeder	12.47	722	27	78,587
4912	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	8196	257	739,944
4913	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	5062	100	288,940
4941	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	1853	38	110,323
4942	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	7098	185	532,237
4943	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	8216	258	744,313
4951	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	7724	223	642,140
4952	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	8360	270	777,248
4953	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	6873	173	497,500
4961	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	6587	158	456,519
4962	KCPL-MO	Northland	Weatherby	Distribution Feeder	12.47	7781	226	653,198
12011	KCPL-MO	East District	West Higginsville	Distribution Feeder	12.47	48	2	6,880
12012	KCPL-MO	East District	West Higginsville	Distribution Feeder	12.47	503	26	73,595
12013	KCPL-MO	East District	West Higginsville	Distribution Feeder	12.47	696	27	77,983

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
4311	KCPL-MO	East District	West Marshall	Distribution Feeder	12.47	568	26	75,048
4312	KCPL-MO	East District	West Marshall	Distribution Feeder	12.47	1530	35	100,151
4313	KCPL-MO	East District	West Marshall	Distribution Feeder	12.47	242	12	34,959
2711	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	3942	23	65,330
2712	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	5355	53	152,519
2713	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	3677	19	55,737
2714	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	2555	10	28,429
2741	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	8809	420	1,211,535
2742	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	9201	532	1,533,305
2743	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	9382	593	1,709,372
2751	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	6718	120	345,599
2752	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	8910	446	1,287,572
2753	KCPL-MO	Northland	Avondale	Distribution Feeder	13.2	5910	74	212,780
5313	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	10410	1098	3,167,499
5332	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	8120	278	801,323
5333	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	3597	18	53,125
5337	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	8099	274	791,471
5338	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	1973	7	20,054
5371	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	8525	354	1,021,837
5372	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	4488	31	90,658
5373	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	726	3	9,488
5374	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	8004	259	747,688
5381	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	5255	50	143,638
5382	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	3916	22	64,355
5383	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	6488	104	300,994
5384	KCPL-MO	F&M	Blue Valley	Distribution Feeder	13.2	2856	12	34,053
4412	KCPL-MO	F&M	Chouteau	Distribution Feeder	13.2	2789	11	32,711
4413	KCPL-MO	F&M	Chouteau	Distribution Feeder	13.2	7697	216	621,824
4414	KCPL-MO	F&M	Chouteau	Distribution Feeder	13.2	9846	783	2,258,254
2411	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5993	78	223,672
2412	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	9903	810	2,336,403
2413	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	6910	134	387,881
2414	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5323	52	149,623
2421	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5721	66	189,973
2422	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	7639	208	600,653
2423	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	713	3	9,417
2424	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5172	47	136,703
2431	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	7946	250	722,233
2432	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	2418	9	26,181
2433	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5545	59	171,011
2434	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	6584	111	318,816
2441	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5069	45	128,503
2442	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5415	55	158,189
2443	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	4855	39	112,990
2444	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5519	58	168,283
2451	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	1426	5	14,440
2452	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	6863	131	377,000
2453	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	4681	35	101,837
2454	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	3793	21	59,751
2461	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	8439	337	970,700
2462	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	2534	10	28,076
2463	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	7925	247	712,912
2464	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	4205	27	76,524
2471	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	3804	21	60,159
2472	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	5916	74	213,665
2473	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	4013	24	68,207
2481	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	6221	89	256,437
2482	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	3838	21	61,399
2483	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	4320	28	81,963
2484	KCPL-MO	F&M	Crosstown	Distribution Feeder	13.2	9976	846	2,441,298
3111	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	4188	26	75,724
3112	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	2586	10	28,958
3114	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	9403	600	1,730,850
3121	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	5299	51	147,510
3122	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	8779	413	1,190,515

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
3123	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	4600	34	96,981
3131	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	3309	16	44,705
3132	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	7168	157	452,749
3134	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	7665	212	610,014
3141	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	3672	19	55,579
3142	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	3409	16	47,469
3143	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	8287	307	885,782
3144	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	7298	170	489,446
3151	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	8102	275	792,941
3152	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	8366	322	928,992
3153	KCPL-MO	Dodson	Forest	Distribution Feeder	13.2	11534	577	1,663,223
1511	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	2279	8	24,098
1512	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	4577	33	95,670
1514	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3544	18	51,476
1521	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	6349	96	277,051
1522	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	5088	45	129,942
1523	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	5072	45	128,742
1524	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	4098	25	71,756
1561	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	4367	29	84,328
1562	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	6274	92	264,819
1563	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	2798	11	32,893
1564	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	4062	24	70,219
1565	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	6018	79	227,018
1567	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3325	16	45,121
1568	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3081	14	38,993
1572	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3520	18	50,717
1573	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	2534	10	28,076
1574	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	1705	6	17,075
1575	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3669	19	55,476
1576	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	2999	13	37,110
1577	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	3152	14	40,668
1578	KCPL-MO	F&M	Grand Avenue	Distribution Feeder	13.2	5218	49	140,475
9611	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	7079	149	429,294
9612	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	3622	19	53,920
9613	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	4310	28	81,508
9614	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	8575	365	1,053,283
9621	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	1507	5	15,163
9622	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	3511	17	50,467
9623	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	11174	559	1,611,340
9624	KCPL-MO	F&M	Hawthorn	Distribution Feeder	13.2	6781	124	359,020
6111	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	5500	58	166,420
6112	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	8042	265	764,998
6113	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	8829	425	1,226,392
6121	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	4503	32	91,503
6122	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	8038	265	763,107
6123	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	7564	199	574,134
6131	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	5862	72	206,774
6132	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	8269	304	876,516
6133	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	3942	23	65,358
6134	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	2036	7	20,825
6141	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	1510	5	15,191
6142	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	4254	27	78,781
6144	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	1312	5	13,490
6151	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	6190	87	251,722
6152	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	8647	381	1,099,890
6153	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	4647	35	99,780
6154	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	1145	4	12,204
6162	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	7144	155	446,353
6163	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	3294	15	44,292
6164	KCPL-MO	Dodson	Leeds	Distribution Feeder	13.2	7481	189	546,415
7511	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5414	55	158,091
7512	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5956	76	218,747
7513	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	2310	9	24,550
7514	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5721	66	189,973
7521	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5656	63	182,713

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
7522	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5979	77	221,881
7523	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	3719	20	57,148
7531	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	3442	17	48,418
7532	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6066	81	233,714
7533	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	2856	12	34,053
7534	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6342	96	275,854
7541	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	4722	36	104,324
7542	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5959	76	219,153
7543	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	7954	252	725,367
7544	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6310	94	270,615
7551	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6067	81	233,859
7552	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	265	2	7,196
7553	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5314	52	148,885
7561	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5042	44	126,453
7562	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	8900	444	1,279,868
7563	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5797	69	198,871
7564	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	1277	5	13,209
7571	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	10513	526	1,516,048
7572	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6310	94	270,615
7573	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	12172	609	1,755,244
7574	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	6288	93	266,957
7581	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5651	63	182,148
7582	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	7138	154	444,699
7584	KCPL-MO	Dodson	Midtown	Distribution Feeder	13.2	5373	53	154,228
1741	KCPL-MO	F&M	Navy	Distribution Feeder	13.2	3980	23	66,871
1742	KCPL-MO	F&M	Navy	Distribution Feeder	13.2	4056	24	69,959
1743	KCPL-MO	F&M	Navy	Distribution Feeder	13.2	2978	13	36,654
9411	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	3917	22	64,387
9412	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	8264	303	873,941
9413	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	2781	11	32,564
9414	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	6091	82	237,278
9421	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	5855	71	205,864
9422	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	6980	140	404,451
9423	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	4457	31	89,032
9441	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	5230	49	141,510
9443	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	5328	52	150,133
9444	KCPL-MO	Northland	North Kansas City	Distribution Feeder	13.2	8808	420	1,211,329
7401	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3914	22	64,275
7402	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5689	65	186,365
7404	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4877	40	114,538
7411	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5991	77	223,396
7412	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	6347	96	276,709
7413	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4469	31	89,654
7414	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	7734	220	635,826
7421	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3275	15	43,801
7422	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	6641	114	330,053
7423	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5975	77	221,333
7424	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4956	42	120,051
7431	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5724	66	190,326
7432	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3936	23	65,115
7433	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	2680	11	30,654
7434	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4048	24	69,657
7443	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4423	30	87,193
7444	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	6025	79	228,003
7445	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4068	24	70,481
7446	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	8544	358	1,033,917
7451	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5114	46	132,049
7452	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4010	24	68,081
7453	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	5430	55	159,565
7454	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3993	23	67,369
7471	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4353	29	83,601
7472	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	923	4	10,677
7473	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	7984	256	738,496
7482	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3452	17	48,688
7483	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3610	19	53,554

Table E-2 KCPL-Missouri Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
7484	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4136	25	73,417
7485	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	2378	9	25,573
7491	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4440	31	88,114
7492	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	3332	16	45,317
7493	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4596	34	96,741
7494	KCPL-MO	F&M	Northeast	Distribution Feeder	13.2	4004	24	67,829
2301	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5192	48	138,319
2302	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	461	3	8,093
2303	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	6527	107	308,152
2304	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	3855	22	62,010
2332	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	4389	30	85,431
2333	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5767	68	195,335
2334	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5926	74	214,858
2335	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	3390	16	46,914
2341	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	7032	145	417,251
2342	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	3163	14	40,946
2343	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	9596	674	1,943,096
2352	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	6912	135	388,361
2354	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	7812	231	666,430
2355	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	6309	94	270,448
2372	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5379	54	154,801
2373	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5128	46	133,115
2374	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	5909	74	212,742
2391	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	7627	207	596,211
2392	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	712	3	9,412
2393	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	7785	227	655,392
2394	KCPL-MO	Dodson	Southtown	Distribution Feeder	13.2	7347	175	504,196
3711	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	8868	435	1,255,560
3712	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	4864	39	113,620
3713	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	2286	8	24,188
3714	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	3945	23	65,479
3721	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	4200	26	76,288
3722	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	3837	21	61,361
3723	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	4014	24	68,250
3724	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	5342	52	151,392
3731	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	10	1	1,487
3732	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	7047	146	421,140
3733	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	2236	8	23,480
3734	KCPL-MO	F&M	Terrace	Distribution Feeder	13.2	43	2	6,300
42105	KCPL-MO	East District	Brunswick	Sub-Transmission	34.5	2611	113	327,120
42106	KCPL-MO	East District	Brunswick	Sub-Transmission	34.5	4422	103	297,943
Brun R.T.	KCPL-MO	East District	Brunswick	Sub-Transmission	34.5	687	34	99,030
104101	KCPL-MO	East District	Carrollton	Sub-Transmission	34.5	14522	95	273,982
104202	KCPL-MO	East District	Carrollton	Sub-Transmission	34.5	25404	177	511,560
PO 268	KCPL-MO	East District	Carrollton	Sub-Transmission	34.5	171	9	24,626
95102	KCPL-MO	East District	Norton	Sub-Transmission	34.5	3060	111	319,171
95103	KCPL-MO	East District	Norton	Sub-Transmission	34.5	10653	89	255,350
CO 1284	KCPL-MO	East District	Norton	Sub-Transmission	34.5	7074	93	268,861
83101	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	7414	92	266,310
83103	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	7187	93	267,985
83104	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	19427	120	347,247
PO 2308	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	5874	97	280,013
PO 450	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	3477	108	312,216
PO 460	KCPL-MO	East District	Salisbury	Sub-Transmission	34.5	4965	101	290,671
127202	KCPL-MO	East District	South Waverly	Sub-Transmission	34.5	5170	100	288,102
127203	KCPL-MO	East District	South Waverly	Sub-Transmission	34.5	10260	89	255,390
CO 1440	KCPL-MO	East District	Carrollton	Sub-Transmission	34.5	2632	113	326,732
PO 448	KCPL-MO	East District	Carrollton	Sub-Transmission	34.5	13085	91	263,031
						TOTAL Loss	57,480	165,773,836

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
26611	GMO-MPS	Nevada	Iantha	Distribution Feeder	2.4	168	1	1,569
35411	GMO-MPS	Platte	Smithville	Distribution Feeder	2.4	545	28	65,921
30211	GMO-SJLP	Trenton	Modena	Distribution Feeder	2.4	91	0	735
33411	GMO-SJLP	Trenton	Ridgeway	Distribution Feeder	2.4	266	2	4,152
33412	GMO-SJLP	Trenton	Ridgeway	Distribution Feeder	2.4	367	5	11,320
36311	GMO-SJLP	Trenton	Tindall	Distribution Feeder	2.4	261	2	3,944
21811	GMO-SJLP	Trenton	Cainsville	Distribution Feeder	4.16	93	0	747
21812	GMO-SJLP	Trenton	Cainsville	Distribution Feeder	4.16	486	16	36,686
24311	GMO-SJLP	Trenton	Gilman City	Distribution Feeder	4.16	588	29	69,100
30411	GMO-SJLP	Trenton	Mt. Moriah	Distribution Feeder	4.16	161	1	1,472
35811	GMO-SJLP	Trenton	Spickard	Distribution Feeder	4.16	521	22	51,730
36532	GMO-SJLP	Trenton	Trenton	Distribution Feeder	4.16	950	48	111,726
36533	GMO-SJLP	Trenton	Trenton	Distribution Feeder	4.16	0	0	299
36534	GMO-SJLP	Trenton	Trenton	Distribution Feeder	4.16	0	0	299
36535	GMO-SJLP	Trenton	Trenton	Distribution Feeder	4.16	393	6	14,553
20811	GMO-MPS	Belton	Belton City	Distribution Feeder	4.16	1064	13	30,006
20812	GMO-MPS	Belton	Belton City	Distribution Feeder	4.16	1291	27	63,525
20813	GMO-MPS	Belton	Belton City	Distribution Feeder	4.16	607	3	6,649
21611	GMO-SJLP	Trenton	Blythedale/Eagleville	Distribution Feeder	12.47	42	0	1,028
21612	GMO-SJLP	Trenton	Blythedale/Eagleville	Distribution Feeder	12.47	1350	33	76,985
22511	GMO-MPS	Sedalia	Cole Camp City	Distribution Feeder	4.16	1572	68	160,466
22512	GMO-MPS	Sedalia	Cole Camp City	Distribution Feeder	4.16	2676	134	314,558
22621	GMO-MPS	Sedalia	Cole Camp Jct	Distribution Feeder	4.16	632	3	7,214
22711	GMO-MPS	Warrensburg	Concordia 34/4	Distribution Feeder	4.16	873	7	15,978
22712	GMO-MPS	Warrensburg	Concordia 34/4	Distribution Feeder	4.16	1169	18	42,400
22713	GMO-MPS	Warrensburg	Concordia 34/4	Distribution Feeder	4.16	603	3	6,547
26311	GMO-MPS	Warrensburg	Holden	Distribution Feeder	4.16	2043	102	240,174
26312	GMO-MPS	Warrensburg	Holden	Distribution Feeder	4.16	2092	105	245,936
26313	GMO-MPS	Warrensburg	Holden	Distribution Feeder	4.16	1419	41	96,679
26511	GMO-MPS	Nevada	Hume	Distribution Feeder	4.16	587	3	6,211
27411	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	1171	18	42,676
27412	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	1461	47	111,053
27413	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	1461	47	111,053
27421	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	799	5	12,516
27422	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	910	8	18,027
27423	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	370	1	3,041
27424	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	937	8	19,745
27431	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	650	3	7,652
27433	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	1344	32	75,566
27434	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	796	5	12,403
27435	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	662	3	7,967
27443	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	532	2	5,190
27444	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	927	8	19,094
27445	GMO-MPS	Sedalia	Kelsey Hayes	Distribution Feeder	4.16	650	3	7,659
28711	GMO-MPS	Nevada	Liberal	Distribution Feeder	4.16	1785	138	324,100
32911	GMO-MPS	Lee's Summit	Raytown No. 2	Distribution Feeder	4.16	1388	37	87,523
33811	GMO-MPS	Clinton	Rockville	Distribution Feeder	4.16	326	1	2,624
33812	GMO-MPS	Clinton	Rockville	Distribution Feeder	4.16	112	1	1,298
34311	GMO-MPS	Sedalia	Sedalia 11th & Grand	Distribution Feeder	4.16	434	2	3,750
34312	GMO-MPS	Sedalia	Sedalia 11th & Grand	Distribution Feeder	4.16	372	1	3,056
34511	GMO-MPS	Sedalia	Sedalia 6th & Kentucky	Distribution Feeder	4.16	1990	99	233,897
34811	GMO-MPS	Sedalia	Sedalia 10th & Porter	Distribution Feeder	4.16	718	4	9,589
34812	GMO-MPS	Sedalia	Sedalia 10th & Porter	Distribution Feeder	4.16	1290	27	63,224
37231	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	4.16	124	1	1,349
37234	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	4.16	1240	23	53,569
23911	GMO-MPS	Belton	Freeman	Distribution Feeder	7.2	225	8	18,040
23912	GMO-MPS	Belton	Freeman	Distribution Feeder	7.2	847	10	23,138
24811	GMO-MPS	Belton	Grandview City	Distribution Feeder	8.32	1690	14	32,418
24812	GMO-MPS	Belton	Grandview City	Distribution Feeder	8.32	1822	15	34,183
24813	GMO-MPS	Belton	Grandview City	Distribution Feeder	8.32	3347	27	62,892
24814	GMO-MPS	Belton	Grandview City	Distribution Feeder	8.32	4241	38	89,953
24815	GMO-MPS	Belton	Grandview City	Distribution Feeder	8.32	2187	17	39,549
24711	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	2037	16	37,243
24712	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	4161	37	87,093

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
24713	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	3446	28	65,444
24721	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	5235	57	133,876
24722	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	4109	36	85,308
24723	GMO-MPS	Belton	Grandview West	Distribution Feeder	8.32	6542	96	225,794
20321	GMO-MPS	Belton	Adrian	Distribution Feeder	12.47	248	12	29,206
20422	GMO-MPS	Clinton	Appleton City	Distribution Feeder	12.47	1463	34	80,014
20423	GMO-MPS	Clinton	Appleton City	Distribution Feeder	12.47	1717	37	86,354
20611	GMO-MPS	Belton	Archie	Distribution Feeder	12.47	2102	41	96,907
20913	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	3434	61	144,525
20914	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	1677	36	85,321
20921	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	7589	214	502,745
20922	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	1675	36	85,268
20925	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	10748	552	1,296,771
20941	GMO-MPS	Belton	Belton South	Distribution Feeder	12.47	8747	303	711,447
21111	GMO-MPS	Clinton	Blairstown	Distribution Feeder	12.47	575	26	61,304
21112	GMO-MPS	Clinton	Blairstown	Distribution Feeder	12.47	940	29	68,403
21211	GMO-MPS	Lee's Summit	Blue Ridge	Distribution Feeder	12.47	1908	39	91,439
21212	GMO-MPS	Lee's Summit	Blue Ridge	Distribution Feeder	12.47	1099	31	71,745
21411	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	3538	63	149,131
21412	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	5162	103	242,693
21414	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	5261	106	250,038
21421	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	9442	373	876,559
21423	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	9336	361	848,963
21431	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	8329	267	627,586
21432	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	2474	46	108,367
21433	GMO-MPS	Blue Springs	Blue Springs East	Distribution Feeder	12.47	4141	76	178,654
21511	GMO-MPS	Blue Springs	Blue Springs South	Distribution Feeder	12.47	7708	222	521,026
21512	GMO-MPS	Blue Springs	Blue Springs South	Distribution Feeder	12.47	5629	119	279,182
21513	GMO-MPS	Blue Springs	Blue Springs South	Distribution Feeder	12.47	6121	138	323,661
21521	GMO-MPS	Blue Springs	Blue Springs South	Distribution Feeder	12.47	1112	31	72,013
21522	GMO-MPS	Blue Springs	Blue Springs South	Distribution Feeder	12.47	922	29	68,034
21311	GMO-MPS	Blue Springs	Blue Springs West	Distribution Feeder	12.47	9214	348	818,414
21312	GMO-MPS	Blue Springs	Blue Springs West	Distribution Feeder	12.47	8696	298	700,702
21321	GMO-MPS	Blue Springs	Blue Springs West	Distribution Feeder	12.47	4969	97	229,071
21322	GMO-MPS	Blue Springs	Blue Springs West	Distribution Feeder	12.47	7040	181	426,312
21323	GMO-MPS	Blue Springs	Blue Springs West	Distribution Feeder	12.47	5694	121	284,698
21711	GMO-MPS	Clinton	Brownington	Distribution Feeder	12.47	447	25	58,995
21911	GMO-MPS	Warrensburg	Calhoun	Distribution Feeder	12.47	2286	44	102,415
22011	GMO-MPS	Warrensburg	Centerview	Distribution Feeder	12.47	514	26	60,190
22012	GMO-MPS	Warrensburg	Centerview	Distribution Feeder	12.47	1772	37	87,778
22311	GMO-MPS	Clinton	Clinton Plant	Distribution Feeder	12.47	6163	139	327,706
22312	GMO-MPS	Clinton	Clinton Plant	Distribution Feeder	12.47	6424	151	354,384
22313	GMO-MPS	Clinton	Clinton Plant	Distribution Feeder	12.47	5441	112	263,921
22811	GMO-MPS	Warrensburg	Concordia 69	Distribution Feeder	12.47	4969	97	229,071
22812	GMO-MPS	Warrensburg	Concordia 69	Distribution Feeder	12.47	2588	48	112,137
23211	GMO-MPS	Clinton	Deepwater	Distribution Feeder	12.47	259	13	30,418
23213	GMO-MPS	Clinton	Deepwater	Distribution Feeder	12.47	984	29	69,293
11801	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	6365	148	348,219
11822	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	4415	83	194,003
11823	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	4026	73	172,622
11824	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	5009	99	231,862
11831	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	6945	176	414,398
11832	GMO-MPS	Blue Springs	Duncan Road	Distribution Feeder	12.47	8803	308	723,653
23511	GMO-MPS	Clinton	East Lynn	Distribution Feeder	12.47	1163	31	73,129
23513	GMO-MPS	Clinton	East Lynn	Distribution Feeder	12.47	551	26	60,865
23711	GMO-MPS	Warrensburg	Elm	Distribution Feeder	12.47	4680	89	210,025
23712	GMO-MPS	Warrensburg	Elm	Distribution Feeder	12.47	1098	31	71,720
24011	GMO-MPS	Lee's Summit	Frost Road	Distribution Feeder	12.47	8944	321	754,926
24012	GMO-MPS	Lee's Summit	Frost Road	Distribution Feeder	12.47	9839	420	987,279
24013	GMO-MPS	Lee's Summit	Frost Road	Distribution Feeder	12.47	5665	120	282,233
24021	GMO-MPS	Lee's Summit	Frost Road	Distribution Feeder	12.47	9093	336	789,454
24023	GMO-MPS	Lee's Summit	Frost Road	Distribution Feeder	12.47	7156	188	441,401
24211	GMO-MPS	Clinton	Garden City	Distribution Feeder	12.47	1711	37	86,190
24212	GMO-MPS	Clinton	Garden City	Distribution Feeder	12.47	1618	36	83,833
24511	GMO-MPS	Blue Springs	Grain Valley	Distribution Feeder	12.47	8484	280	657,481

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
24512	GMO-MPS	Blue Springs	Grain Valley	Distribution Feeder	12.47	9095	336	789,700
24513	GMO-MPS	Blue Springs	Grain Valley	Distribution Feeder	12.47	4274	79	185,980
24611	GMO-MPS	Belton	Grandview East	Distribution Feeder	12.47	5198	104	245,345
24612	GMO-MPS	Belton	Grandview East	Distribution Feeder	12.47	4602	87	205,158
24613	GMO-MPS	Belton	Grandview East	Distribution Feeder	12.47	3786	68	160,621
24622	GMO-MPS	Belton	Grandview East	Distribution Feeder	12.47	5168	103	243,146
24623	GMO-MPS	Belton	Grandview East	Distribution Feeder	12.47	6369	148	348,599
22121	GMO-MPS	Clinton	Green Street	Distribution Feeder	12.47	3832	69	162,868
22122	GMO-MPS	Clinton	Green Street	Distribution Feeder	12.47	6591	158	372,599
22123	GMO-MPS	Clinton	Green Street	Distribution Feeder	12.47	6457	152	357,912
24912	GMO-MPS	Warrensburg	Greenridge	Distribution Feeder	12.47	1391	33	78,312
25311	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	5441	112	263,943
25312	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	8981	325	763,165
25313	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	2311	44	103,177
25321	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	10195	467	1,098,539
25322	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	6447	152	356,870
25323	GMO-MPS	Liberty	Hallmark	Distribution Feeder	12.47	1774	37	87,849
25211	GMO-MPS	Lee's Summit	Harris Road	Distribution Feeder	12.47	6158	139	327,198
25212	GMO-MPS	Lee's Summit	Harris Road	Distribution Feeder	12.47	2279	43	102,193
25611	GMO-MPS	Lee's Summit	Harrisonville Lake	Distribution Feeder	12.47	222	11	26,042
25612	GMO-MPS	Lee's Summit	Harrisonville Lake	Distribution Feeder	12.47	1655	36	84,766
25411	GMO-MPS	Belton	Harrisonville West	Distribution Feeder	12.47	1060	30	70,903
25412	GMO-MPS	Belton	Harrisonville West	Distribution Feeder	12.47	507	26	60,068
25413	GMO-MPS	Belton	Harrisonville West	Distribution Feeder	12.47	871	28	66,986
25911	GMO-MPS	Nevada	Harwood	Distribution Feeder	12.47	116	23	53,414
25912	GMO-MPS	Nevada	Harwood	Distribution Feeder	12.47	57	22	52,477
25913	GMO-MPS	Nevada	Harwood	Distribution Feeder	12.47	17	1	1,947
25111	GMO-MPS	Belton	Honeywell	Distribution Feeder	12.47	4723	90	212,749
25121	GMO-MPS	Belton	Honeywell	Distribution Feeder	12.47	3421	61	143,988
26411	GMO-MPS	Lee's Summit	Hook Road	Distribution Feeder	12.47	7901	235	552,009
26412	GMO-MPS	Lee's Summit	Hook Road	Distribution Feeder	12.47	6857	172	403,635
26421	GMO-MPS	Lee's Summit	Hook Road	Distribution Feeder	12.47	8795	307	721,908
26423	GMO-MPS	Lee's Summit	Hook Road	Distribution Feeder	12.47	9687	401	943,219
26111	GMO-MPS	Warrensburg	Hwy 13 & 40 Jct.	Distribution Feeder	12.47	989	30	69,413
26112	GMO-MPS	Warrensburg	Hwy 13 & 40 Jct.	Distribution Feeder	12.47	424	25	58,583
26211	GMO-MPS	Liberty	Hwy 92	Distribution Feeder	12.47	1242	32	74,887
26711	GMO-SJLP	Trenton	Jamesport	Distribution Feeder	12.47	2181	42	99,244
26712	GMO-SJLP	Trenton	Jamesport	Distribution Feeder	12.47	589	26	61,560
27111	GMO-MPS	Lee's Summit	KC South	Distribution Feeder	12.47	4621	88	206,372
27113	GMO-MPS	Lee's Summit	KC South	Distribution Feeder	12.47	7454	205	482,702
27121	GMO-MPS	Lee's Summit	KC South	Distribution Feeder	12.47	4731	91	213,279
27011	GMO-MPS	Platte	KCI	Distribution Feeder	12.47	932	29	68,225
27013	GMO-MPS	Platte	KCI	Distribution Feeder	12.47	2139	42	98,010
27021	GMO-MPS	Platte	KCI	Distribution Feeder	12.47	1232	32	74,655
27022	GMO-MPS	Platte	KCI	Distribution Feeder	12.47	621	26	62,155
27023	GMO-MPS	Platte	KCI	Distribution Feeder	12.47	1249	32	75,039
27211	GMO-MPS	Warrensburg	Kingsville	Distribution Feeder	12.47	489	25	59,731
27212	GMO-MPS	Warrensburg	Kingsville	Distribution Feeder	12.47	1063	30	70,975
27213	GMO-MPS	Warrensburg	Kingsville	Distribution Feeder	12.47	200	10	23,513
27214	GMO-MPS	Warrensburg	Kingsville	Distribution Feeder	12.47	3533	63	148,893
27215	GMO-MPS	Warrensburg	Kingsville	Distribution Feeder	12.47	976	29	69,137
27511	GMO-MPS	Warrensburg	Knob Noster	Distribution Feeder	12.47	2647	49	114,144
27513	GMO-MPS	Warrensburg	Knob Noster	Distribution Feeder	12.47	6148	139	326,273
27711	GMO-MPS	Lee's Summit	Lake Winnebago	Distribution Feeder	12.47	5027	99	233,090
27712	GMO-MPS	Lee's Summit	Lake Winnebago	Distribution Feeder	12.47	7716	222	522,160
27721	GMO-MPS	Lee's Summit	Lake Winnebago	Distribution Feeder	12.47	5159	103	242,467
27722	GMO-MPS	Lee's Summit	Lake Winnebago	Distribution Feeder	12.47	6224	142	333,767
27612	GMO-MPS	Clinton	Lakeland School	Distribution Feeder	12.47	348	29	68,179
28111	GMO-MPS	Blue Springs	Lakewood	Distribution Feeder	12.47	6640	161	378,164
28112	GMO-MPS	Blue Springs	Lakewood	Distribution Feeder	12.47	10725	548	1,287,895
28121	GMO-MPS	Blue Springs	Lakewood	Distribution Feeder	12.47	9701	403	947,171
28122	GMO-MPS	Blue Springs	Lakewood	Distribution Feeder	12.47	5619	118	278,363
27821	GMO-MPS	Nevada	Lamar	Distribution Feeder	12.47	2485	46	108,708
27911	GMO-MPS	Warrensburg	Lamonte	Distribution Feeder	12.47	1714	37	86,280
28011	GMO-SJLP	Trenton	Laredo	Distribution Feeder	12.47	539	26	60,649

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
28012	GMO-SJLP	Trenton	Laredo	Distribution Feeder	12.47	1290	32	75,964
28211	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	7864	232	545,872
28212	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	12997	29	68,179
28214	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	6471	153	359,483
28221	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	10911	579	1,361,991
28224	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	10535	517	1,216,406
28231	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	6960	177	416,238
28232	GMO-MPS	Lee's Summit	Lees Summit East	Distribution Feeder	12.47	3373	60	141,901
28411	GMO-MPS	Warrensburg	Leeton	Distribution Feeder	12.47	1097	30	71,689
28412	GMO-MPS	Warrensburg	Leeton	Distribution Feeder	12.47	593	26	61,627
28511	GMO-MPS	Henrietta	Lexington	Distribution Feeder	12.47	5023	99	232,838
28512	GMO-MPS	Henrietta	Lexington	Distribution Feeder	12.47	5498	114	268,487
28513	GMO-MPS	Henrietta	Lexington	Distribution Feeder	12.47	7034	181	425,550
28721	GMO-MPS	Nevada	Liberal	Distribution Feeder	12.47	465	25	59,308
29011	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	3209	57	135,106
29012	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	7557	212	497,928
29021	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	10137	459	1,079,655
29022	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	1118	31	72,147
29041	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	2996	54	126,733
29042	GMO-MPS	Liberty	Liberty Moss St	Distribution Feeder	12.47	11872	773	1,816,945
29211	GMO-MPS	Liberty	Liberty South	Distribution Feeder	12.47	7896	234	551,233
29212	GMO-MPS	Liberty	Liberty South	Distribution Feeder	12.47	3377	60	142,093
29221	GMO-MPS	Liberty	Liberty South	Distribution Feeder	12.47	5923	130	304,945
29112	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	9969	437	1,026,679
29113	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	9790	414	972,997
29121	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	4979	98	229,738
29122	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	5475	113	266,584
29123	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	12093	826	1,941,724
29131	GMO-MPS	Liberty	Liberty West	Distribution Feeder	12.47	3219	58	135,487
29311	GMO-MPS	Sedalia	Lincoln	Distribution Feeder	12.47	3697	67	156,387
29312	GMO-MPS	Sedalia	Lincoln	Distribution Feeder	12.47	924	29	68,077
28311	GMO-MPS	Lee's Summit	Longview	Distribution Feeder	12.47	7826	230	539,803
28312	GMO-MPS	Lee's Summit	Longview	Distribution Feeder	12.47	5963	131	308,641
28321	GMO-MPS	Lee's Summit	Longview	Distribution Feeder	12.47	8075	247	581,576
28322	GMO-MPS	Lee's Summit	Longview	Distribution Feeder	12.47	3520	63	148,299
28323	GMO-MPS	Lee's Summit	Longview	Distribution Feeder	12.47	5280	107	251,439
29611	GMO-MPS	Clinton	Lowry City	Distribution Feeder	12.47	683	27	63,315
29612	GMO-MPS	Clinton	Lowry City	Distribution Feeder	12.47	684	27	63,334
30311	GMO-MPS	Clinton	Montrose City	Distribution Feeder	12.47	321	16	37,739
30312	GMO-MPS	Clinton	Montrose City	Distribution Feeder	12.47	564	26	61,092
30313	GMO-MPS	Clinton	Montrose City	Distribution Feeder	12.47	233	12	27,436
30711	GMO-MPS	Nevada	Nevada 3M	Distribution Feeder	12.47	4845	94	220,691
30713	GMO-MPS	Nevada	Nevada 3M	Distribution Feeder	12.47	8125	251	590,310
30721	GMO-MPS	Nevada	Nevada 3M	Distribution Feeder	12.47	4924	96	225,962
30722	GMO-MPS	Nevada	Nevada 3M	Distribution Feeder	12.47	9839	420	987,279
30611	GMO-MPS	Nevada	Nevada Plant	Distribution Feeder	12.47	2981	54	126,183
30612	GMO-MPS	Nevada	Nevada Plant	Distribution Feeder	12.47	4472	84	197,346
30613	GMO-MPS	Nevada	Nevada Plant	Distribution Feeder	12.47	3168	57	133,438
30614	GMO-MPS	Nevada	Nevada Plant	Distribution Feeder	12.47	4555	86	202,310
31011	GMO-MPS	Henrietta	Norborne	Distribution Feeder	12.47	435	25	58,772
31012	GMO-MPS	Henrietta	Norborne	Distribution Feeder	12.47	1455	34	79,815
31111	GMO-MPS	Blue Springs	Oak Grove	Distribution Feeder	12.47	9110	337	793,387
31112	GMO-MPS	Blue Springs	Oak Grove	Distribution Feeder	12.47	4969	97	229,071
31113	GMO-MPS	Blue Springs	Oak Grove	Distribution Feeder	12.47	621	26	62,155
31121	GMO-MPS	Blue Springs	Oak Grove	Distribution Feeder	12.47	4356	81	190,599
31311	GMO-MPS	Henrietta	Orrick	Distribution Feeder	12.47	3339	60	140,454
31312	GMO-MPS	Henrietta	Orrick	Distribution Feeder	12.47	2100	41	96,877
31511	GMO-MPS	Clinton	Osceola	Distribution Feeder	12.47	923	29	68,056
31512	GMO-MPS	Clinton	Osceola	Distribution Feeder	12.47	2072	41	96,066
31513	GMO-MPS	Clinton	Osceola	Distribution Feeder	12.47	3611	65	152,412
31611	GMO-MPS	Belton	Peculiar	Distribution Feeder	12.47	7333	198	465,477
31612	GMO-MPS	Belton	Peculiar	Distribution Feeder	12.47	2931	53	124,278
32311	GMO-MPS	Warrensburg	Post Oak Rural	Distribution Feeder	12.47	462	25	59,257
32312	GMO-MPS	Warrensburg	Post Oak Rural	Distribution Feeder	12.47	204	10	23,946
32511	GMO-MPS	Blue Springs	Prairie Lee	Distribution Feeder	12.47	2684	49	115,423

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
32513	GMO-MPS	Blue Springs	Prairie Lee	Distribution Feeder	12.47	6641	161	378,267
32521	GMO-MPS	Blue Springs	Prairie Lee	Distribution Feeder	12.47	9277	355	834,066
32522	GMO-MPS	Blue Springs	Prairie Lee	Distribution Feeder	12.47	7521	210	492,545
32611	GMO-MPS	Lee's Summit	Ralph Green	Distribution Feeder	12.47	1035	30	70,377
32612	GMO-MPS	Lee's Summit	Ralph Green	Distribution Feeder	12.47	4595	87	204,776
32633	GMO-MPS	Lee's Summit	Ralph Green	Distribution Feeder	12.47	8515	282	663,636
32711	GMO-MPS	Belton	Raymore	Distribution Feeder	12.47	4864	94	221,928
32712	GMO-MPS	Belton	Raymore	Distribution Feeder	12.47	9107	337	792,648
32721	GMO-MPS	Belton	Raymore	Distribution Feeder	12.47	9224	349	820,960
32722	GMO-MPS	Belton	Raymore	Distribution Feeder	12.47	9928	431	1,014,003
32723	GMO-MPS	Belton	Raymore	Distribution Feeder	12.47	4655	89	208,498
32812	GMO-MPS	Belton	Raymore North	Distribution Feeder	12.47	6683	163	383,115
33011	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	7661	218	513,635
33012	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	4659	89	208,692
33013	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	6004	133	312,499
33021	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	6729	165	388,386
33022	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	6108	137	322,356
33023	GMO-MPS	Lee's Summit	Raytown No. 1	Distribution Feeder	12.47	5694	121	284,698
33211	GMO-MPS	Nevada	Rich Hill	Distribution Feeder	12.47	93	5	10,952
33212	GMO-MPS	Nevada	Rich Hill	Distribution Feeder	12.47	3352	60	141,023
33312	GMO-MPS	Henrietta	Richmond	Distribution Feeder	12.47	4007	73	171,659
33313	GMO-MPS	Henrietta	Richmond	Distribution Feeder	12.47	7069	183	430,035
33321	GMO-MPS	Henrietta	Richmond	Distribution Feeder	12.47	4673	89	209,601
33322	GMO-MPS	Henrietta	Richmond	Distribution Feeder	12.47	8202	257	604,222
34013	GMO-MPS	Nevada	Schell City	Distribution Feeder	12.47	612	26	61,982
34211	GMO-MPS	Sedalia	Sedalia East	Distribution Feeder	12.47	4348	81	190,126
34212	GMO-MPS	Sedalia	Sedalia East	Distribution Feeder	12.47	7868	232	546,551
34221	GMO-MPS	Sedalia	Sedalia East	Distribution Feeder	12.47	2584	48	111,998
34222	GMO-MPS	Sedalia	Sedalia East	Distribution Feeder	12.47	8845	312	732,750
34411	GMO-MPS	Sedalia	Sedalia Pittsburg-Corn	Distribution Feeder	12.47	4472	84	197,346
34711	GMO-MPS	Sedalia	Sedalia Plant, 9th & In	Distribution Feeder	12.47	9524	382	898,331
34712	GMO-MPS	Sedalia	Sedalia Plant, 9th & In	Distribution Feeder	12.47	6729	165	388,386
34131	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	9541	384	902,806
34132	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	7156	188	441,401
34141	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	10352	490	1,151,701
34142	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	8944	321	754,926
34151	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	8360	269	633,429
34152	GMO-MPS	Sedalia	Sedalia West	Distribution Feeder	12.47	5029	99	233,234
35011	GMO-MPS	Nevada	Sheldon	Distribution Feeder	12.47	1478	34	80,382
35012	GMO-MPS	Nevada	Sheldon	Distribution Feeder	12.47	273	14	32,127
35111	GMO-MPS	Blue Springs	Sibley	Distribution Feeder	12.47	3960	72	169,224
35112	GMO-MPS	Blue Springs	Sibley	Distribution Feeder	12.47	3429	61	144,301
35912	GMO-MPS	Liberty	Staley Road	Distribution Feeder	12.47	10923	581	1,366,909
35913	GMO-MPS	Liberty	Staley Road	Distribution Feeder	12.47	5890	128	302,003
35921	GMO-MPS	Liberty	Staley Road	Distribution Feeder	12.47	2872	52	122,101
35922	GMO-MPS	Liberty	Staley Road	Distribution Feeder	12.47	8541	285	668,892
35923	GMO-MPS	Liberty	Staley Road	Distribution Feeder	12.47	3145	56	132,537
36011	GMO-MPS	Warrensburg	Strasburg	Distribution Feeder	12.47	2290	44	102,554
36012	GMO-MPS	Warrensburg	Strasburg	Distribution Feeder	12.47	989	30	69,414
36111	GMO-MPS	Blue Springs	Strother Road	Distribution Feeder	12.47	5153	103	242,091
36112	GMO-MPS	Blue Springs	Strother Road	Distribution Feeder	12.47	5041	100	234,033
36113	GMO-MPS	Blue Springs	Strother Road	Distribution Feeder	12.47	10023	444	1,043,394
36521	GMO-SJLP	Trenton	Trenton	Distribution Feeder	12.47	2155	42	98,485
36611	GMO-MPS	Belton	Turner Road	Distribution Feeder	12.47	6159	139	327,300
36612	GMO-MPS	Belton	Turner Road	Distribution Feeder	12.47	2434	46	107,066
36621	GMO-MPS	Belton	Turner Road	Distribution Feeder	12.47	8949	322	755,865
36622	GMO-MPS	Belton	Turner Road	Distribution Feeder	12.47	1499	34	80,883
36623	GMO-MPS	Belton	Turner Road	Distribution Feeder	12.47	4659	89	208,692
36711	GMO-MPS	Platte	TWA	Distribution Feeder	12.47	2981	54	126,183
36712	GMO-MPS	Platte	TWA	Distribution Feeder	12.47	1193	31	73,779
36722	GMO-MPS	Platte	TWA	Distribution Feeder	12.47	1006	30	69,768
36723	GMO-MPS	Platte	TWA	Distribution Feeder	12.47	3131	56	131,955
37013	GMO-MPS	Clinton	Urich	Distribution Feeder	12.47	4621	88	206,372
37111	GMO-MPS	Nevada	Walker	Distribution Feeder	12.47	150	8	17,645
37112	GMO-MPS	Nevada	Walker	Distribution Feeder	12.47	512	26	60,161

Table E-3 MPS Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
37311	GMO-MPS	Warrensburg	Warrensburg East	Distribution Feeder	12.47	6505	154	363,187
37313	GMO-MPS	Warrensburg	Warrensburg East	Distribution Feeder	12.47	8626	292	686,059
37321	GMO-MPS	Warrensburg	Warrensburg East	Distribution Feeder	12.47	8756	303	713,438
37322	GMO-MPS	Warrensburg	Warrensburg East	Distribution Feeder	12.47	11114	616	1,447,473
37323	GMO-MPS	Warrensburg	Warrensburg East	Distribution Feeder	12.47	6260	144	337,414
37211	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	12.47	7006	180	422,096
37212	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	12.47	8199	257	603,659
37221	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	12.47	4621	88	206,372
37222	GMO-MPS	Warrensburg	Warrensburg Plant	Distribution Feeder	12.47	4141	76	178,676
37511	GMO-MPS	Sedalia	Warsaw	Distribution Feeder	12.47	4249	78	184,541
37521	GMO-MPS	Sedalia	Warsaw	Distribution Feeder	12.47	5292	107	252,378
37522	GMO-MPS	Sedalia	Warsaw	Distribution Feeder	12.47	6410	150	352,956
37611	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	9938	433	1,017,157
37612	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	5963	131	308,641
37613	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	7426	204	478,671
37614	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	5565	117	273,943
37621	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	6162	139	327,605
37622	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	9286	356	836,401
37623	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	10733	549	1,291,145
37624	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	6758	167	391,778
37631	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	6477	153	360,154
37632	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	12739	1002	2,356,327
37641	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	4621	88	206,372
37642	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	10913	580	1,362,837
37644	GMO-MPS	Lee's Summit	Western Electric	Distribution Feeder	12.47	6016	133	313,568
38011	GMO-MPS	Warrensburg	Whiteman AFB East Di	Distribution Feeder	12.47	13439	1237	2,907,693
37711	GMO-MPS	Warrensburg	Whiteman AFB West D	Distribution Feeder	12.47	3304	59	139,022
38111	GMO-MPS	Warrensburg	Windsor	Distribution Feeder	12.47	3014	54	127,404
38112	GMO-MPS	Warrensburg	Windsor	Distribution Feeder	12.47	4141	76	178,676
247111	GMO-SJLP	Trenton	Bethany N.W. Sub(N W	Distribution Feeder	13.8	673	27	63,134
32131	GMO-MPS	Platte	Pope Lane	Distribution Feeder	13.8	575	3	7,066
32132	GMO-MPS	Platte	Pope Lane	Distribution Feeder	13.8	12367	618	1,453,803
35511	GMO-MPS	Platte	Smithville	Distribution Feeder	13.8	6720	120	282,085
35512	GMO-MPS	Platte	Smithville	Distribution Feeder	13.8	4745	37	86,261
35522	GMO-MPS	Platte	Smithville	Distribution Feeder	13.8	3640	19	44,445
20311	GMO-MPS	Belton	Adrian	Distribution Feeder	24.9	6082	38	89,988
23811	GMO-MPS	Platte	Ferrelview	Distribution Feeder	24.9	5837	37	87,811
23812	GMO-MPS	Platte	Ferrelview	Distribution Feeder	24.9	16672	110	259,501
23813	GMO-MPS	Platte	Ferrelview	Distribution Feeder	24.9	21606	181	424,999
23822	GMO-MPS	Platte	Ferrelview	Distribution Feeder	24.9	26060	282	663,502
23823	GMO-MPS	Platte	Ferrelview	Distribution Feeder	24.9	6696	41	95,690
14221	GMO-MPS	Platte	North Congress	Distribution Feeder	24.9	4506	33	76,869
31911	GMO-MPS	Platte	Platte City	Distribution Feeder	24.9	21001	170	400,084
31912	GMO-MPS	Platte	Platte City	Distribution Feeder	24.9	16037	104	243,539
32111	GMO-MPS	Platte	Pope Lane	Distribution Feeder	24.9	5706	37	86,676
204111	GMO-MPS	Clinton	Appleton City	Sub-Transmission	34.5	1275	64	149,835
204112	GMO-MPS	Clinton	Appleton City	Sub-Transmission	34.5	596	30	70,099
226111	GMO-MPS	Sedalia	Cole Camp Jct	Sub-Transmission	34.5	7442	92	216,929
226112	GMO-MPS	Sedalia	Cole Camp Jct	Sub-Transmission	34.5	5155	100	235,003
22821	GMO-MPS	Warrensburg	Concordia 69	Sub-Transmission	34.5	3039	111	260,491
278109	GMO-MPS	Nevada	Lamar	Sub-Transmission	34.5	4280	104	244,515
300111	GMO-MPS	Nevada	Metz	Sub-Transmission	34.5	1636	120	282,027
31411	GMO-MPS	Clinton	Osceola 161	Sub-Transmission	34.5	6891	94	220,386
322111	GMO-MPS	Warrensburg	Post Oak 69/34kV	Sub-Transmission	34.5	2777	112	264,232
322112	GMO-MPS	Warrensburg	Post Oak 69/34kV	Sub-Transmission	34.5	4687	102	239,916
326R24	GMO-MPS	Lee's Summit	Ralph Green	Sub-Transmission	34.5	2806	112	263,811
3526R22	GMO-MPS	Lee's Summit	Ralph Green	Sub-Transmission	34.5	2221	116	272,588
33511	GMO-SJLP	Trenton	Ridgeway (N W) 34kV S	Sub-Transmission	34.5	3680	107	251,874
						TOTAL Loss	47,394	111,424,980

Table E-4 SJLP Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
40311	GMO-SJLP	St Joe	Krause Mills	Distribution Feeder	2.4	0	0	0
38211	GMO-SJLP	St Joe	Ajax	Distribution Feeder	12.47	8357	269	876,470
38221	GMO-SJLP	St Joe	Ajax	Distribution Feeder	12.47	5411	111	362,188
38231	GMO-SJLP	St Joe	Ajax	Distribution Feeder	12.47	7428	204	663,288
38241	GMO-SJLP	St Joe	Ajax	Distribution Feeder	12.47	3953	72	233,853
38311	GMO-SJLP	St Joe	Alabama Street	Distribution Feeder	12.47	5677	120	392,287
38312	GMO-SJLP	St Joe	Alabama Street	Distribution Feeder	12.47	5492	114	371,111
38313	GMO-SJLP	St Joe	Alabama Street	Distribution Feeder	12.47	1726	37	119,906
38321	GMO-SJLP	St Joe	Alabama Street	Distribution Feeder	12.47	6552	157	510,043
38322	GMO-SJLP	St Joe	Alabama Street	Distribution Feeder	12.47	7062	183	594,233
38511	GMO-SJLP	St Joe	Belt Junction	Distribution Feeder	12.47	3197	57	186,391
38521	GMO-SJLP	St Joe	Belt Junction	Distribution Feeder	12.47	9699	403	1,311,124
38531	GMO-SJLP	St Joe	Belt Junction	Distribution Feeder	12.47	5457	113	367,151
38541	GMO-SJLP	St Joe	Belt Junction	Distribution Feeder	12.47	1908	39	126,629
38561	GMO-SJLP	St Joe	Belt Junction	Distribution Feeder	12.47	2644	48	157,891
38611	GMO-SJLP	Maryville	Brown's Curve	Distribution Feeder	12.47	916	29	94,027
38711	GMO-SJLP	Maryville	Burlington Junction	Distribution Feeder	12.47	375	25	79,937
38712	GMO-SJLP	Maryville	Burlington Junction	Distribution Feeder	12.47	2749	50	162,935
38821	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	6403	150	487,664
38822	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	4622	88	285,861
38823	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	5134	102	333,288
38824	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	4303	80	259,737
38831	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	6786	168	547,100
38832	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	8228	259	843,213
38833	GMO-SJLP	St Joe	Cook Road	Distribution Feeder	12.47	7311	197	640,458
39031	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	8546	285	927,547
39032	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	7083	184	598,100
39033	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	8925	319	1,039,335
39041	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	2894	52	170,190
39042	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	8429	275	895,549
39043	GMO-SJLP	St Joe	East Side	Distribution Feeder	12.47	8989	325	1,059,334
43611	GMO-SJLP	St Joe	Eastowne	Distribution Feeder	12.47	2061	41	132,575
43612	GMO-SJLP	St Joe	Eastowne	Distribution Feeder	12.47	6234	142	463,614
39151	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	2616	48	156,563
39152	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	3519	63	205,301
39153	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	3754	68	220,317
39154	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	518	26	83,454
39161	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	5587	117	381,799
39162	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	459	25	81,981
39163	GMO-SJLP	St Joe	Edmond Street	Distribution Feeder	12.47	1312	33	105,903
39311	GMO-SJLP	Maryville	Fairfax	Distribution Feeder	12.47	2562	47	154,078
39411	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	2038	40	131,662
39412	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	4990	98	319,182
39421	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	647	27	86,731
39431	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	6145	139	451,368
39441	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	3588	64	209,596
39442	GMO-SJLP	Maryville	Fillmore Street	Distribution Feeder	12.47	3734	67	219,010
39511	GMO-SJLP	St Joe	Gower	Distribution Feeder	12.47	4751	91	297,084
39521	GMO-SJLP	St Joe	Gower	Distribution Feeder	12.47	3139	56	183,190
39611	GMO-SJLP	Maryville	Grant City	Distribution Feeder	12.47	1112	31	99,719

Table E-4 SJLP Distribution Feeder Losses								
KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
39612	GMO-SJLP	Maryville	Grant City	Distribution Feeder	12.47	1303	32	105,616
40011	GMO-SJLP	St Joe	Industrial Park	Distribution Feeder	12.47	8712	299	974,843
40021	GMO-SJLP	St Joe	Industrial Park	Distribution Feeder	12.47	9258	353	1,148,556
40121	GMO-SJLP	St Joe	Kellog	Distribution Feeder	12.47	3480	62	202,928
40122	GMO-SJLP	St Joe	Kellog	Distribution Feeder	12.47	1367	33	107,644
40211	GMO-SJLP	St Joe	King City	Distribution Feeder	12.47	1558	35	113,986
40212	GMO-SJLP	St Joe	King City	Distribution Feeder	12.47	1654	36	117,323
40432	GMO-SJLP	St Joe	Lake Road	Distribution Feeder	12.47	3064	55	179,110
40611	GMO-SJLP	Maryville	Maitland	Distribution Feeder	12.47	2174	42	137,139
40761	GMO-SJLP	Maryville	Maryville	Distribution Feeder	12.47	4998	98	319,941
40781	GMO-SJLP	Maryville	Maryville	Distribution Feeder	12.47	7659	218	710,821
40782	GMO-SJLP	Maryville	Maryville	Distribution Feeder	12.47	3837	69	225,855
40911	GMO-SJLP	St Joe	Messanie Street	Distribution Feeder	12.47	5999	133	432,002
40921	GMO-SJLP	St Joe	Messanie Street	Distribution Feeder	12.47	3836	69	225,772
40931	GMO-SJLP	St Joe	Messanie Street	Distribution Feeder	12.47	4800	93	301,478
40941	GMO-SJLP	St Joe	Messanie Street	Distribution Feeder	12.47	5191	104	339,063
41311	GMO-SJLP	Maryville	Mound City	Distribution Feeder	12.47	3590	64	209,738
41321	GMO-SJLP	Maryville	Mound City	Distribution Feeder	12.47	2023	40	131,060
41411	GMO-SJLP	St Joe	Muddy Creek	Distribution Feeder	12.47	4615	88	285,237
41412	GMO-SJLP	St Joe	Muddy Creek	Distribution Feeder	12.47	1538	35	113,330
41511	GMO-SJLP	Maryville	Nodaway	Distribution Feeder	12.47	4083	75	243,152
41521	GMO-SJLP	Maryville	Nodaway	Distribution Feeder	12.47	8448	277	900,592
38911	GMO-SJLP	Maryville	North Ward (Craig)	Distribution Feeder	12.47	862	28	92,527
41611	GMO-SJLP	St Joe	Oak Street	Distribution Feeder	12.47	3513	63	204,932
41621	GMO-SJLP	St Joe	Oak Street	Distribution Feeder	12.47	4058	74	241,309
41631	GMO-SJLP	St Joe	Oak Street	Distribution Feeder	12.47	1956	39	128,470
41641	GMO-SJLP	St Joe	Oak Street	Distribution Feeder	12.47	7226	192	624,283
41711	GMO-SJLP	Maryville	Oregon	Distribution Feeder	12.47	2366	45	145,249
41721	GMO-SJLP	Maryville	Oregon	Distribution Feeder	12.47	2464	46	149,599
41811	GMO-SJLP	Maryville	Parnell	Distribution Feeder	12.47	1051	30	97,908
PO2475-11	GMO-SJLP	Maryville	Phelps City	Distribution Feeder	12.47	1888	39	125,874
41911	GMO-SJLP	Maryville	Pickering	Distribution Feeder	12.47	1863	38	124,939
4210151	GMO-SJLP	St Joe	Quaker Oats	Distribution Feeder	12.47	7770	226	735,050
4210152	GMO-SJLP	St Joe	Quaker Oats	Distribution Feeder	12.47	4932	96	313,675
42212	GMO-SJLP	Maryville	Ravenwood	Distribution Feeder	12.47	1540	35	113,373
42213	GMO-SJLP	Maryville	Ravenwood	Distribution Feeder	12.47	1421	34	109,415
42411	GMO-SJLP	St Joe	Rochester	Distribution Feeder	12.47	699	27	88,097
42412	GMO-SJLP	St Joe	Rochester	Distribution Feeder	12.47	595	26	85,403
42511	GMO-SJLP	St Joe	Rosecrans	Distribution Feeder	12.47	320	24	78,631
42521	GMO-SJLP	St Joe	Rosecrans	Distribution Feeder	12.47	1858	38	124,745
42611	GMO-SJLP	St Joe	Rushville	Distribution Feeder	12.47	1863	38	124,929
42612	GMO-SJLP	St Joe	Rushville	Distribution Feeder	12.47	1863	38	124,929
42711	GMO-SJLP	St Joe	Savannah	Distribution Feeder	12.47	8791	307	998,367
42721	GMO-SJLP	St Joe	Savannah	Distribution Feeder	12.47	4052	74	240,895
42731	GMO-SJLP	St Joe	Savannah	Distribution Feeder	12.47	4518	85	277,027
39815	GMO-SJLP	St Joe	Snow Creek	Distribution Feeder	12.47	3094	56	180,746
398051	GMO-SJLP	St Joe	Snow Creek	Distribution Feeder	12.47	980	29	95,862
43021	GMO-SJLP	Maryville	Tarkio	Distribution Feeder	12.47	950	29	94,996
43022	GMO-SJLP	Maryville	Tarkio	Distribution Feeder	12.47	989	30	96,107
43031	GMO-SJLP	Maryville	Tarkio	Distribution Feeder	12.47	1571	35	114,456
43032	GMO-SJLP	Maryville	Tarkio	Distribution Feeder	12.47	2675	49	159,403
43311	GMO-SJLP	St Joe	Woodbine	Distribution Feeder	12.47	4959	97	316,248
43312	GMO-SJLP	St Joe	Woodbine	Distribution Feeder	12.47	9918	430	1,399,855
43313	GMO-SJLP	St Joe	Woodbine	Distribution Feeder	12.47	8802	308	1,001,743
43411	GMO-SJLP	Maryville	Worth	Distribution Feeder	12.47	375	25	79,936
39011	GMO-SJLP	St Joe	East Side	Distribution Feeder	34.5	27325	202	656,822
39921	GMO-SJLP	St Joe	Industrial Park	Distribution Feeder	34.5	12029	89	291,255
40422	GMO-SJLP	St Joe	Lake Road	Distribution Feeder	34.5	25854	183	595,202
40423	GMO-SJLP	St Joe	Lake Road	Distribution Feeder	34.5	34629	321	1,046,377
407771	GMO-SJLP	Maryville	Maryville	Distribution Feeder	34.5	2252	116	376,799
39012	GMO-SJLP	St Joe	East Side	Mix Trs & Fdr	34.5	8015	91	296,255
39021	GMO-SJLP	St Joe	East Side	Mix Trs & Fdr	34.5	10478	89	288,212
40413	GMO-SJLP	St Joe	Lake Road	Mix Trs & Fdr	34.5	17980	111	361,077

Table E-4 SJLP Distribution Feeder Losses

KCPL ID	Region	DISTRICT	Substation	Item Type	Voltage	Circuit Demand Loading (kVA)	Non-Coincident Peak Loss (kW)	Circuit Energy Loss (kWh)
386221	GMO-SJLP	Maryville	Brown's Curve	Sub-Transmission	34.5	2519	114	371,163
386222	GMO-SJLP	Maryville	Brown's Curve	Sub-Transmission	34.5	6420	95	309,884
39022	GMO-SJLP	St Joe	East Side	Sub-Transmission	34.5	51497	761	2,476,873
39141	GMO-SJLP	St Joe	Edmond Street	Sub-Transmission	34.5	1938	118	383,680
39142	GMO-SJLP	St Joe	Edmond Street	Sub-Transmission	34.5	3078	111	359,935
39911	GMO-SJLP	St Joe	Industrial Park	Sub-Transmission	34.5	25905	183	597,223
39922	GMO-SJLP	St Joe	Industrial Park	Sub-Transmission	34.5	30628	251	815,758
401222	GMO-SJLP	St Joe	Kellog	Sub-Transmission	34.5	6176	96	312,554
40412	GMO-SJLP	St Joe	Lake Road	Sub-Transmission	34.5	13328	92	298,623
40414	GMO-SJLP	St Joe	Lake Road	Sub-Transmission	34.5	20688	130	423,370
404R3	GMO-SJLP	St Joe	Lake Road	Sub-Transmission	34.5	4898	101	329,071
404R6	GMO-SJLP	St Joe	Lake Road	Sub-Transmission	34.5	10512	89	288,211
407441	GMO-SJLP	Maryville	Maryville	Sub-Transmission	34.5	7775	92	297,882
						TOTAL Loss	14,213	46,270,359

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Appendix

F

Substation Use and Meter Losses

Table F-01

SUBSTATION USE				
Station Light and Power				
	Number of Substations	Station Non-coincident Demand kW	Station Coincident Demand kW	Station Energy Use kWhr
Kansas	37	1,480	1,464	7,778,880
Missouri	80	3,200	2,858	16,819,200
Total KCPL	117	4,680	4,322	24,598,080
MPS	94	3,760	3,760	19,762,560
SJLP	33	1,320	1,272	6,937,920
Combined	244	9,760	9,354	51,298,560

Assume 3-45 kVA Transformer
Assume 40 kW peak load
Assume 60% load factor

Table F-02

Meter Losses				
KCP&L-KS				
	Quantity	**Loss/Meter (W/Hr)**	**Demand Losses (W)**	**Energy Losses (Wh)**
Single Phase Mechanical	7,710	0.9	6,939	60,785,640
Three Phase Mechanical	114	3.5	399	3,495,240
Single Phase Electronic	236,442	0.2	47,288	414,242,880
Three Phase Electronic	15,309	0.3	4,593	40,234,680
Subtotal for KCPL-KS	**259,575**		**59,219**	**518,758,440**
KCP&L-MO				
	Quantity	**Loss/Meter (W/Hr)**	**Demand Losses (W)**	**Energy Losses (Wh)**
Single Phase Mechanical	8,476	0.9	7,628	66,821,280
Three Phase Mechanical	128	3.5	448	3,924,480
Single Phase Electronic	260,756	0.2	52,151	456,842,760
Three Phase Electronic	23,539	0.3	7,062	61,863,120
Subtotal for KCPL-MO	**292,899**		**67,289**	**589,451,640**
Subtotal for KCPL MO+KS	**552,474**		**126,508**	**1,108,210,080**
MPS				
	Quantity	**Loss/Meter (W/Hr)**	**Demand Losses (W)**	**Energy Losses (Wh)**
Single Phase Mechanical	203,424	0.9	183,082	1,603,798,320
Three Phase Mechanical	773	3.5	2,706	23,704,560
Single Phase Electronic	39,576	0.2	7,915	69,335,400
Three Phase Electronic	10,999	0.3	3,300	28,908,000
Subtotal for MPS	**254,772**		**197,003**	**1,725,746,280**
SJLP				
	Quantity	**Loss/Meter (W/Hr)**	**Demand Losses (W)**	**Energy Losses (Wh)**
Single Phase Mechanical	51,013	0.9	45,912	402,189,120
Three Phase Mechanical	284	3.5	994	8,707,440
Single Phase Electronic	12,007	0.2	2,401	21,032,760
Three Phase Electronic	3,553	0.3	1,066	9,338,160
Subtotal for SJL&P	**66,857**		**50,373**	**441,267,480**

COMBINED SYSTEM (KCPL+MPS+SJLP)				
	Quantity	**Loss/Meter (W/Hr)**	**Demand Losses (W)**	**Energy Losses (Wh)**
Single Phase Mechanical	262,147	0.9	235,932	2,066,764,320
Three Phase Mechanical	1,171	3.5	4,099	35,907,240
Single Phase Electronic	288,025	0.2	57,605	504,619,800
Three Phase Electronic	29,861	0.3	8,958	78,472,080
Total for KCPL+MPS+SJLP	**874,103**		**373,884**	**3,275,223,840**

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KCP&L Green Circuits Analysis

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CONTENTS

1 INTRODUCTION AND LOSS STUDY SUMMARY

This report summarizes the modeling and simulation results for the 9111, 3111, 5051, and 7812 circuits as part of the EPRI Green Circuits collaborative project. The Green Circuits project is aimed at evaluating the effectiveness of various distribution system efficiency initiatives on specific feeders through detailed modeling and simulation. Section 2 of this report provides results from the model-based efficiency evaluations for the four circuits. Section 3 compares the results of Section 2 to other circuits that have been modeled in the Green Circuits project.

Summary of Loss Study

As stated, Section 2 of this document presents the model results of 9111, 3111, 5051, and 7812 circuits that were presented in the October 2009 and February 2010 Green Circuits briefings. The feeder models were used to evaluate various loss reduction options such as phase balancing, capacitor controls, re-conductoring, and/or voltage optimization. The 5051 circuit also included a look at possible savings when a 4.16kV section was converted to 12.47kV.

A summary of the base case model (base case – model as is with no loss reduction techniques included) losses are shown in Figure 1-1 through Figure 1-4 for each circuit studied. Overall, voltage optimization resulted in a reduction in losses for all circuits studied. Table 1-1 and Table 1-2 provides a summary of the voltage optimization annual and peak simulation results, respectively. Circuit #5051 had the smallest improvement of savings from voltage optimization due to the fact that additional var support had to be included on the 4.16kV section for voltage regulation purposes. Circuit #9111 had the second smallest improvement because its losses were dominated by line losses as seen in Figure 1-1. Because the other circuits were dominated by no-load transformer losses they had significant improvement in their losses when voltage optimization was implemented.

Each circuit had loss reductions when an ideal var case was simulated. This would be the case if capacitors could be ‘perfectly’ controlled from a var perspective at the customer location. Because of the difficulty in achieving this, a realistic var control case was modeled where capacitor control was included on existing capacitors and in some cases capacitors were added or reduced in order to improve var flow. Circuit #9111 resulted in the greatest improvement when the capacitor control was altered. If the capacitor var control was permitted to control the capacitors during the non-summer months opposed to switching to temperature control, it would result in an annual loss reduction of 10.2MWh.

Circuit #5051 benefited when the 4.16kV section was upgraded to 12.47kV. This upgrade resulted in an annual loss reduction of 22.1MWh. This loss reduction was primarily due to the elimination of the 12.47/4.16 transformer and reduced line losses.

All circuits benefited from an increased conductor size on its primary backbone; however, the loss savings obtained from re-conductoring would not justify the costs associated with re-conductoring.

Table 1-1
Voltage Optimization Annual Summary

Circuit	Average % Voltage Decrease	Annual Loss Reduction (MWh)	Annual Consumption Reduction (MWh)	Annual Consumption Reduction (%)	Annual Loss Reduction (%)	Transformer Loss Reduction (Load and No-Load Loss)	Line Loss Reduction (Primary and Secondary Line Losses)	Effective CVR factor
9111	2.01%	7.08	348.90	1.72%	1.27%	3.41%	-0.12%	0.85
3111	3.33%	12.49	408.64	2.72%	4.25%	5.70%	1.26%	0.83
7812	3.57%	20.49	699.90	3.15%	3.83%	6.23%	1.13%	0.89
5051*	3.33%	5.88	484.79	3.21%	1.54%	2.89%	-0.01%	N/A*

* Circuit 5051 had to include additional capacitance for voltage regulation purposes during the CVR case; therefore, the CVR factor would include savings/losses from the additional capacitance in addition to any CVR savings.

Table 1-2
Voltage Optimization Peak Summary

Circuit	% Voltage Decrease at Peak	Peak Loss Reduction (kW)	Peak Consumption Reduction (kW)	Peak Consumption Reduction (%)	Peak Loss Reduction (%)	Transformer Loss Reduction (Load and No-Load Loss)	Line Loss Reduction (Primary and Secondary Line Losses)	Effective CVR Factor
9111	1.97%	1.47	83.66	1.94%	0.90%	2.71%	0.40%	0.96*
3111	3.14%	2.36	119.16	2.80%	2.32%	3.85%	1.43%	0.89
7812	1.89%	2.00	94.00	1.66%	1.16%	2.00%	0.00%	0.87
5051**	0.00%	3.00	192.00	3.78%	1.48%	5.45%	-0.68%	N/A**

* Circuit 9111 had significant power factor improvement at CVR peak which will skew the effective CVR factor favorably.

** Circuit 5051 had to include additional capacitance for voltage regulation purposes during the CVR case; therefore, the CVR factor would include savings/losses from the additional capacitance in addition to any CVR savings.

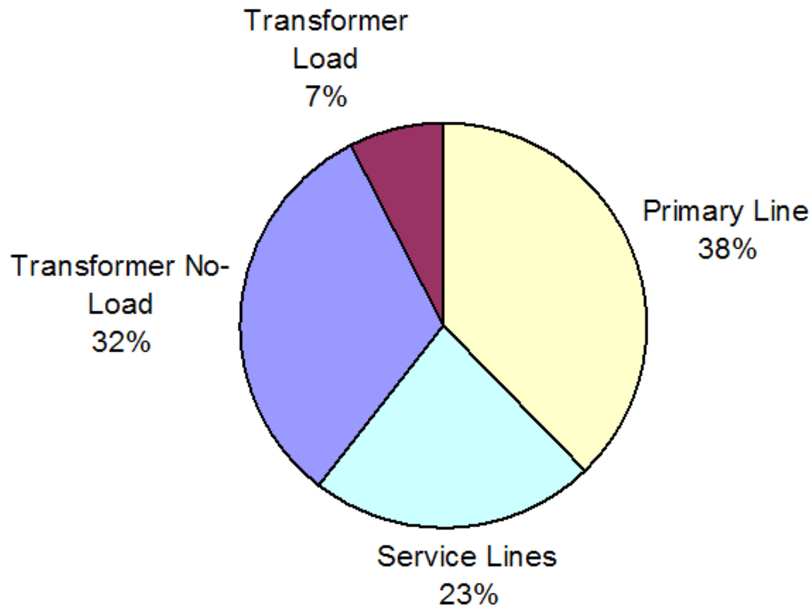


Figure 1-1:
Circuit 9111 Base Case Loss Break-Down

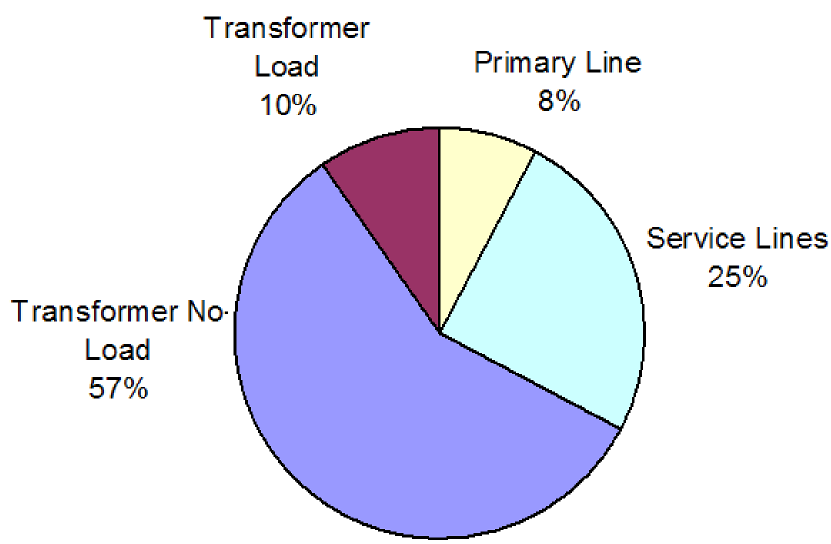


Figure 1-2:
Circuit 3111 Base Case Loss Break-Down

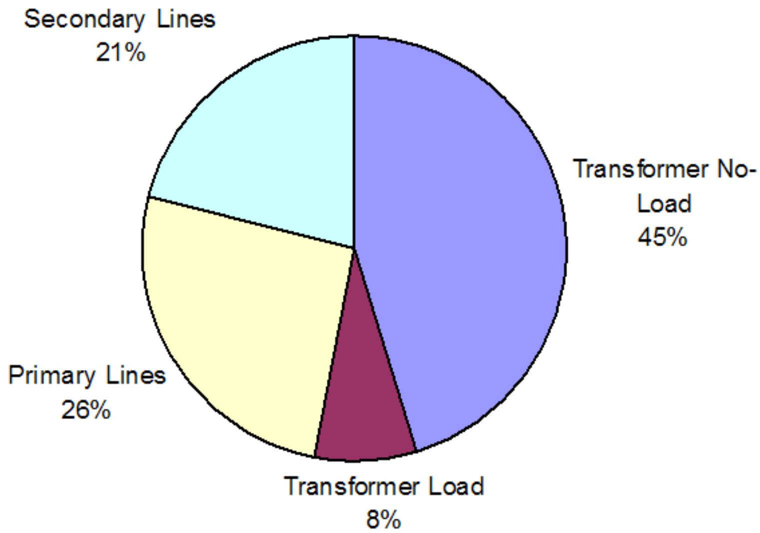


Figure 1-3:
Circuit 7812 Base Case Loss Break-Down

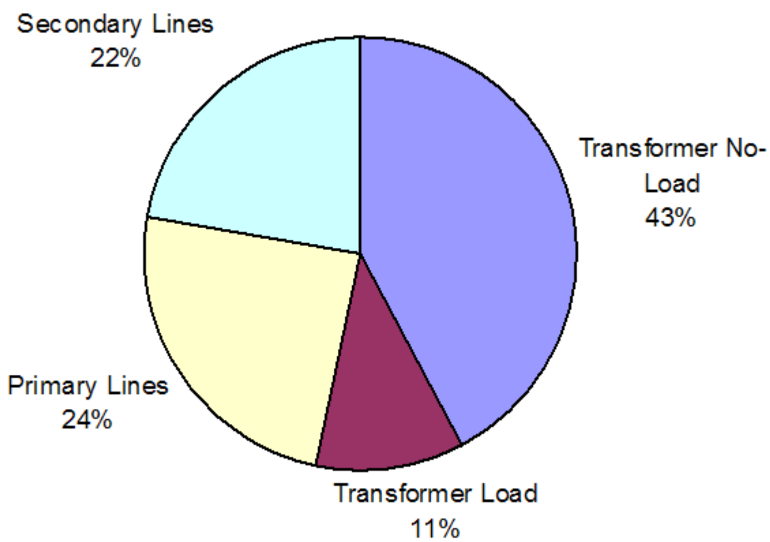


Figure 1-4:
Circuit 5051 Base Case Loss Break-Down

2
MODELING DETAILS AND ORIGINAL ANALYSIS

This section covers some of the background and modeling used in evaluating the four circuits from the October 2009 and February 2010 Green Circuits briefing.

Green Circuit Project Background

The Green Circuit project is a field demonstration of circuits with a goal of improving distribution efficiency. Loss-reduction approaches could include optimal var reduction using switched capacitors, voltage control, and targeted design changes (re-conductoring or reconfiguring).

Member utilities have wide latitude in circuit selections, and utilities are ultimately responsible for their selection. The selection depends on several factors, including the overall goals of the utility and the type of circuit that they are most interested in. The three main criteria considered when selecting the Green Circuits are:

- Diversity – Do the circuits represent a good cross section of circuits and customer load types?
- Metering – Do the circuits have AMI or other advanced metering? Are there voltage and current measurements available at the substation on all three phases?
- Modeling – Are circuits modeled in CYMDIST, SYNERGEE, WindMil, or other circuit modeling program with accurate phasing and customer data?

Other considerations include ability to control voltage and that the circuits were readily accessible to local personnel.

Modeling Approach

The main steps in the modeling approach for KCP&L are:

- Convert SYNERGEE data to OpenDSS
- Scale loads based on measurement data
- Evaluate base-case losses
- Evaluate loss reduction options

The Distribution System Simulator (DSS) is a comprehensive electrical system simulation tool for electric utility distribution systems. The OpenDSS is being provided as an open source program to the electric power system analysis community at large by EPRI under a BSD license. The OpenDSS is available at http://electricdss.wiki.sourceforge.net/. The main advantages of OpenDSS for modeling distribution efficiency include:

- *Yearly simulations* – The OpenDSS can run yearly simulations where the load, regulators, and switched capacitor banks are adjusted on an hour-by-hour basis, allowing accurate estimates of energy losses.
- *Custom load model* – A voltage-sensitive load model with user-configurable parameters is available to help predict changes in load based on voltage.
- *Custom control modes* – Custom controllers for switched capacitor banks and for voltage regulators can be readily implemented.

To determine the best load model, we need to know the impacts of voltage on loads. Even if a circuit is not amenable to voltage optimization for either demand reduction or for energy reduction, a voltage-sensitive load model will best reflect how loads change for other circuit improvement options such as changes in var management. The impact of voltage on loads is often quantified as a CVR factor (conservation-voltage reduction factor), the percent change in load for a 1% change in voltage. Kirshner and Giorsetto[1] analyzed trials of voltage reduction at several utilities. While results varied significantly, most test circuits had energy savings of between 0.5 and 1% for each 1% voltage reduction. Their regression analysis of the feeders found that residential energy savings were 0.76% for each 1% reduction in voltage, while commercial and industrial loads had reductions of 0.99% and 0.41% (but, the correlations between load class and energy reduction were fairly small).

More recently, the Northwest Energy Efficiency Alliance (NEEA) and their contractor RW Beck and several utilities evaluated voltage reduction in the US pacific northwest.[2] They evaluated changes at the circuit level and also changes directly to residential customers. In their evaluation of voltage changes at the circuit level, using temperature adjusted regressions, they found an average CVR factor of 0.69 based on a voltage change of 2.5%. In their evaluation of 395 residential customer evaluations, they estimated a CVR factor of 0.57 based on a voltage change of 4.3%.

The NEEA study found seasonal differences. In the customer evaluation, they found a CVR factor in the winter of 0.5 compared to a summer CVR factor of 0.78.

The NEEA study found even more dramatic changes with reactive power. In their feeder monitoring study, they found that CVR_{var} factors between 3.0 and 3.5 (vars drop by 3% for every 1% drop in voltage). That indicates that a large component of the change is due to the reduction in magnetizing current in motors and transformers as this exciting current is highly nonlinear. The change in vars was not particularly sensitive to season.

[1] Kirshner, D. and Giorsetto, P., "Statistical Tests of Energy Savings Due to Voltage Reduction," *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-103, no. 6, pp. 1205-10, June 1984.
[2] NEEA 1207, Distribution Efficiency Initiative, Northwest Energy Efficiency Alliance, 2007. Available at http://rwbeck.com/neea/.

A voltage-sensitive load model was used for all modeling in OpenDSS, where the watts and vars both vary with voltage based on a linear relationship. For these simulations, a CVR factor of 0.9 (provided by KCP&L) was used for watts and a CVR factor of 3.0 was used for vars. As the study progresses, we will fine-tune these models based on the feeder and measurements for any circuit for which voltage reduction is implemented in the field. In the modeling, the CVR factor does not vary by customer type or by season; hopefully, we will learn more about both of these during the Green Circuits studies.

The distribution transformers were modeled based on information obtained from KCP&L 2007 transformer specifications. The services were modeled with 100 ft of overhead and underground services based on kVA size of transformer.

KCP&L Circuits

The following table summarizes some of the characteristics of the KCP&L circuits selected for the Green Circuits study.

Table 2-1
KCP&L Green Circuits Summary

Base characteristics	**9111**	**3111**	**5051**	**7812**
System voltage (kV)	12.47 kV	13.2 kV	12.47 / 4.16 kV	12.47 kV
Residential	74%	88.4%	92%	64%
3-phase primary circuit miles total	8.0	2.8	5.4	6.9
Non 3-phase primary circuit miles total	1.5	2.3	5.5	5.6
2008 Load Factor	54%	40%	36%	44%
Substation Control	LTC	LTC	LTC	LTC

Circuit #9111

Circuit #9111 is primarily an urban residential circuit. It has a primary voltage of 12.47 kV. Figure 2-1 shows the layout of the circuit.

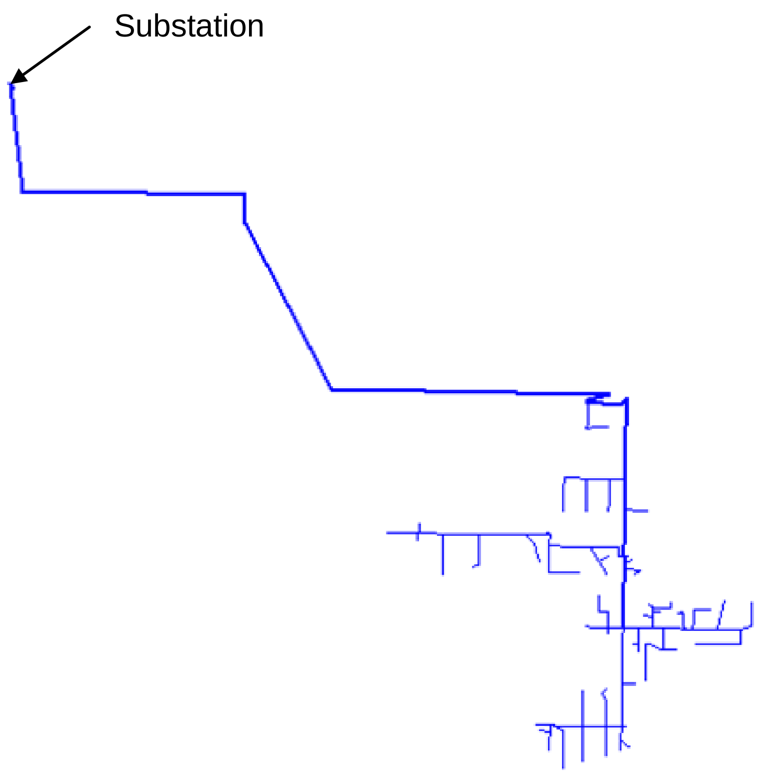


Figure 2-1:
Circuit 9111

Base Case

Using a peak-load case provided by KCP&L in the 2008 loadshape, the real power load is scaled on each phase to match the measurements. The capacitor controls were implemented in the model to match the operation of the line capacitors. The implemented capacitor controls are as follows:

- JO-4284 (600kvar)
  - Voltage Override
    - Low Voltage Override Setpoint – 119.0 V
    - High Voltage Override Setpoint – 127.5 V
  - Summer Season Operation – Temperature Control
    - High Temperature at Which Bank Switches In – 85°F
    - High Temperature at Which Bank Switches Out – 70°F
  - Non Summer Season Operation – Var Control
    - Var Control Which Bank Switches In – 400 kvar
    - Var Control Which Bank Switches Out – -400 kvar
- JO-87031 (600kvar)
  - Voltage Override
    - Low Voltage Override Setpoint – 119.0 V
    - High Voltage Override Setpoint – 127.5 V

- o Summer Season Operation – Temperature Control
  - High Temperature at Which Bank Switches In – 85°F
  - High Temperature at Which Bank Switches Out – 70°F
- o Non Summer Season Operation – Var Control
  - Var Control Which Bank Switches In – 300 var
  - Var Control Which Bank Switches Out – -500 var

- JO-2285 (900kvar)
  - o Fixed

Because JO-4284 and JO87031 capacitors include temperature control in the summer season the temperature fluctuations were included in the model. Figure 2-2 illustrates the capacitor switching operation in the during the summer season (May 15 to September 15). The capacitor switches OFF at 70F and switches ON above 85F.

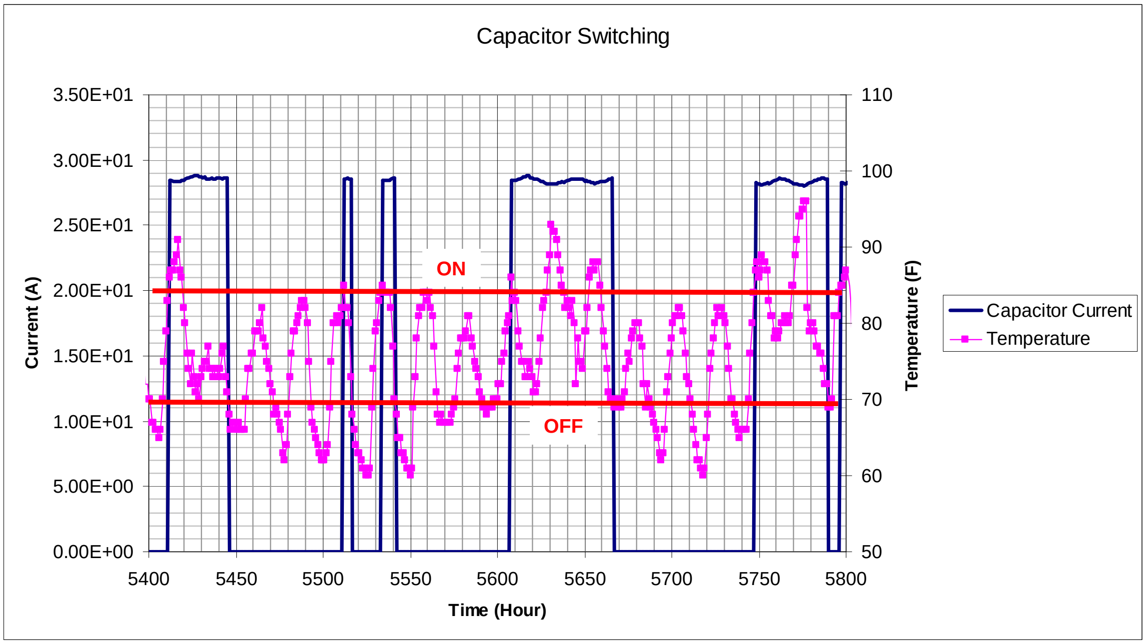


Figure 2-2
Summer Capacitor Switching

The implementation of the capacitor's summer temperature control and non-summer var control along with the load allocations, allowed for the base model current to match the measured current provide from the substation metering. Figure 2-3 shows the comparison between the measured feeder current and the simulated feeder current. The load factor of this loadshape (2008) was 54% and the average power factor was 0.965.

The annual losses were calculated to be 2.75% with the primary and service lines dominating the majority of losses (61%).

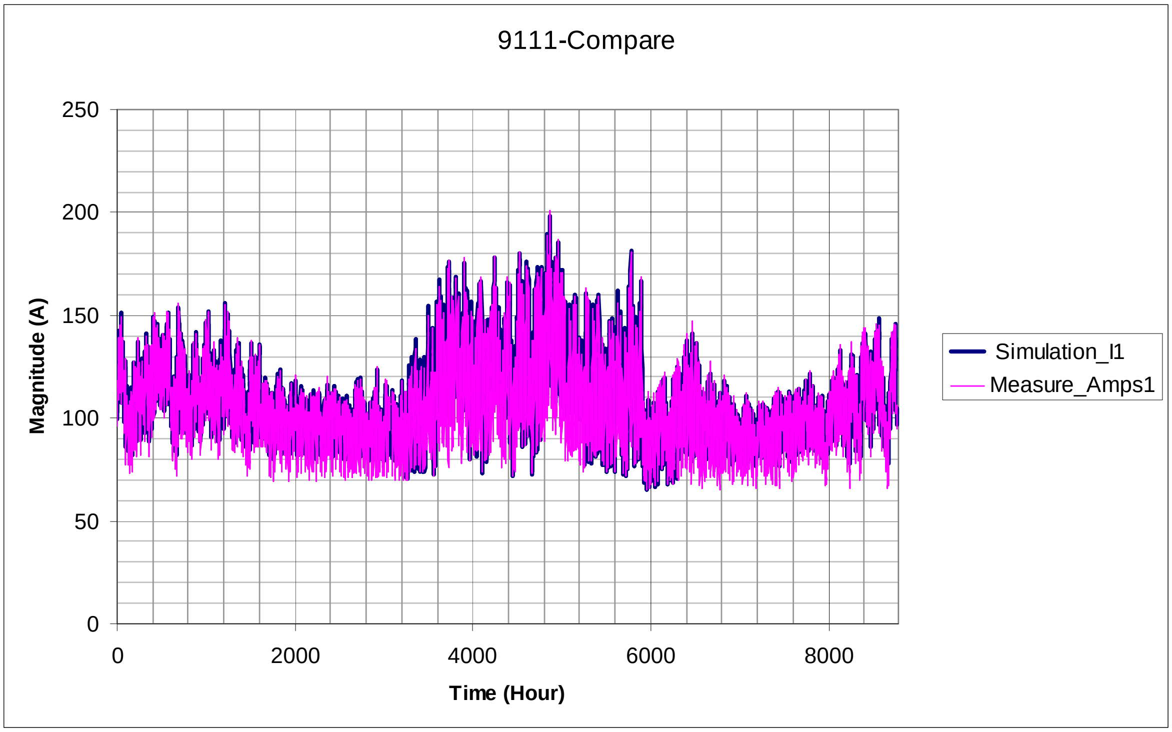


Figure 2-3
9111 Current Simulated vs. Measured

Figure 2-4 summarizes the results of the yearly and peak-day losses for the 9111 circuit.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4315**		**20321760**	
Total Losses	163	3.77%	559103	2.75%
Line Losses	127	2.94%	339313	1.67%
Xfmr Losses	36	0.83%	219790	1.08%
Load Losses	143	3.32%	380592	1.87%
No-Load Losses	20	0.45%	178511	0.88%
Primary Losses	113	2.61%	431413	2.12%
Secondary Losses	50	1.16%	127691	0.63%

Figure 2-4:
9111 modeled losses at the peak-hour and annual energy losses

Phase Balancing

The phase currents were balanced at the peak hour for the circuits which had some unbalance. The average unbalance in the base case was 9.9% and this was improved to 0.4% in the Phase Balancing Case. The unbalanced calculation is based on the ANSI/NEMA Standard MG1-1993 definition. Figure 2-5 shows the results of the phase balancing simulation. Generally, the loss reductions were very low.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4332**		**20385722**	
Total Losses	164	3.78%	558977	2.74%
Line Losses	128	2.95%	338873	1.66%
Xfmr Losses	36	0.83%	220104	1.08%
Load Losses	144	3.33%	380469	1.87%
No-Load Losses	20	0.45%	178508	0.88%
Primary Losses	113	2.61%	429971	2.11%
Secondary Losses	51	1.17%	129006	0.63%

Figure 2-5:
9111 phase balance modeled losses at the peak-hour and annual energy losses

Voltage Optimization

To model voltage optimization the LTC base was reduced to 120V from 122.5V. This reduction maintained a minimum voltage above 0.949 pu at the customer service. Before the voltage reduction the minimum voltage on the feeder was maintained at 0.967 pu. See Figure 2-6.

Figure 2-7 shows the results of the voltage optimization simulation. For the annual simulation the consumption was reduced by 348.9 MWh and the loss was reduced by 7.1 MWh. At peak, the consumption was reduced by 83 kW and the losses reduce by 2 kW.

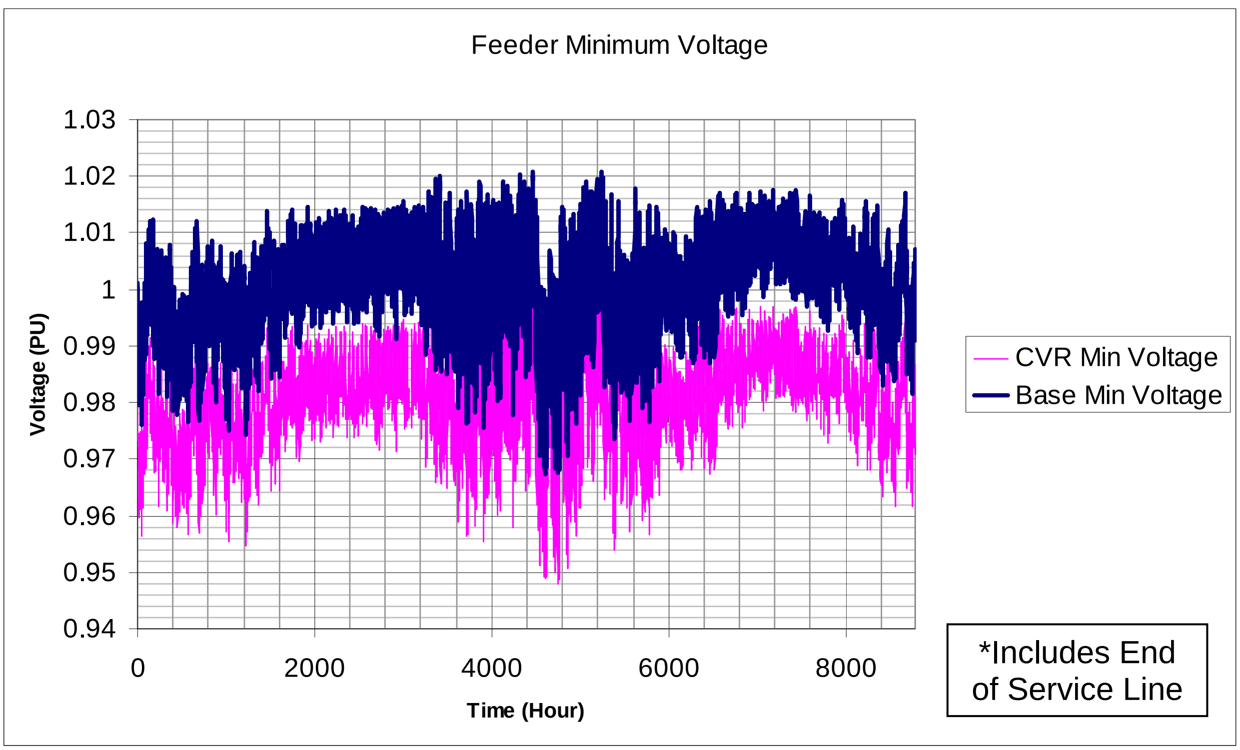


Figure 2-6:
9111 minimum voltage across entire feeder during yearly loadflow

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4232**		**19972858**	
Total Losses	161	3.81%	552025	2.76%
Line Losses	127	2.99%	339727	1.70%
Xfmr Losses	35	0.82%	212298	1.06%
Load Losses	142	3.37%	380621	1.91%
No-Load Losses	19	0.45%	171404	0.86%
Primary Losses	112	2.64%	425504	2.13%
Secondary Losses	49	1.17%	126521	0.63%

Figure 2-7:
9111 voltage optimization modeled losses at the peak-hour and annual energy losses

Re-conductoring

A loss reduction approach could be to re-conductor the circuit. The conductor simulation replaced the all AAC 477 with AAC 795 on the overhead three phase mains. The annual energy savings reduced to 2.66% from 2.75%. Figure 2-8 shows the results of the re-conductor simulation.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4321**		**20332799**	
Total Losses	156	3.61%	540814	2.66%
Line Losses	120	2.79%	320788	1.58%
Xfmr Losses	36	0.83%	220026	1.08%
Load Losses	137	3.16%	362079	1.78%
No-Load Losses	20	0.46%	178735	0.88%
Primary Losses	106	2.46%	413089	2.03%
Secondary Losses	50	1.16%	127725	0.63%

Figure 2-8:
9111 re-conductor model losses at the peak-hour and annual energy losses

Ideal var Optimization

A somewhat theoretical case is the ideal var optimization case. The ideal var optimization case attempts to answer what the maximum achievable losses would be if all capacitors were removed from the circuit and the loads power factors were set to 1.0 across the circuit. This would be the case if the capacitors could be ‘perfectly’ controlled from a var perspective. The annual energy losses were improved to 2.51% from 2.75%. The average power factor was improved to 0.9998 from 0.965.

Figure 2-9 shows the results of the ideal var simulation.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4337**		**20316692**	
Total Losses	149	3.43%	509363	2.51%
Line Losses	115	2.66%	294185	1.45%
Xfmr Losses	33	0.77%	215177	1.06%
Load Losses	129	2.96%	327436	1.61%
No-Load Losses	20	0.47%	181927	0.90%
Primary Losses	108	2.49%	406809	2.00%
Secondary Losses	41	0.94%	102554	0.50%

Figure 2-9:
9111 ideal var model losses at the peak-hour and annual energy losses

Capacitor Control

Added capacitor control was studied for 9111 as another approach to reduce losses. For the capacitor control case the existing var control was continued throughout the year (opposed to switching to temperature control during the summer season) and the JO-2285 capacitor was disabled. This change in capacitor control improves the average power factor from 0.965 to 0.992. The annual energy savings reduced to 2.70% from 2.75%.

Figure 2-10 shows the results of the capacitor control simulation.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4301**		**20358181**	
Total Losses	165	3.83%	548890	2.70%
Line Losses	129	3.00%	328172	1.61%
Xfmr Losses	36	0.83%	220718	1.08%
Load Losses	145	3.38%	369482	1.81%
No-Load Losses	19	0.45%	179408	0.88%
Primary Losses	115	2.67%	421105	2.07%
Secondary Losses	50	1.16%	127785	0.63%

Figure 2-10:
9111 capacitor control model losses at the peak-hour and annual energy losses

Summary

Figure 2-11 and Figure 2-12 below compares the results to the base case. As can be seen the var control results in the biggest savings followed by the re-conductoring case. However, the voltage optimization (referred to as CVR, Conservation -Voltage Reduction) may be the most cost effective approach to reduce losses.

	Base	Ideal var	Balance	CVR 0.9	Capacitor Control	Reconductor
GWh Consumption	20.32	20.32	20.39	19.97	20.36	20.33
GWh Losses	0.5591	0.5094	0.5590	0.5520	0.5489	0.5408
Delta Loss (MWh)		**49.7**	**0.1**	**7.1**	**10.2**	**18.3**
Delta Consumption (MWh)		5.1	-64.0	348.9	-36.4	-11.0
% Loss (Base)	2.75%	2.51%	2.75%	2.72%	2.70%	2.66%
% Consumption (Base)		100.0%	100.3%	98.3%	100.2%	100.1%
% Base		8.90%	0.02%	1.27%	1.83%	3.27%

Figure 2-11:
9111 efficiency analysis comparison summary

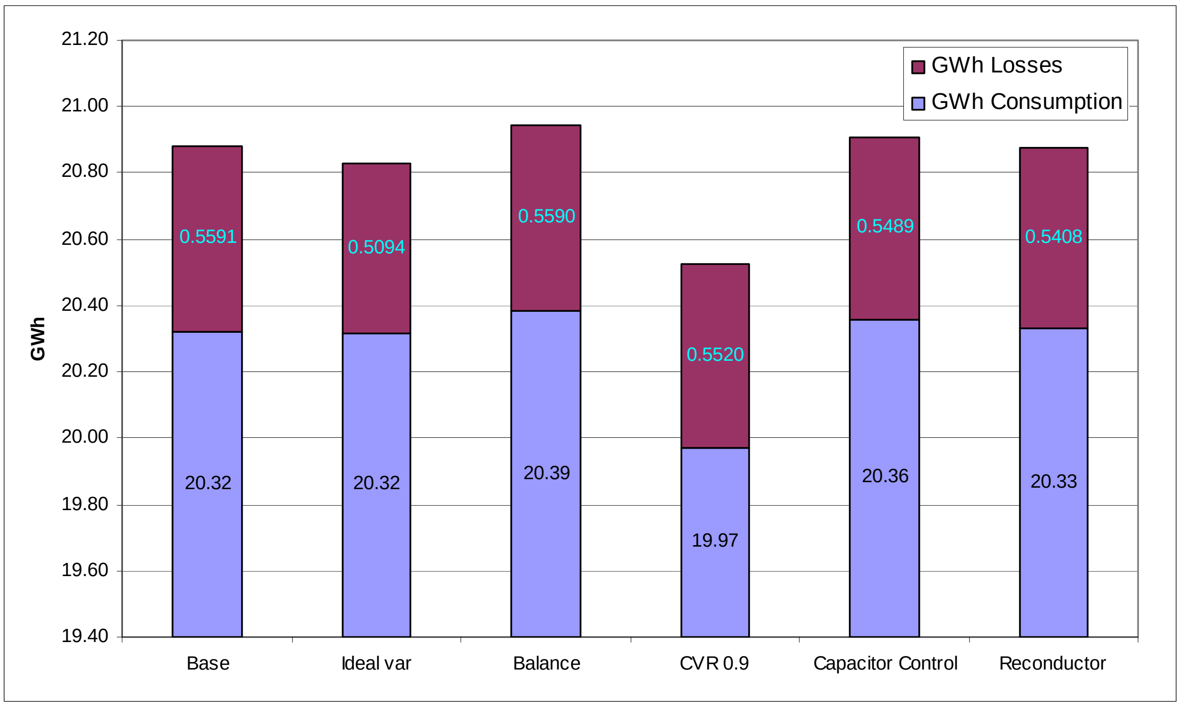


Figure 2-12:
9111 efficiency comparison summary graph

Circuit #3111

Circuit #3111 is primarily an urban residential circuit. It has a primary voltage of 13.2 kV. Figure 2-13 shows the layout of the circuit.

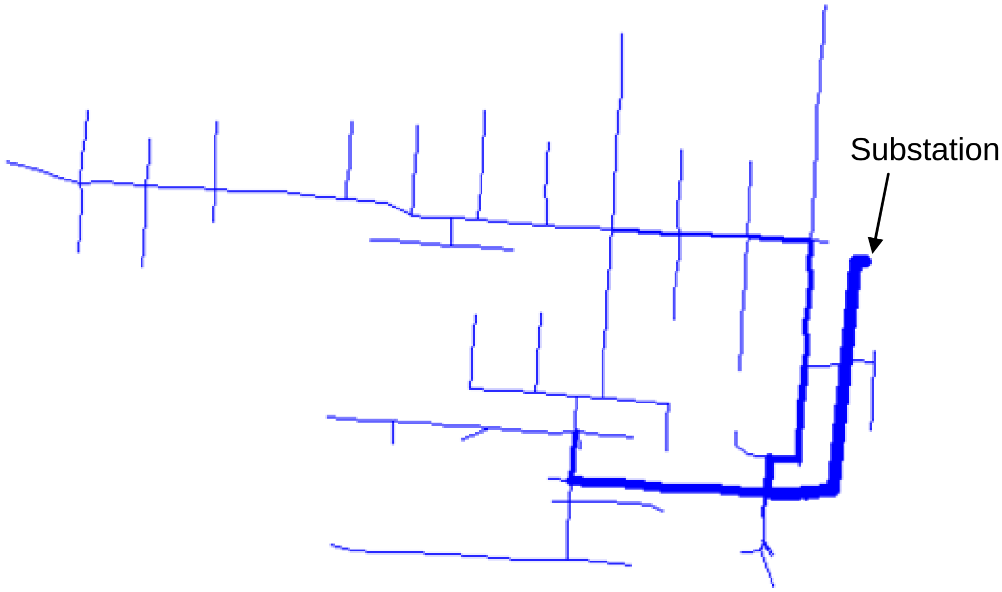


Figure 2-13:
Circuit 3111

Base Case

Using a peak-load case provided by KCP&L in the 2008 loadshape, the real power load is scaled on each phase to match the measurements. The capacitor controls provided by KCP&L were implemented in the model. The provided capacitor controls are as follows:

- JA-85076 (1200kvar), JA-86271 (1200kvar)
  - Temperature with Voltage Override
    - Voltage Override
      - Low Voltage Override Setpoint – 119.9 V
      - High Voltage Override Setpoint – 126.1 V
  - Summer Season Operation
    - High Temperature at Which Bank Switches In – 85°F
    - High Temperature at Which Bank Switches Out – 70°F
  - Non Summer Season Operation
    - Low Temperature at Which Bank Switches Out – 40°F
    - Low Temperature at Which Bank Switches In – 30°F
- JA-90031 (600kvar)
  - Fixed

Because JA-85076 and JA-86271 capacitors include temperature control in the summer and non-summer season the temperature fluctuations were included in the model. Figure 2-14 illustrates the capacitor switching operation in the during the summer season (May 15 to September 15). Figure 2-15 illustrates the capacitor switching operation in the during the non-summer season

(September 15 to May 15). In the summer the capacitor switches OFF at 70F and switches ON above 85F. During the non-summer season the capacitor switches OFF at 40F and switches ON below 30F.

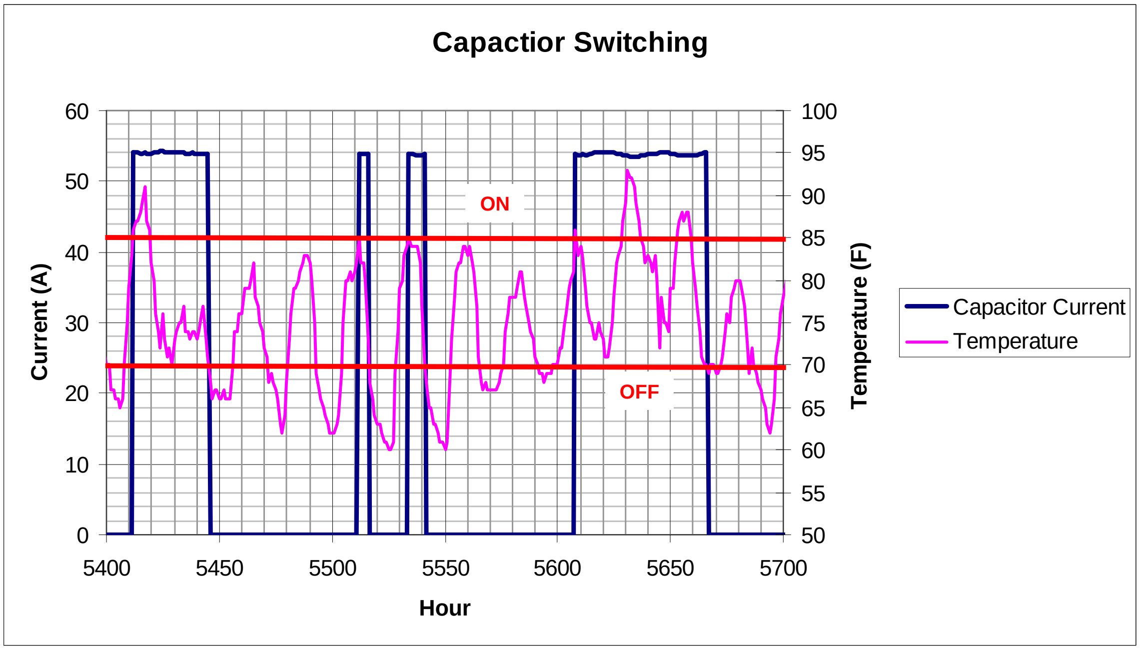


Figure 2-14
Summer Capacitor Switching

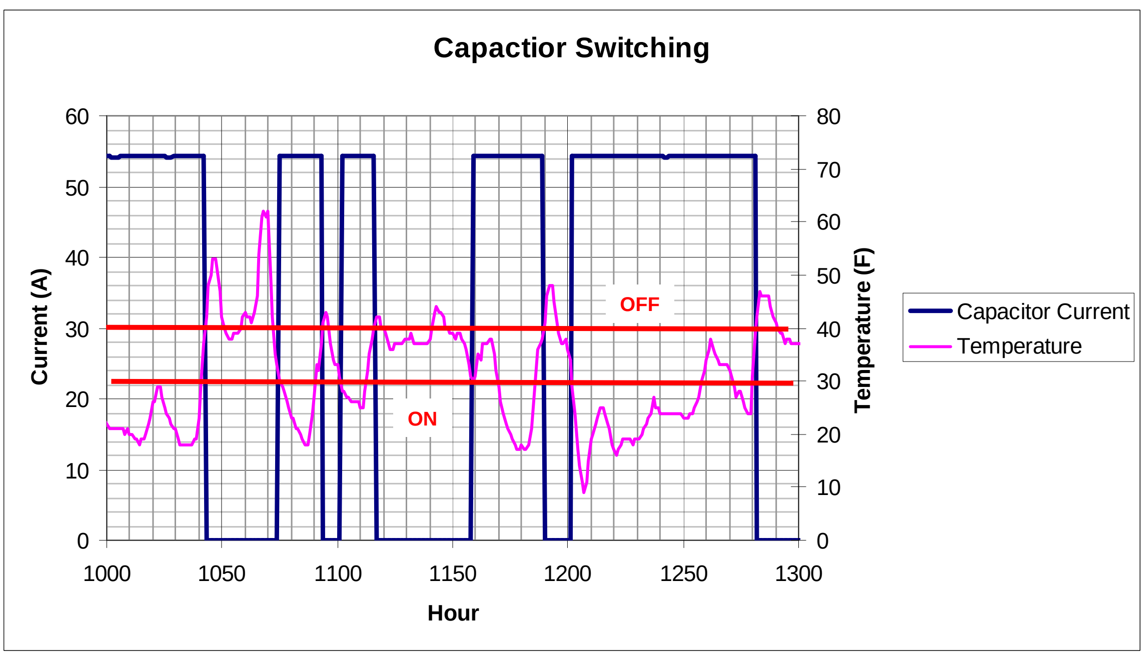


Figure 2-15
Non-Summer Capacitor Switching

The implementation of the capacitor's summer and non-summer temperature control along with the load allocations, did not result in a match between the base model current and the measured current provide from the substation metering. Figure 2-16 shows the comparison between the measured feeder current and the simulated feeder current with the summer and non-summer controls included. This simulated results indicated an excess of vars in the circuit. A second base case was developed with JA-86271, JA-85076 disabled, and JA-90031 enabled. As can be seen in Figure 2-17 this new case resulted in a closer match between the simulated and measured current values; therefore, this was the base case used for the 3111 analysis. The load factor of this loadshape (2008) was 40% and the average power factor was 0.992.

The annual losses were calculated to be 1.96% with the transformer no-load losses dominating (57%).

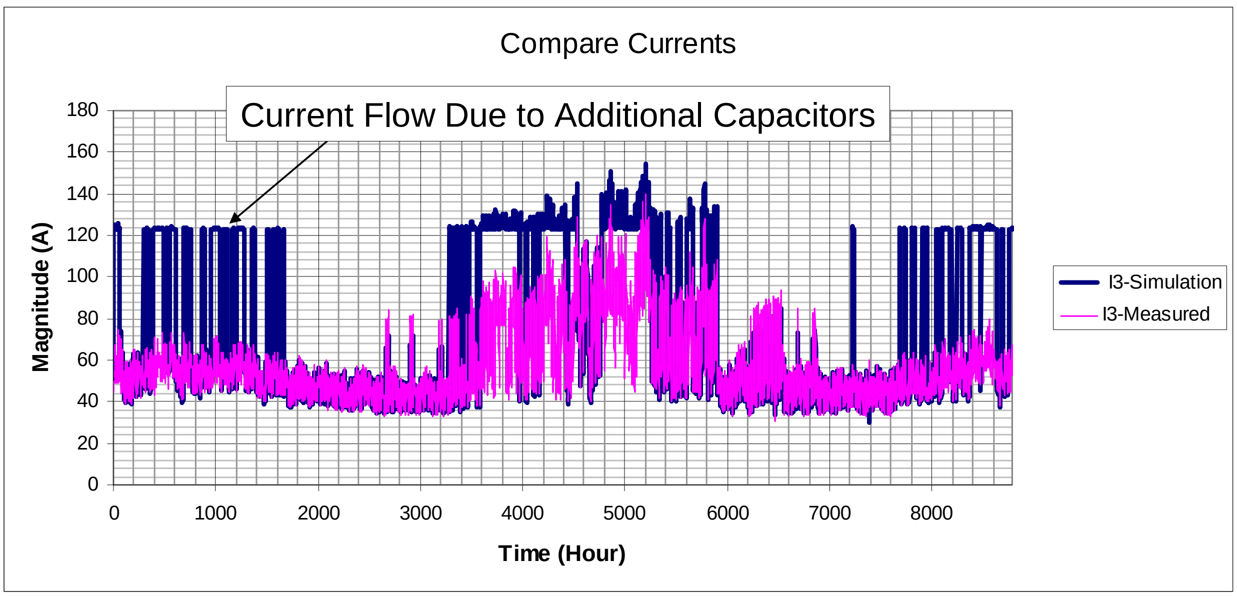


Figure 2-16
3111 Current Simulated vs. Measured (With Capacitor Controls)

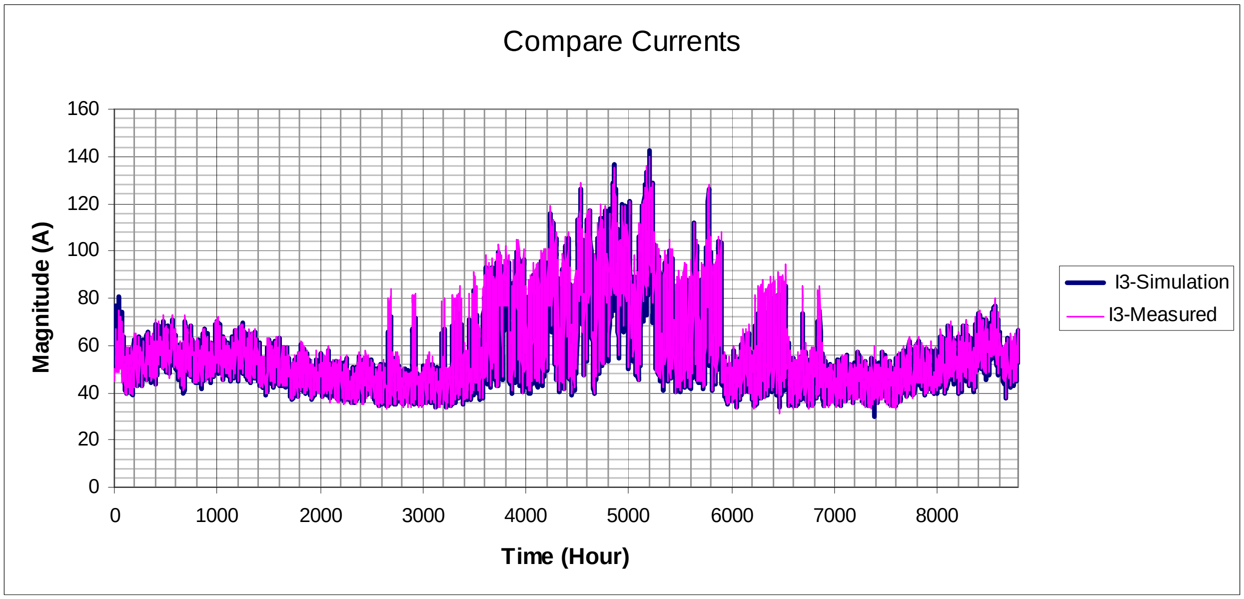


Figure 2-17
3111 Current Simulated vs. Measured (Without Capacitor Controls)

Figure 2-18 summarizes the results of the yearly and peak-day losses for the 3111 circuit.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4261**		**15004676**	
Total Losses	102	2.38%	294191	1.96%
Line Losses	64	1.50%	96238	0.64%
Xfmr Losses	37	0.88%	197953	1.32%
Load Losses	83	1.94%	124523	0.83%
No-Load Losses	19	0.44%	169668	1.13%
Primary Losses	53	1.24%	220822	1.47%
Secondary Losses	49	1.14%	73369	0.49%

Figure 2-18:
3111 modeled losses at the peak-hour and annual energy losses

Phase Balancing

The phase currents were balanced at the peak hour for the circuits which had some unbalance. The average unbalance in the base case was 11% and this was improved to 0.4% at the substation. The unbalanced calculation is based on the ANSI/NEMA Standard MG1-1993 definition. Figure 2-19 shows the results of the phase balancing simulation. Generally, there was a slight increase in the overall losses. This had to do with the fact that balancing the current at the head of the feeder resulted in more unbalance downstream of the feeder, see Figure 2-20. This indicates that the phase balancing has been reasonably optimized already.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4247**		**14998264**	
Total Losses	102	2.40%	295626	1.97%
Line Losses	64	1.50%	96342	0.64%
Xfmr Losses	38	0.90%	199284	1.33%
Load Losses	83	1.95%	125879	0.84%
No-Load Losses	19	0.45%	169747	1.13%
Primary Losses	52	1.21%	219280	1.46%
Secondary Losses	50	1.18%	76346	0.51%

Figure 2-19:
3111 phase balance modeled losses at the peak-hour and annual energy losses

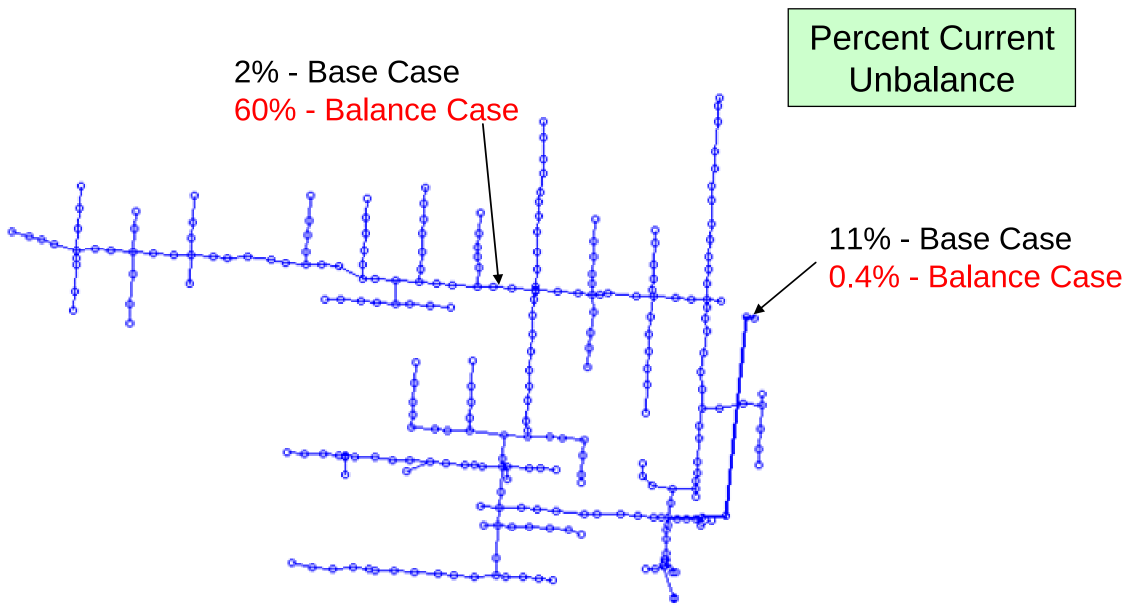


Figure 2-20:
3111 phase balance model percent unbalances in the circuit

Voltage Optimization

To model voltage optimization the LTC base was reduced to 118V from 122.5V. This reduction maintained a minimum voltage above 0.965 pu at the customer service. Before the voltage reduction the minimum voltage on the feeder was maintained at 0.99 pu. See Figure 2-21.

Figure 2-22 shows the results of the voltage optimization simulation. For the annual simulation the consumption was reduced by 408.6 MWh and the loss was reduced by 12.5 MWh. At peak, the consumption was reduced by 119 kW and the losses reduce by 3 kW.

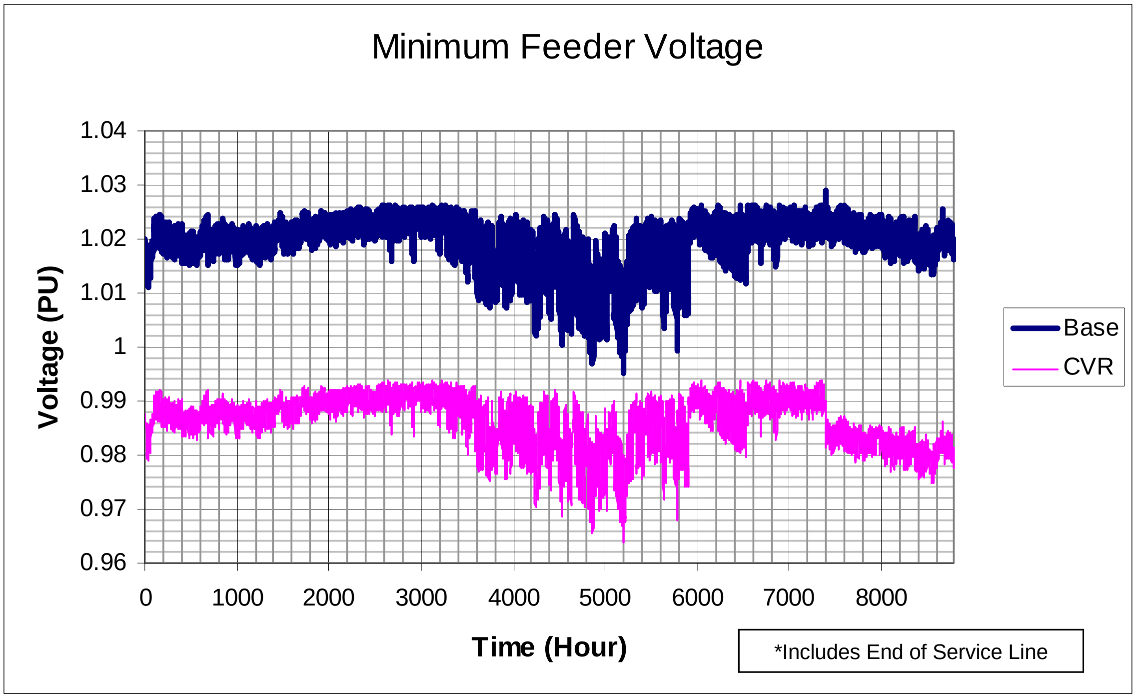


Figure 2-21:
3111 minimum voltage across entire feeder during yearly loadflow

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4142**		**14596031**	
Total Losses	99	2.40%	281700	1.93%
Line Losses	63	1.53%	95027	0.65%
Xfmr Losses	36	0.87%	186673	1.28%
Load Losses	81	1.97%	122901	0.84%
No-Load Losses	18	0.43%	158799	1.09%
Primary Losses	51	1.24%	209369	1.43%
Secondary Losses	48	1.16%	72331	0.50%

Figure 2-22:
3111 voltage optimization modeled losses at the peak-hour and annual energy losses

Re-conductoring

A loss reduction approach could be to re-conductor the circuit. The conductor simulation replaced the all 477 AAC with 795 AAC on the overhead three phase mains. The annual energy savings reduced to 1.95% from 1.96%. Figure 2-23 shows the results of the re-conductor simulation.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4262**		**15005802**	
Total Losses	101	2.36%	292984	1.95%
Line Losses	63	1.48%	94999	0.63%
Xfmr Losses	38	0.88%	197986	1.32%
Load Losses	82	1.92%	123285	0.82%
No-Load Losses	19	0.44%	169699	1.13%
Primary Losses	52	1.22%	219612	1.46%
Secondary Losses	49	1.14%	73372	0.49%

Figure 2-23:
3111 re-conductor model losses at the peak-hour and annual energy losses

Ideal var Optimization

A somewhat theoretical case is the ideal var optimization case. The ideal var optimization case attempts to answer what the maximum achievable losses would be if all capacitors were removed from the circuit and the loads power factors were set to 1.0 across the circuit. This would be the case if the capacitors could be 'perfectly' controlled from a var perspective. The annual energy losses were improved to 1.81% from 1.96%. The average power factor was improved to 0.999 from 0.992.

Figure 2-24 shows the results of the ideal var simulation.

	Peak Demand		Annual Energy	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4286**		**15005208**	
Total Losses	87	2.03%	271920	1.81%
Line Losses	53	1.23%	78627	0.52%
Xfmr Losses	34	0.80%	193293	1.29%
Load Losses	68	1.58%	101471	0.68%
No-Load Losses	19	0.45%	170449	1.14%
Primary Losses	47	1.10%	212669	1.42%
Secondary Losses	40	0.92%	59251	0.39%

Figure 2-24:
3111 ideal var model losses at the peak-hour and annual energy losses

Capacitor Control

Added capacitor control was studied for 3111 as another approach to reduce losses. For the capacitor control case, var control was added to the two temperature controlled capacitors and all capacitors were reduced to 300kvar each. This change in capacitor control improves the average power factor from 0.992 to 0.995. The annual energy savings reduced to 1.95% from 1.96%.

Figure 2-25 shows the results of the capacitor control simulation.

	Peak Demand		**Annual Energy**	
	kW	% Peak	kWh	% Consumpt.
Consumption/Demand	**4264**		**15004908**	
Total Losses	101	2.36%	292777	1.95%
Line Losses	63	1.48%	94717	0.63%
Xfmr Losses	38	0.88%	198060	1.32%
Load Losses	82	1.92%	122990	0.82%
No-Load Losses	19	0.44%	169787	1.13%
Primary Losses	52	1.22%	219440	1.46%
Secondary Losses	49	1.14%	73337	0.49%

Figure 2-25:
3111 capacitor control model losses at the peak-hour and annual energy losses

Summary

Figure 2-26 and Figure 2-27 below compares the results to the base case. As can be seen the ideal var control results but this may not be practical in achieving. The voltage optimization (referred to as CVR, Conservation -Voltage Reduction) may be the most cost effective approach to reduce losses.

	Base	**Ideal var**	**Balance**	**CVR 0.9**	**Capacitor Control**	**Reconductor**
GWh Consumption	15.0	15.0	15.0	14.6	15.0	15.0
GWh Losses	0.2942	0.2719	0.2956	0.2817	0.2928	0.2930
Delta Loss (MWh)		**22.3**	**-1.4**	**12.5**	**1.4**	**1.2**
Delta Consumption (MWh)		-0.5	6.4	408.6	-0.2	-1.1
% Loss (Base)	1.96%	1.81%	1.97%	1.88%	1.95%	1.95%
% Consumption (Base)		100.0%	100.0%	97.3%	100.0%	100.0%
% Base		7.57%	-0.49%	4.25%	0.48%	0.41%

Figure 2-26:
3111 efficiency analysis comparison summary

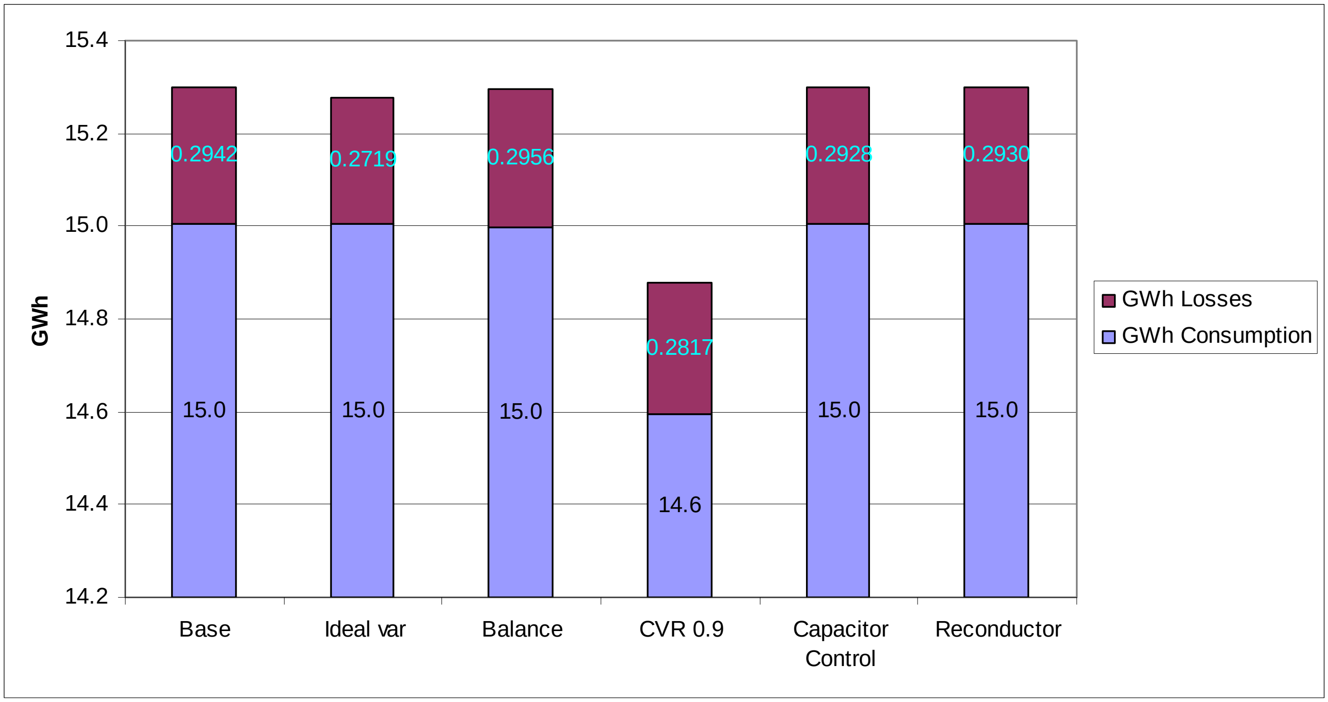


Figure 2-27:
3111 efficiency comparison summary graph

Circuit #7812

Circuit #7812 is primarily an urban residential circuit. It has a primary voltage of 12.47 kV. Figure 2-28 shows the layout of the circuit.

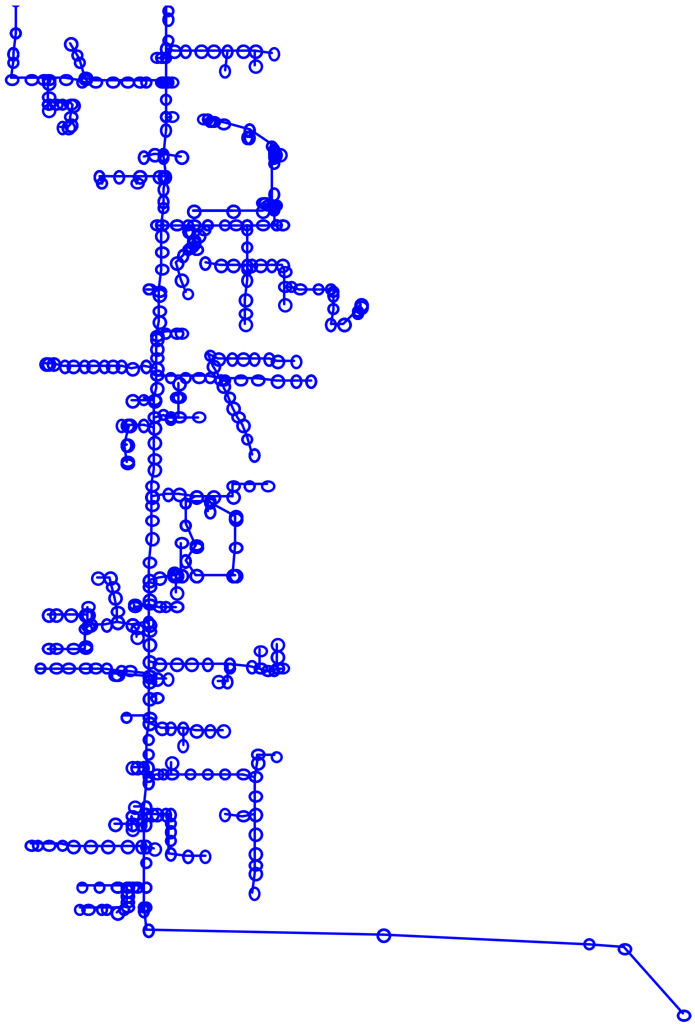


Figure 2-28:
Circuit 7812

Base Case

Using a peak-load case provided by KCP&L in the 2008 loadshape, the real power load is scaled on each phase to match the measurements. The capacitor controls were implemented in the model to match the operation of the line capacitors. The implemented capacitor controls are as follows:

- CL-1484 (900kvar)
  - Voltage Override
    - Low Voltage Override Setpoint – 119.9 V
    - High Voltage Override Setpoint – 126.1 V
  - Summer Season Operation – Temperature Control
    - High Temperature at Which Bank Switches In – 85°F
    - High Temperature at Which Bank Switches Out – 70°F
  - Non Summer Season Operation – Temperature Control

- Low Temperature at Which Bank Switches Out – 40°F
- Low Temperature at Which Bank Switches In – 30°F

- CL-85094 (1200kvar)
  - Voltage Override
    - Low Voltage Override Setpoint – 119.9 V
    - High Voltage Override Setpoint – 126.1 V
  - Summer Season Operation
    - High Temperature at Which Bank Switches In – 85°F
    - High Temperature at Which Bank Switches Out – 70°F
    - Var Control Which Bank Switches In – 600 kvar
    - Var Control Which Bank Switches Out – -1000 kvar
  - Non Summer Season Operation – Var Control
    - Low Temperature at Which Bank Switches Out – 40°F
    - Low Temperature at Which Bank Switches In – 30°F

Because CL-1484 and CL-85094 capacitors include temperature control in the summer season the temperature (provided by KCP&L) the temperature fluctuations were included in the model.

The implementation of the capacitor's summer control and non-summer control along with the load allocations, allowed for the base model current to match the measured current provide from the substation metering. Figure 2-29 shows the comparison between the measured feeder current and the simulated feeder current. The load factor of this loadshape (2008) was 44% and the average power factor was 0.9.

The annual losses were calculated to be 2.4% with the transformer no-load loss dominating (45%).

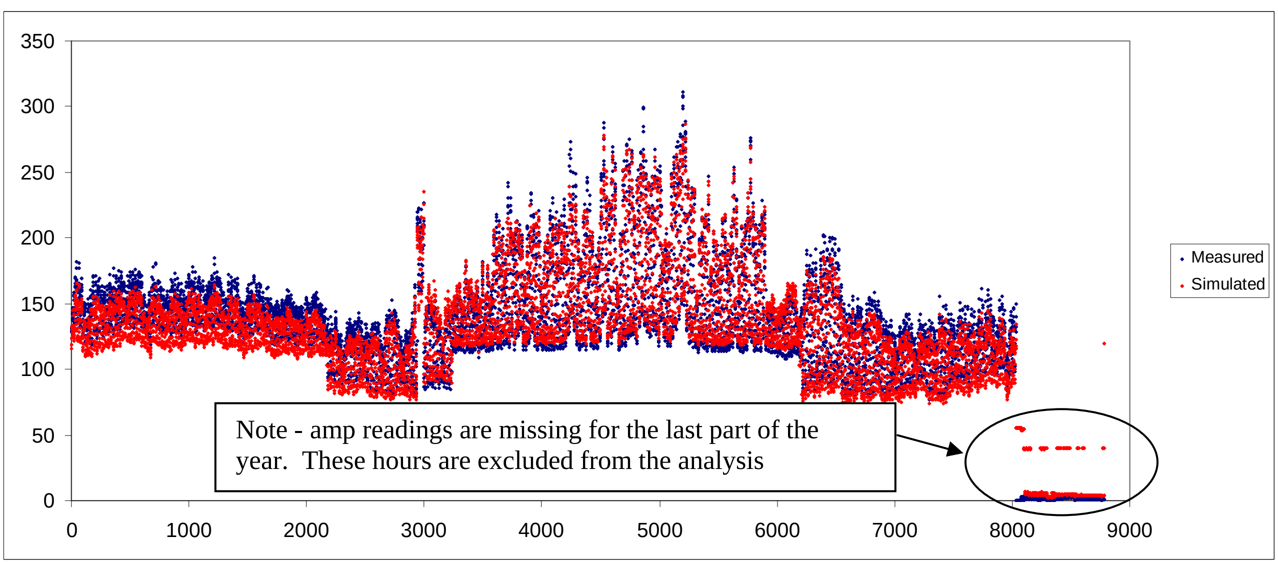


Figure 2-29
7812 Current Simulated vs. Measured

Figure 2-30 summarizes the results of the yearly and peak-day losses for the 7812 circuit.

	At Peak Hour		**Annual Energy**	
Demand values for the peak hour of (load + loss)	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5665**		**22222498**	
Total Loss	173	3.06%	534293	2.40%
Line Loss (Wires)	123	2.18%	250568	1.13%
Transformer Loss (load plus no-load)	50	0.88%	283726	1.28%
Load Loss (Wires and transformers)	144	2.54%	291879	1.31%
No-Load Loss (Transformer magnetizing)	29	0.52%	242414	1.09%
Primary Loss (Includes transformers)	116	2.05%	421316	1.90%
Secondary Loss (No transformers)	57	1.01%	112978	0.51%
Primary Lines (Wires)	66	1.17%	137590	0.62%
Secondary Lines (Wires)	57	1.01%	112978	0.51%
No-Load Loss (Transformer magnetizing)	29	0.52%	242414	1.09%
Transformer Load Loss	21	0.36%	41312	0.19%

Figure 2-30:
7812 modeled losses at the peak-hour and annual energy losses

Phase Balancing

The phase currents were balanced at the peak hour for the circuits which had some unbalance. The average unbalance in the base case was 9.1% and this was improved to 1.0% in the Phase Balancing Case. The unbalanced calculation is based on the ANSI/NEMA Standard MG1-1993 definition. Figure 2-5 shows the results of the phase balancing simulation. Generally, the loss reductions were very low.

	At Peak Hour		**Annual Energy**	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5662**		**22243050**	
Total Loss	172	3.04%	533611	2.40%
Line Loss (Wires)	122	2.16%	249736	1.12%
Transformer Loss (load plus no-load)	50	0.88%	283876	1.28%
Load Loss (Wires and transformers)	143	2.52%	291232	1.31%
No-Load Loss (Transformer magnetizing)	29	0.52%	242379	1.09%
Primary Loss (Includes transformers)	115	2.03%	420155	1.89%
Secondary Loss (No transformers)	57	1.01%	113457	0.51%

Figure 2-31:
7812 phase balance modeled losses at the peak-hour and annual energy losses

Voltage Optimization

To model voltage optimization the LTC base was reduced from 122.5V to 117.5V with line compensation implemented (monitoring end of feeder). This reduction maintained a minimum voltage above 0.95 pu at the customer service. Before the voltage reduction the minimum voltage on the feeder was maintained at 0.97 pu. See Figure 2-32.

Figure 2-33 shows the results of the voltage optimization simulation. For the annual simulation the consumption was reduced by 700 MWh and the loss was reduced by 20.5 MWh.

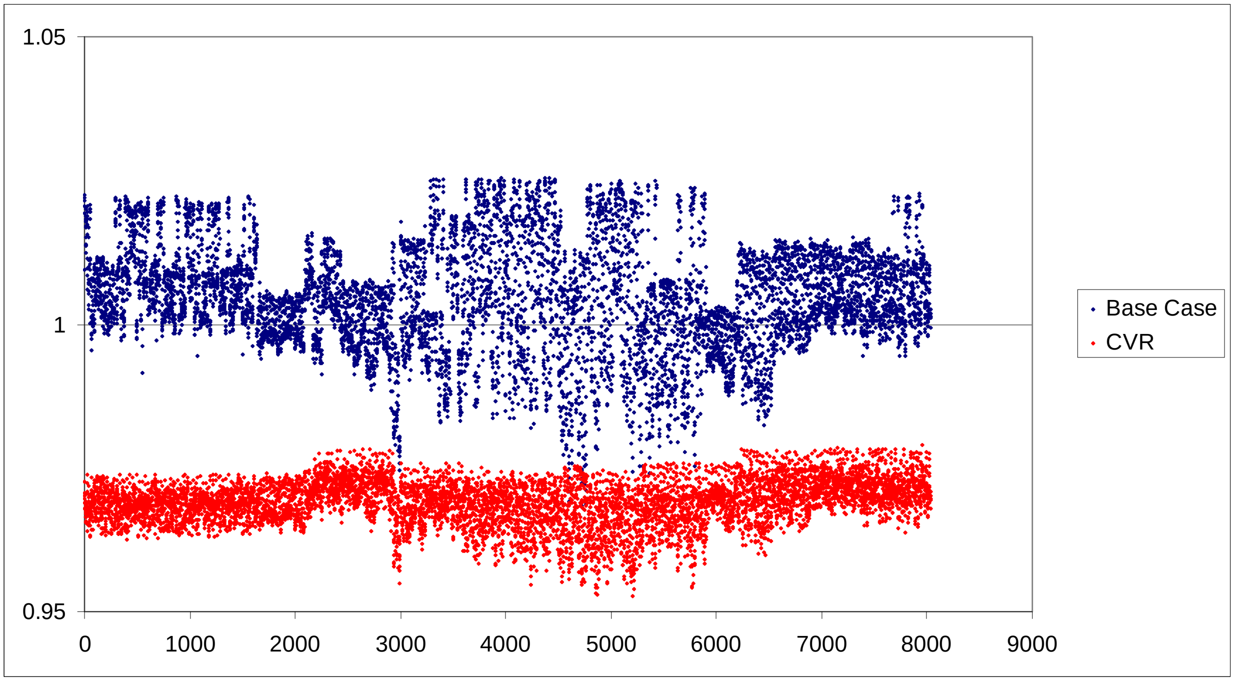


Figure 2-32:
7812 minimum voltage across entire feeder during yearly loadflow

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5571**		**21522594**	
Total Loss	171	3.08%	513803	2.39%
Line Loss (Wires)	123	2.20%	247748	1.15%
Transformer Loss (load plus no-load)	49	0.87%	266055	1.24%
Load Loss (Wires and transformers)	143	2.57%	288143	1.34%
No-Load Loss (Transformer magnetizing)	28	0.51%	225660	1.05%
Primary Loss (Includes transformers)	115	2.06%	403117	1.87%
Secondary Loss (No transformers)	57	1.02%	110685	0.51%

Figure 2-33:
7812 voltage optimization modeled losses at the peak-hour and annual energy losses

Re-conductoring

A loss reduction approach could be to re-conductor the circuit. The conductor simulation replaced:

1.3 miles of U_2_AL upgraded with U_1/0_AL,
0.7 miles of U_600_CU upgraded with U_750_CU,
2.2 miles of O_477_AL upgraded with O_750_AL,
1.0 mile of O_2_Al upgraded with O_3/0_AL

The annual energy savings reduced to 2.33% from 2.40%. Figure 2-34 shows the results of the re-conductor simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5672**		**22235364**	
Total Loss	166	2.93%	518749	2.33%
Line Loss (Wires)	116	2.05%	234715	1.06%
Transformer Loss (load plus no-load)	50	0.88%	284034	1.28%
Load Loss (Wires and transformers)	137	2.41%	276045	1.24%
No-Load Loss (Transformer magnetizing)	29	0.52%	242704	1.09%
Primary Loss (Includes transformers)	109	1.92%	405724	1.82%
Secondary Loss (No transformers)	57	1.01%	113026	0.51%

Figure 2-34:
7812 re-conductor model losses at the peak-hour and annual energy losses

Ideal var Optimization

A somewhat theoretical case is the ideal var optimization case. The ideal var optimization case attempts to answer what the maximum achievable losses would be if all capacitors were removed from the circuit and the loads power factors were set to 1.0 across the circuit. This would be the case if the capacitors could be ‘perfectly’ controlled from a var perspective. The annual energy losses were improved by 43.6MWh. The average power factor was improved to 0.99 from 0.9.

Figure 2-35 shows the results of the ideal var simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5725**		**22286731**	
Total Loss	156	2.73%	490687	2.20%
Line Loss (Wires)	110	1.91%	214009	0.96%
Transformer Loss (load plus no-load)	46	0.81%	276678	1.24%
Load Loss (Wires and transformers)	126	2.20%	246451	1.11%
No-Load Loss (Transformer magnetizing)	30	0.52%	244236	1.10%
Primary Loss (Includes transformers)	110	1.92%	400515	1.80%
Secondary Loss (No transformers)	46	0.81%	90172	0.40%

Figure 2-35:
7812 ideal var model losses at the peak-hour and annual energy losses

Capacitor Control

Added capacitor control was studied for 7812 as another approach to reduce losses. This is a more realistic approach to var control opposed to the ideal var case. For the capacitor control the summer temperature settings were reduced to increase kvar hours produced by existing capacitors. This had minimal impact on losses.

Figure 2-36 shows the results of the capacitor control simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5665**		**22236894**	
Total Loss	173	3.06%	533109	2.40%
Line Loss (Wires)	123	2.18%	249034	1.12%
Transformer Loss (load plus no-load)	50	0.88%	284075	1.28%
Load Loss (Wires and transformers)	144	2.54%	290366	1.31%
No-Load Loss (Transformer magnetizing)	29	0.52%	242742	1.09%
Primary Loss (Includes transformers)	116	2.05%	420078	1.89%
Secondary Loss (No transformers)	57	1.01%	113030	0.51%

Figure 2-36:
7812 capacitor control model losses at the peak-hour and annual energy losses

Summary

Figure 2-37 and Figure 2-38 below compares the results to the base case. As can be seen the ideal var control results in the biggest savings in loss reduction followed by the voltage optimization case (referred to as CVR, Conservation -Voltage Reduction) case. However, the voltage optimization may be the most cost effective approach to reduce losses.

	Base	Ideal var	Balance	CVR 0.9	Capacitor Control	Reconductor
GWh Consumption	22.2	22.3	22.2	21.5	22.2	22.2
GWh Losses	0.53	0.49	0.53	0.51	0.53	0.52
Delta Loss (MWh)		**43.6**	**0.7**	**20.5**	**1.2**	**15.5**
Delta Consumption (MWh)		-64.2	-20.6	699.9	-14.4	-12.9
% Loss (Base)	2.40%	2.21%	2.40%	2.31%	2.40%	2.33%
% Consumption (Base)		100.3%	100.1%	96.9%	100.1%	100.1%
% Base		8.16%	0.13%	3.83%	0.22%	2.91%

Figure 2-37:
7812 efficiency analysis comparison summary

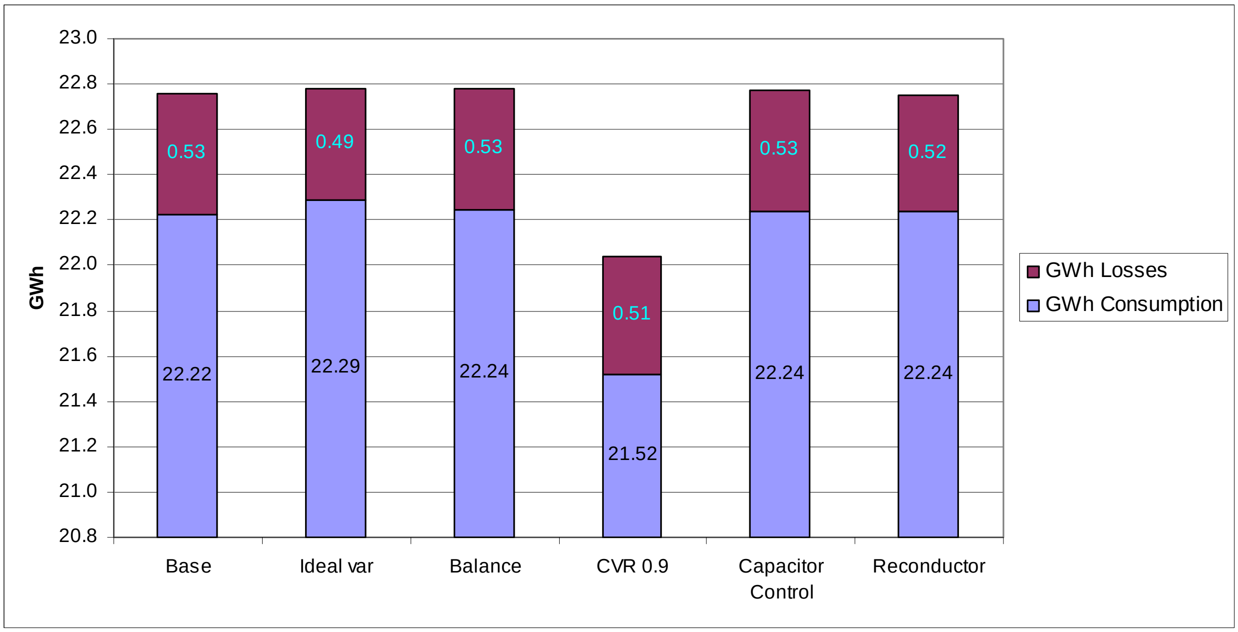


Figure 2-38:
7812 efficiency comparison summary graph

Circuit #5051

Circuit #5051 is primarily an urban residential circuit. It has a primary voltage of 12.47 kV with a portion 4.16kV. Figure 2-28 shows the layout of the circuit.

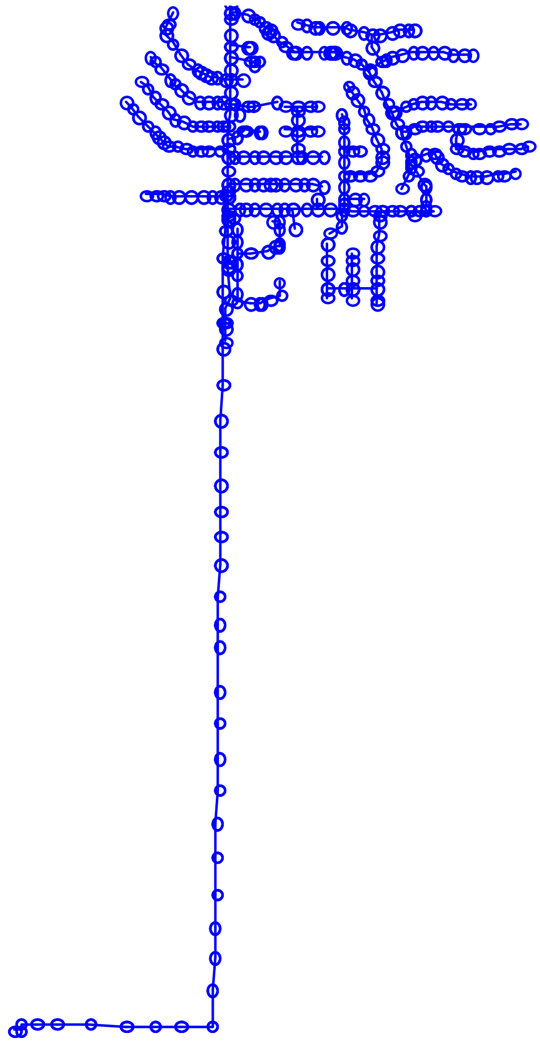


Figure 2-39:
Circuit 5051

Base Case

Using a peak-load case provided by KCP&L in the 2008 loadshape, the real power load is scaled on each phase to match the measurements. The capacitor controls were implemented in the model to match the operation of the line capacitors. The implemented capacitor controls are as follows:

- JO-86186 (1200kvar)
  - Voltage Override
    - Low Voltage Override Setpoint – 119.9 V
    - High Voltage Override Setpoint – 126.1 V
  - Summer Season Operation – Temperature Control
    - High Temperature at Which Bank Switches In – 85°F
    - High Temperature at Which Bank Switches Out – 70°F
  - Non Summer Season Operation – Temperature Control

        - High Temperature at Which Bank Switches Out – 40°F
        - Low Temperature at Which Bank Switches In – 30°F
- JO-2384 (600 kVAr), JO-86307 (1200 kVAr)
        - Low Voltage Override Setpoint – 119.9 V
        - High Voltage Override Setpoint – 126.1 V
    - Summer Season Operation
        - High Temperature at Which Bank Switches In – 85°F
        - High Temperature at Which Bank Switches Out – 70°F
        - Var Control Which Bank Switches In – 600 kvar
        - Var Control Which Bank Switches Out – -1000 kvar
    - Non Summer Season Operation – Var Control
        - High Temperature at Which Bank Switches Out – 40°F
        - Low Temperature at Which Bank Switches In – 30°F
- JO-86190 (600kVAr)
    - Fixed

Because the JO-86186, JO-2384, and JO-86307 capacitors include temperature control in the temperature fluctuations were included in the model.

The simulated models are developed to replicate the actual feeder; therefore, it is imperative to validate simulations with substation measurements. In this case, when the provided temperature control settings were used on 5051, too many capacitors were switching on in the summer season. To match the measured values, especially during the shoulder regions, the summer temperature settings had to be raised to 95F/85F, to compensate for any temperature difference at 5051. This may be in part due to C5051 being cooler than the temperature monitoring point, and also in part that C5051 is almost entirely residential load.

The implementation of the modified capacitor's summer control and non-summer control along with the load allocations, the base model current matched the measured current provide from the substation metering. Figure 2-40 shows the comparison between the measured feeder current and the simulated feeder current. The load factor of this loadshape (2008) was 36% and the average power factor was 0.9.

The annual losses were calculated to be 2.53% with the transformer no-load loss dominating (43%).

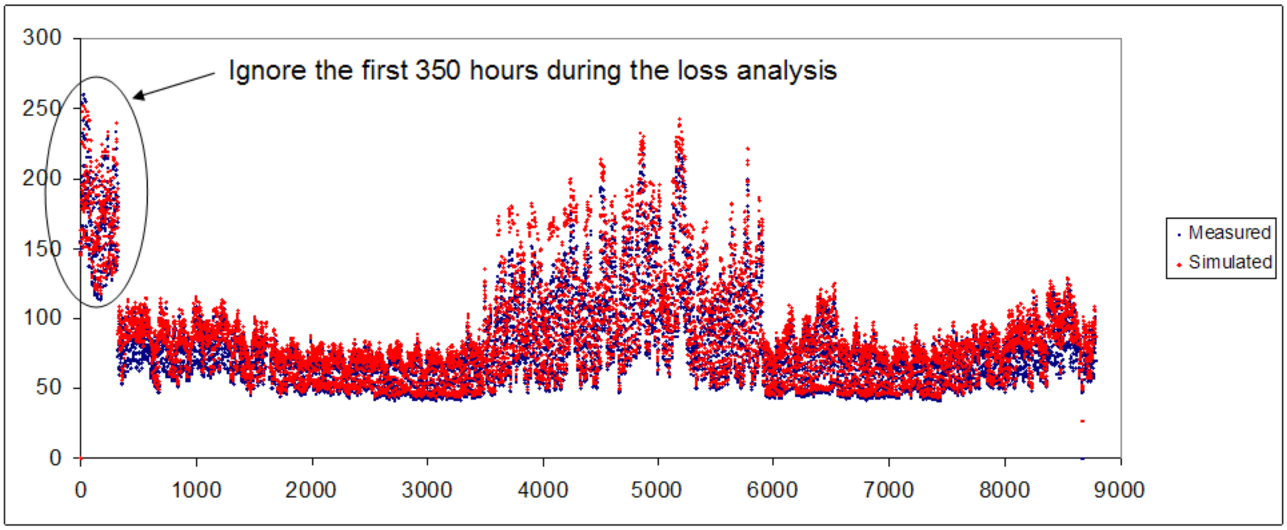


Figure 2-40
5051 Current Simulated vs. Measured

Figure 2-41 summarizes the results of the yearly and peak-day losses for the 9111 circuit.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5079**		**15121877**	
Total Loss	203	3.99%	382523	2.53%
Line Loss (Wires)	147	2.90%	178201	1.18%
Transformer Loss (load plus no-load)	55	1.08%	204322	1.35%
Load Loss (Wires and transformers)	184	3.62%	221432	1.46%
No-Load Loss (Transformer magnetizing)	19	0.37%	161092	1.07%
Primary Loss (Includes transformers)	129	2.55%	297824	1.97%
Secondary Loss (No transformers)	73	1.44%	84700	0.56%

Figure 2-41:
5051 modeled losses at the peak-hour and annual energy losses

Phase Balancing

The phase currents were balanced at the peak hour for the circuits which had some unbalance. The average unbalance in the base case was 11.2% and this was improved to 1.0% in the Phase Balancing Case. The unbalanced calculation is based on the ANSI/NEMA Standard MG1-1993 definition. Figure 2-42 shows the results of the phase balancing simulation. The loss reductions were very low and with a slight increase in some areas.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5097**		**15158859**	
Total Loss	205	4.03%	383787	2.53%
Line Loss (Wires)	149	2.93%	178640	1.18%
Transformer Loss (load plus no-load)	56	1.10%	205146	1.35%
Load Loss (Wires and transformers)	187	3.66%	222749	1.47%
No-Load Loss (Transformer magnetizing)	19	0.37%	161038	1.06%
Primary Loss (Includes transformers)	131	2.58%	298432	1.97%
Secondary Loss (No transformers)	74	1.45%	85355	0.56%

Figure 2-42:
5051 phase balance modeled losses at the peak-hour and annual energy losses

Voltage Optimization

To model voltage optimization the LTC base was reduced from 122.5V to 118.5V with line compensation implemented (monitoring end of 12.47kV feeder). This reduction maintained a minimum voltage equivalent to the minimum voltage from the base case. See Figure 2-43. **Note: It was necessary to add a 450kvar capacitor at the 4.16kV bus of the 12.47/4.16 transformer to keep voltage in the 4.16kV section from dropping lower than the base case.**

Figure 2-44 shows the results of the voltage optimization simulation. For the annual simulation the consumption was reduced by 484.79 MWh and the loss was reduced by 5.88 MWh.

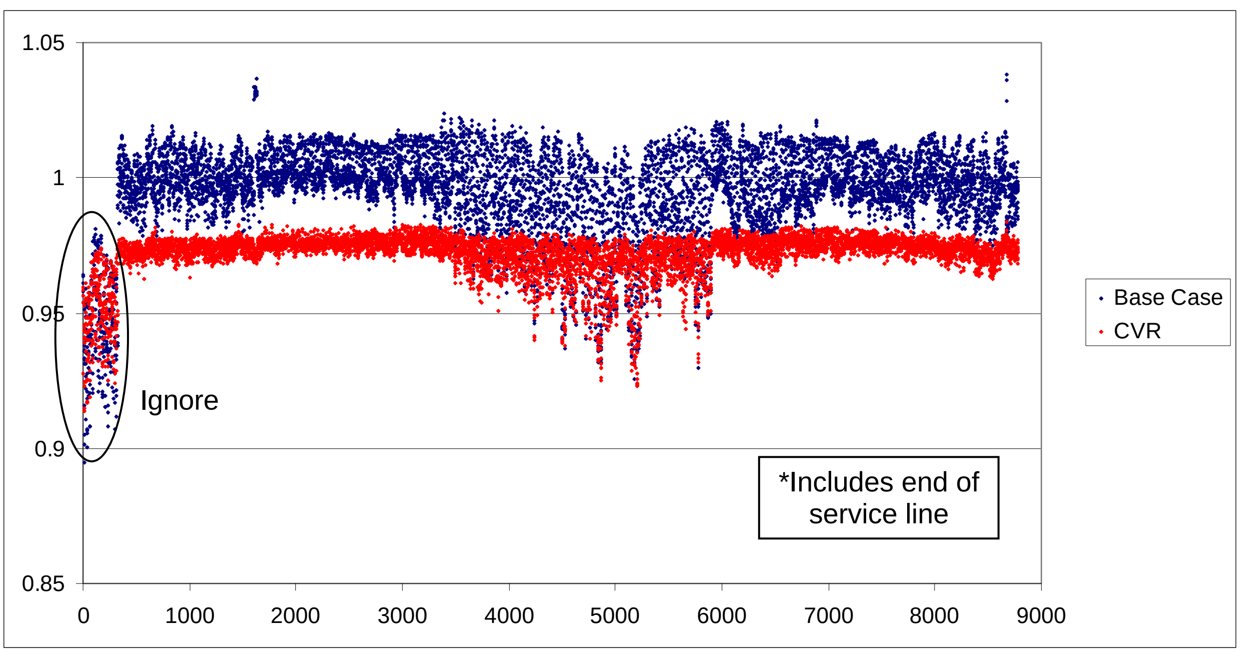


Figure 2-43:
5051 minimum voltage across entire feeder during yearly loadflow

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**4887**		**14637088**	
Total Loss	200	4.08%	376648	2.57%
Line Loss (Wires)	148	3.03%	178224	1.22%
Transformer Loss (load plus no-load)	52	1.05%	198424	1.36%
Load Loss (Wires and transformers)	182	3.73%	226721	1.55%
No-Load Loss (Transformer magnetizing)	17	0.35%	149927	1.02%
Primary Loss (Includes transformers)	128	2.62%	293722	2.01%
Secondary Loss (No transformers)	71	1.46%	82926	0.57%

Figure 2-44:
5051 voltage optimization modeled losses at the peak-hour and annual energy losses

Re-conductoring

A loss reduction approach could be to re-conductor the circuit. The conductor simulation replaced:

1 2 miles of U_600_CU with U_750_CU;
1 mile of O_477_AL with O_750_AL;

The annual energy savings reduced by 11.46MWh. Figure 2-45 shows the results of the re-conductor simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5086**		**15131157**	
Total Loss	193	3.80%	371062	2.45%
Line Loss (Wires)	138	2.71%	166523	1.10%
Transformer Loss (load plus no-load)	55	1.09%	204539	1.35%
Load Loss (Wires and transformers)	174	3.43%	209774	1.39%
No-Load Loss (Transformer magnetizing)	19	0.37%	161287	1.07%
Primary Loss (Includes transformers)	120	2.36%	286321	1.89%
Secondary Loss (No transformers)	73	1.44%	84740	0.56%

Figure 2-45:
5051 re-conductor model losses at the peak-hour and annual energy losses

Ideal var Optimization

A somewhat theoretical case is the ideal var optimization case. The ideal var optimization case attempts to answer what the maximum achievable losses would be if all capacitors were removed from the circuit and the loads power factors were set to 1.0 across the circuit. This would be the case if the capacitors could be ‘perfectly’ controlled from a var perspective. The annual energy losses were improved by 38Mhr. The average power factor was improved to 0.99 from 0.9.

Figure 2-46 shows the results of the ideal var simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5102**		**15236063**	
Total Loss	176	3.45%	344540	2.26%
Line Loss (Wires)	127	2.50%	147368	0.97%
Transformer Loss (load plus no-load)	48	0.95%	197172	1.29%
Load Loss (Wires and transformers)	157	3.08%	181616	1.19%
No-Load Loss (Transformer magnetizing)	19	0.37%	162924	1.07%
Primary Loss (Includes transformers)	116	2.28%	276606	1.82%
Secondary Loss (No transformers)	59	1.16%	67935	0.45%

Figure 2-46:
5051 ideal var model losses at the peak-hour and annual energy losses

Capacitor Control

Added capacitor control was studied for 5051 as another approach to reduce losses. This is a more realistic approach to var control opposed to the ideal var case. For better var control, a 300kvar capacitor was added to the 4.16kV section. This had minimal impact on losses.

Figure 2-47 shows the results of the capacitor control simulation.

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5055**		**15193953**	
Total Loss	199	3.93%	384578	2.53%
Line Loss (Wires)	145	2.88%	178146	1.17%
Transformer Loss (load plus no-load)	53	1.06%	206432	1.36%
Load Loss (Wires and transformers)	180	3.57%	221620	1.46%
No-Load Loss (Transformer magnetizing)	19	0.37%	162958	1.07%
Primary Loss (Includes transformers)	126	2.49%	299622	1.97%
Secondary Loss (No transformers)	73	1.44%	84956	0.56%

Figure 2-47:
5051 capacitor control model losses at the peak-hour and annual energy losses

Upgrade 4.16kV Section with 12.47kV

Upgrading the 4.16kV section to 12.47kV was studied for 5051 as another approach to reduce losses. This upgrade resulted in removing the 12.47/4.16kV step-down transformer. This resulted in an annual 22.08Mhr reduction in losses. Figure 2-48 shows the results of the 4.16kV upgrade simulation. **Note: No change to service transformer impedances or line impedances of the 4.16kV section when upgraded to 12.47kV.**

	At Peak Hour		Annual Energy	
	Total kW	% of Consump	Total kWh	% of Consumpt
Consumption/Demand	**5123**		**15173630**	
Total Loss	184	3.59%	360441	2.38%
Line Loss (Wires)	138	2.69%	166376	1.10%
Transformer Loss (load plus no-load)	46	0.90%	194065	1.28%
Load Loss (Wires and transformers)	165	3.22%	198174	1.31%
No-Load Loss (Transformer magnetizing)	19	0.37%	162266	1.07%
Primary Loss (Includes transformers)	111	2.16%	275529	1.82%
Secondary Loss (No transformers)	73	1.43%	84912	0.56%

Figure 2-48:
5051 4.16kV upgrade model losses at the peak-hour and annual energy losses

Summary

Figure 2-49 and Figure 2-50 below compares the results to the base case. As can be seen the ideal var results in the biggest savings followed by the upgrade to 4.16kV upgrade. The voltage optimization case (referred to as CVR, Conservation Voltage Reduction) resulted in an annual savings of 5.9MWh.

	Base	Ideal var	Balance	CVR 0.9	Capacitor Control	Reconductor	Upgrade 4.16kV
GWh Consumption	15.1	15.2	15.2	14.6	15.2	15.1	15.2
GWh Losses	0.38	0.34	0.38	0.38	0.38	0.37	0.36
Delta Loss (MWh)		**38.0**	**-1.3**	**5.9**	**-2.1**	**11.5**	**22.1**
Delta Consumption (MWh)		-114.2	-37.0	484.8	-72.1	-9.3	-51.8
% Loss (Base)	2.53%	2.28%	2.54%	2.49%	2.54%	2.45%	2.38%
% Consumption (Base)		100.8%	100.2%	96.8%	100.5%	100.1%	100.3%
% Base		9.93%	-0.33%	1.54%	-0.54%	3.00%	5.77%

Figure 2-49:
5051 efficiency analysis comparison summary

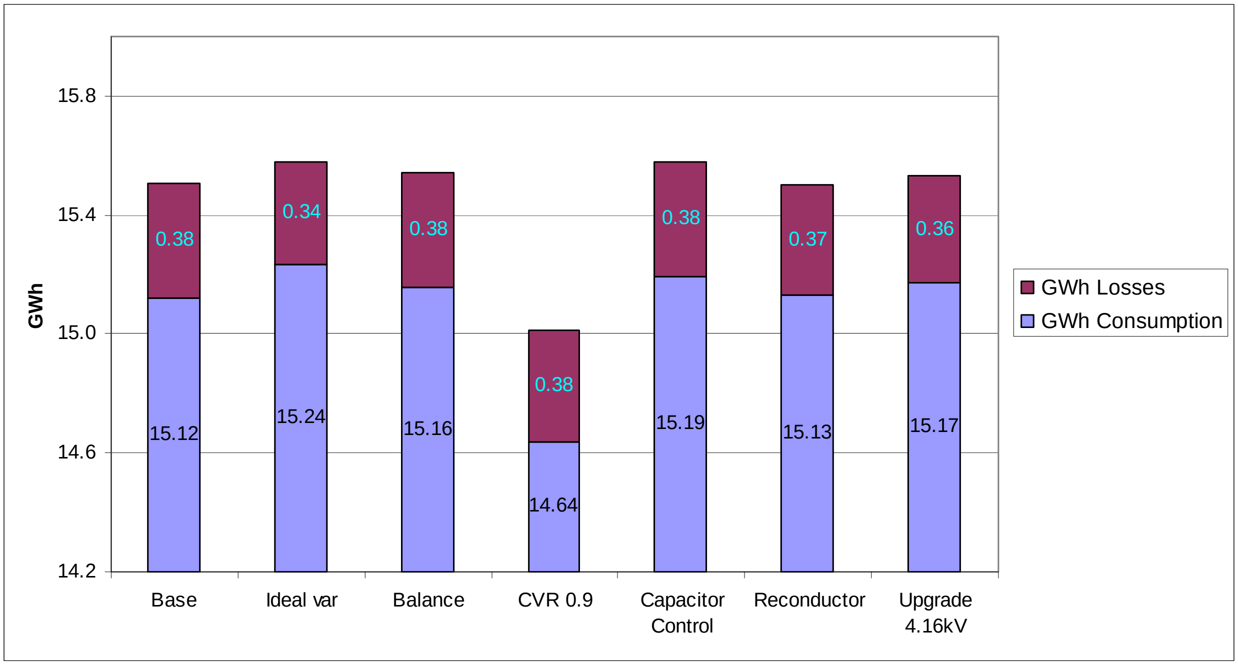


Figure 2-50:
5051 efficiency comparison summary graph

3
MODELING RESULTS

General Characteristics

The following series of graphs shows how the KCP&L circuits compare with general characteristics of the other circuits that have been modeled in the Green Circuits project.

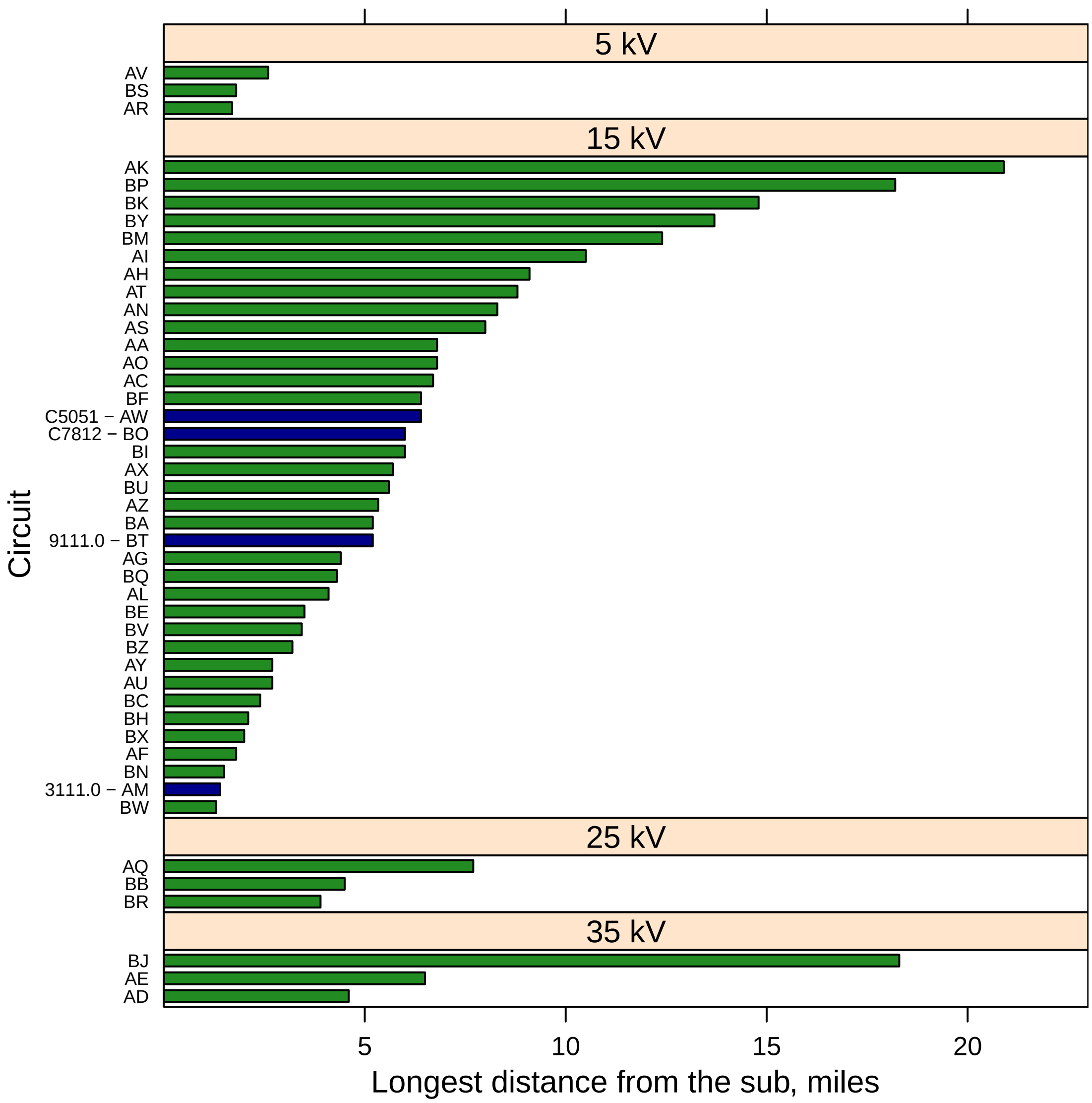


Figure 3-1
Circuits by Voltage and Distance from the Substation

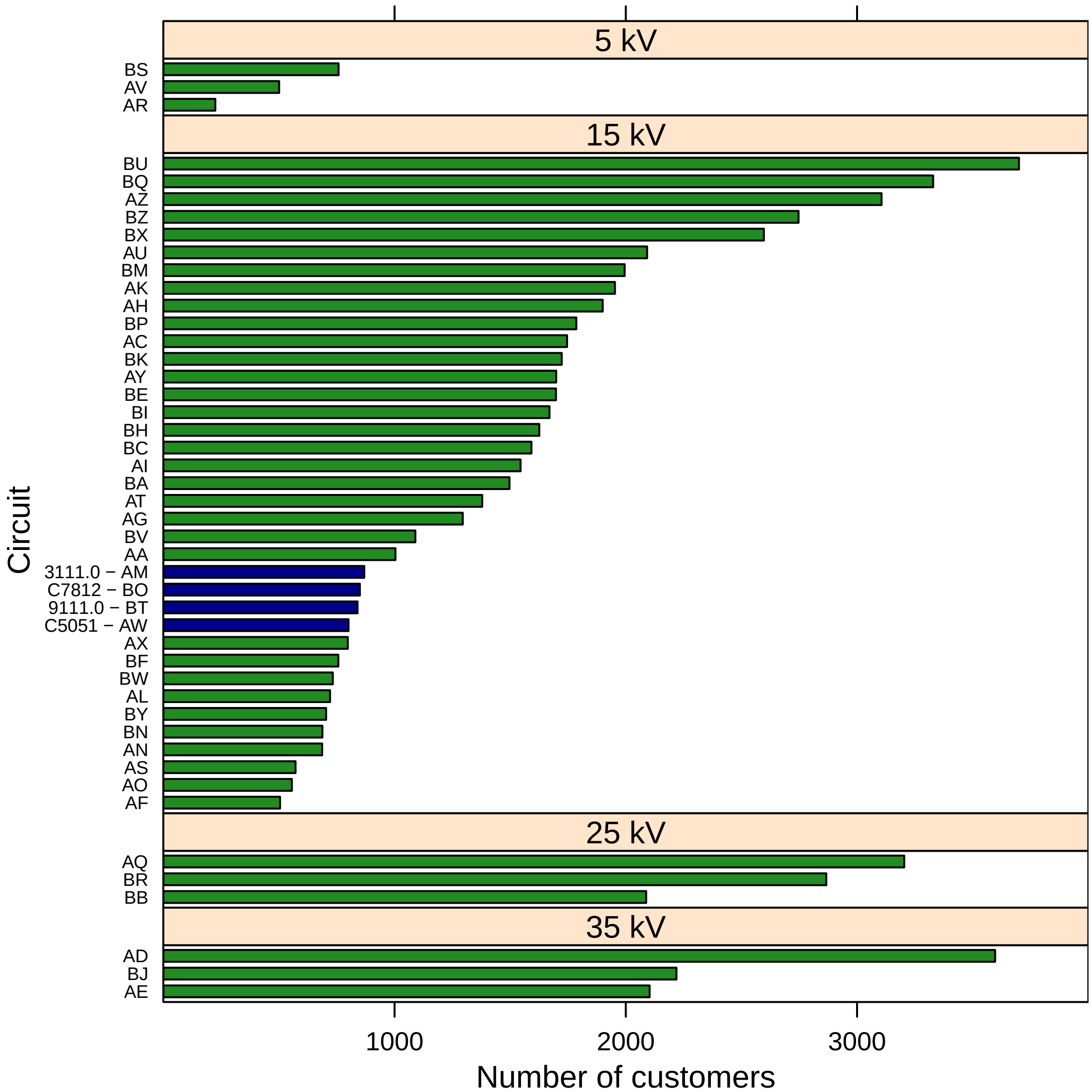


Figure 3-2
Number of Customers per Circuit

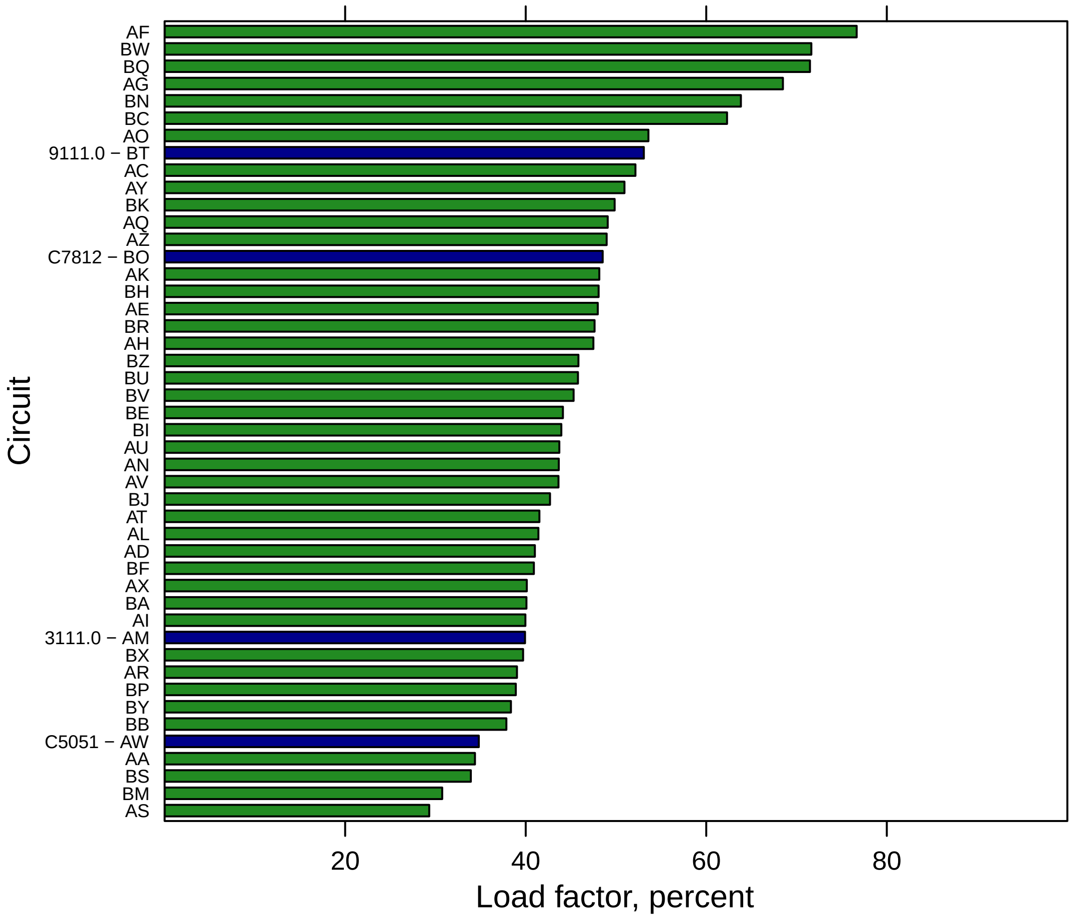


Figure 3-3
Circuit Load Factors

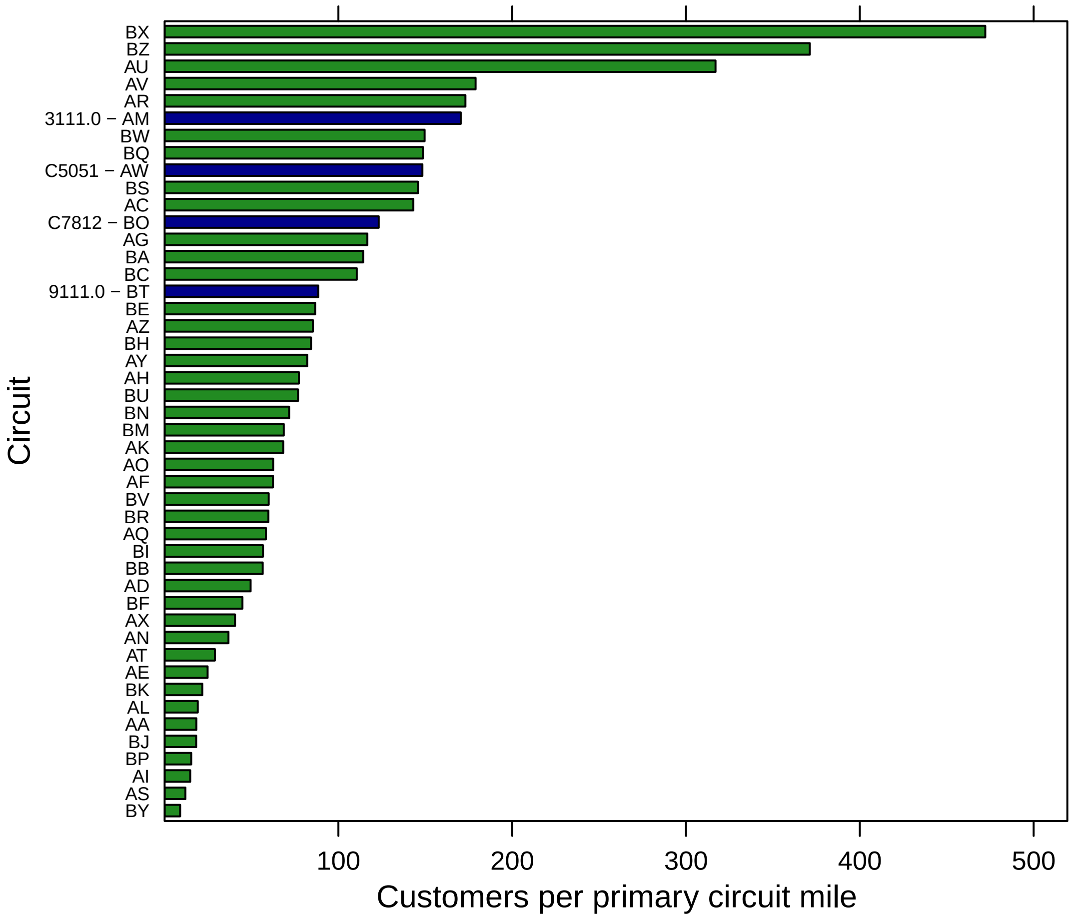


Figure 3-4
Load Densities

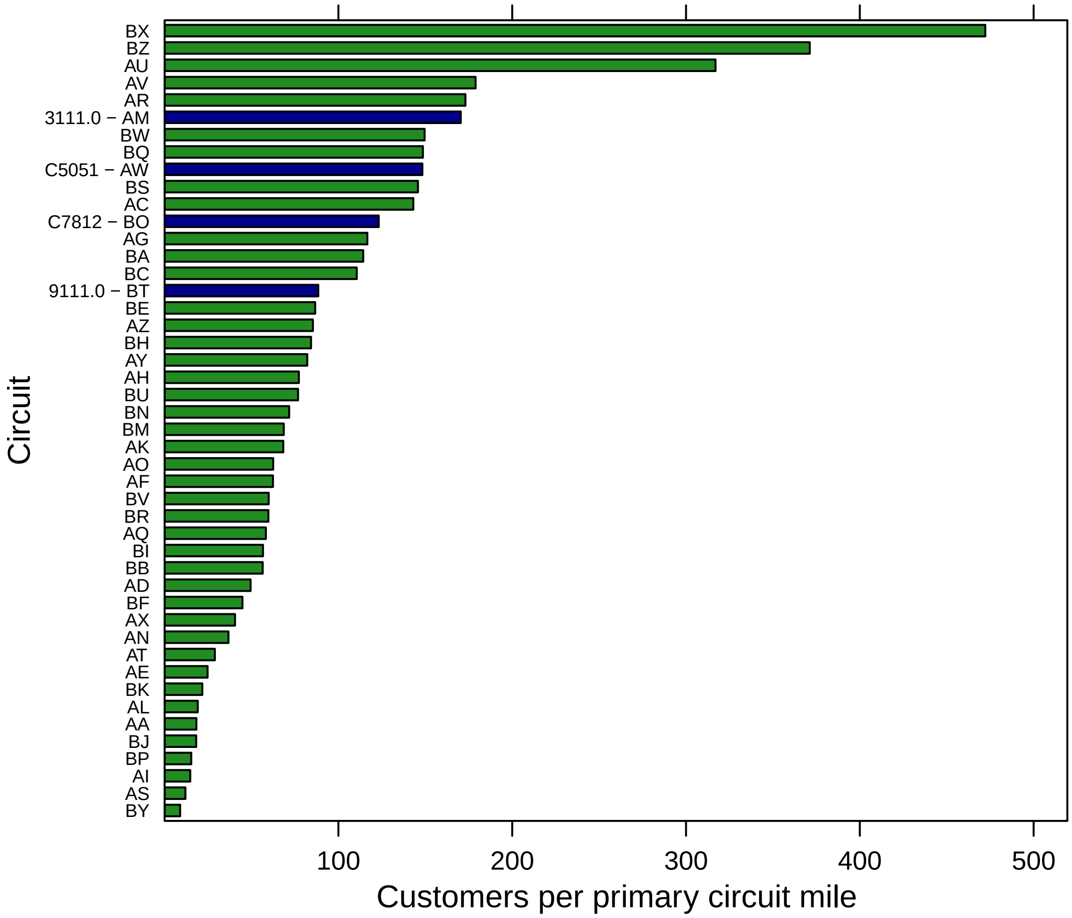


Figure 3-5
Load Densities

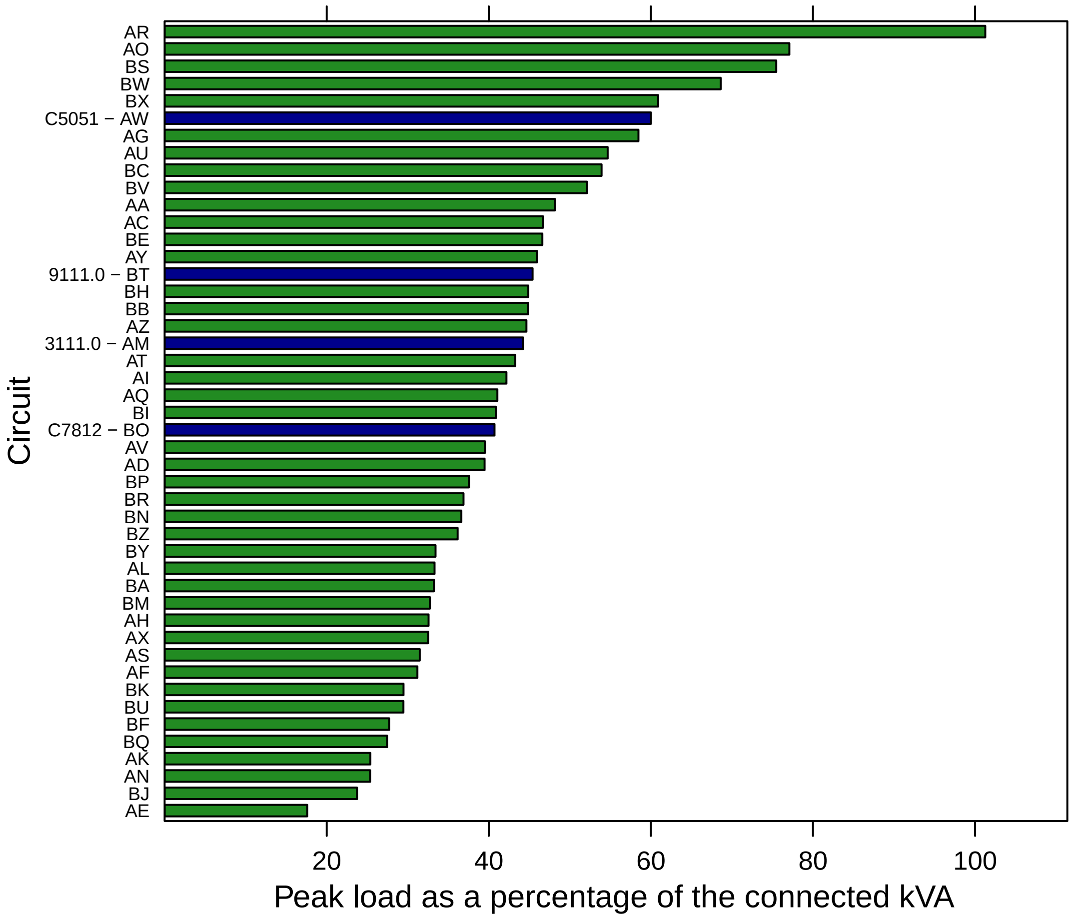


Figure 3-6
Load versus Connected kVA

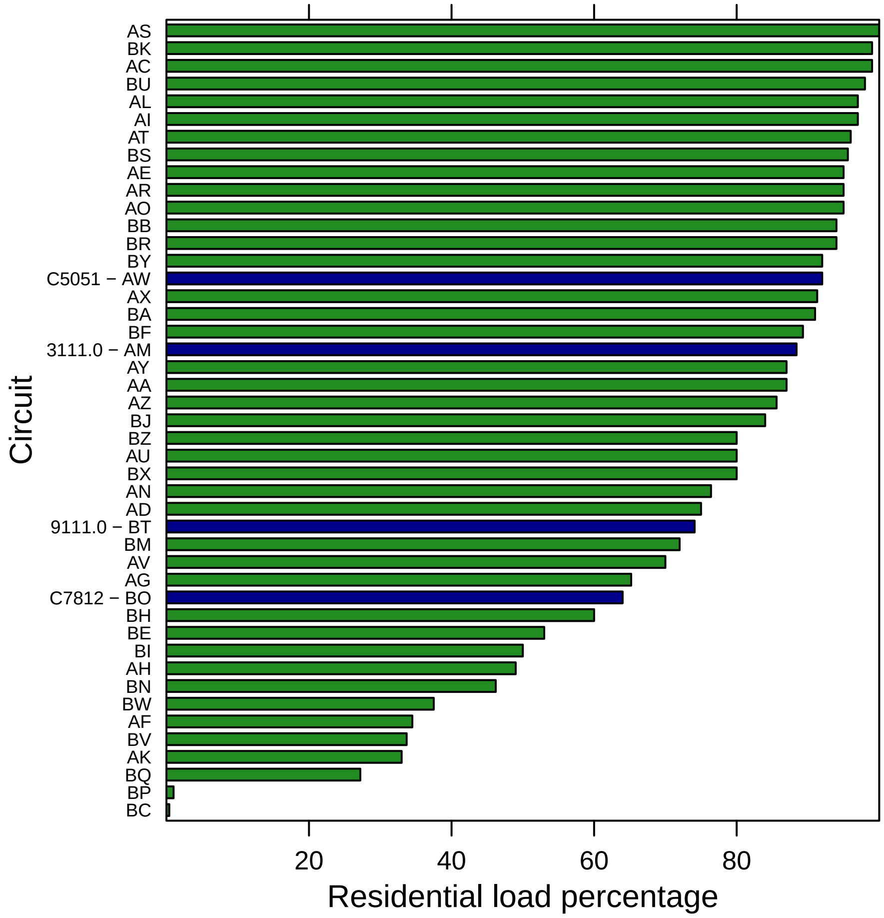


Figure 3-7
Residential Load as a Percentage of Connected kVA

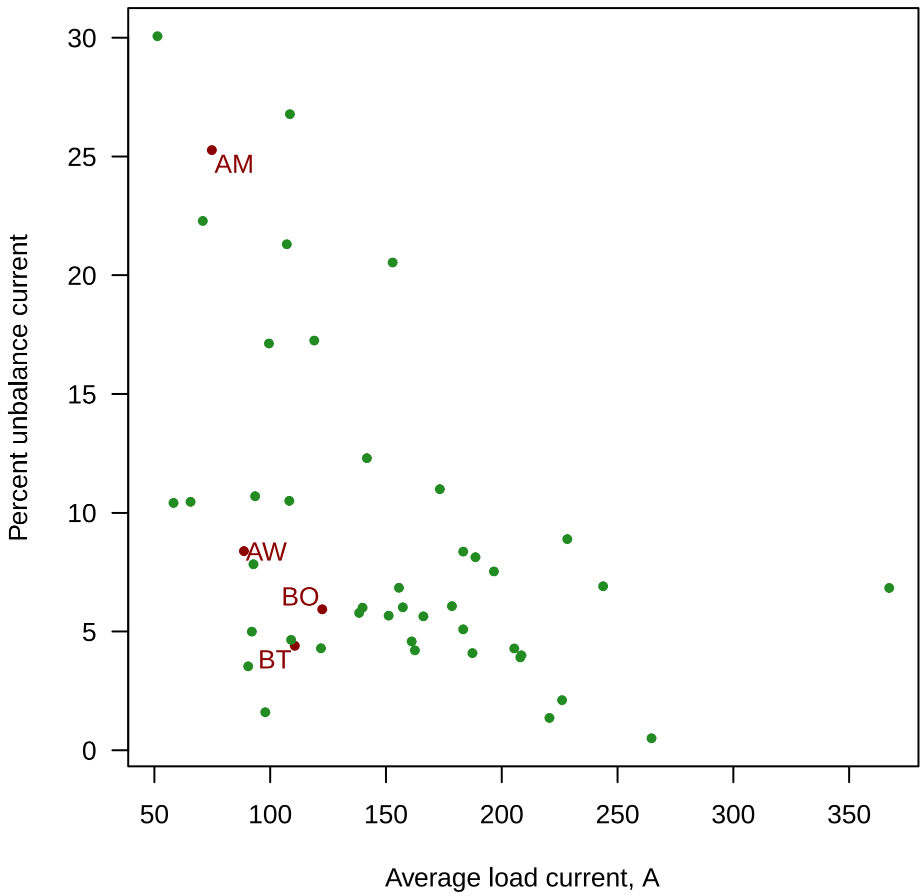


Figure 3-8
Unbalance versus Load Current

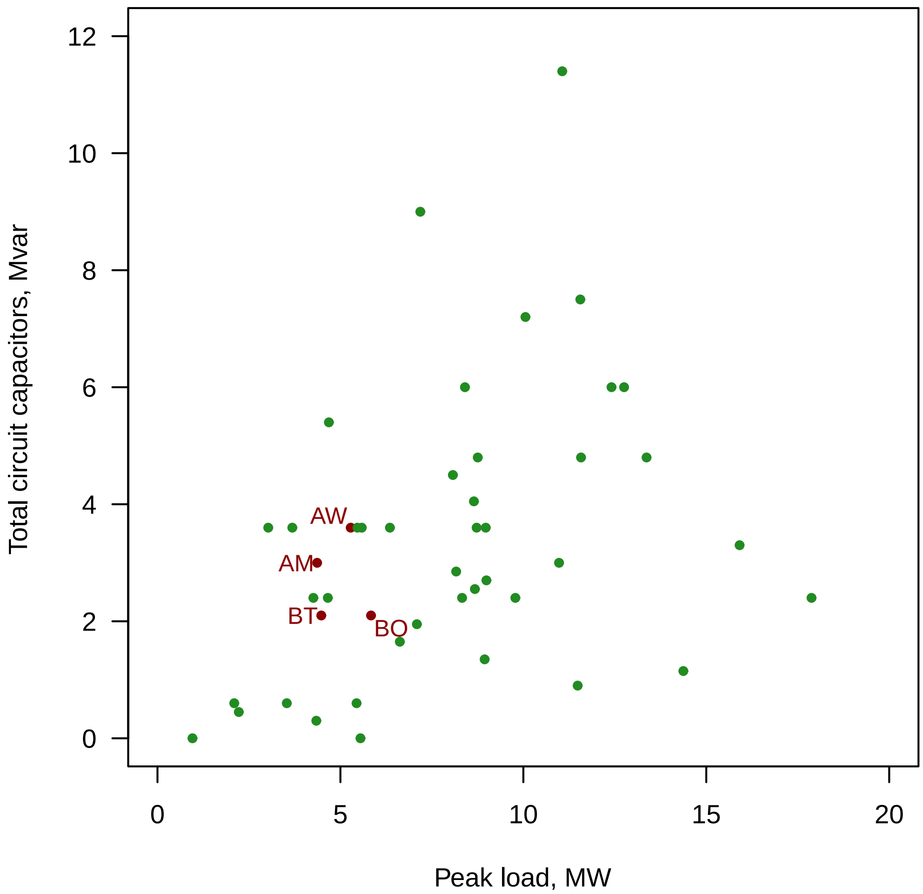


Figure 3-9
Peak Load and Total Connected Capacitance

Loss Characteristics

The following series of graphs shows how the losses on the KCPL circuits compare with those on other circuits that have been modeled in the Green Circuits project.

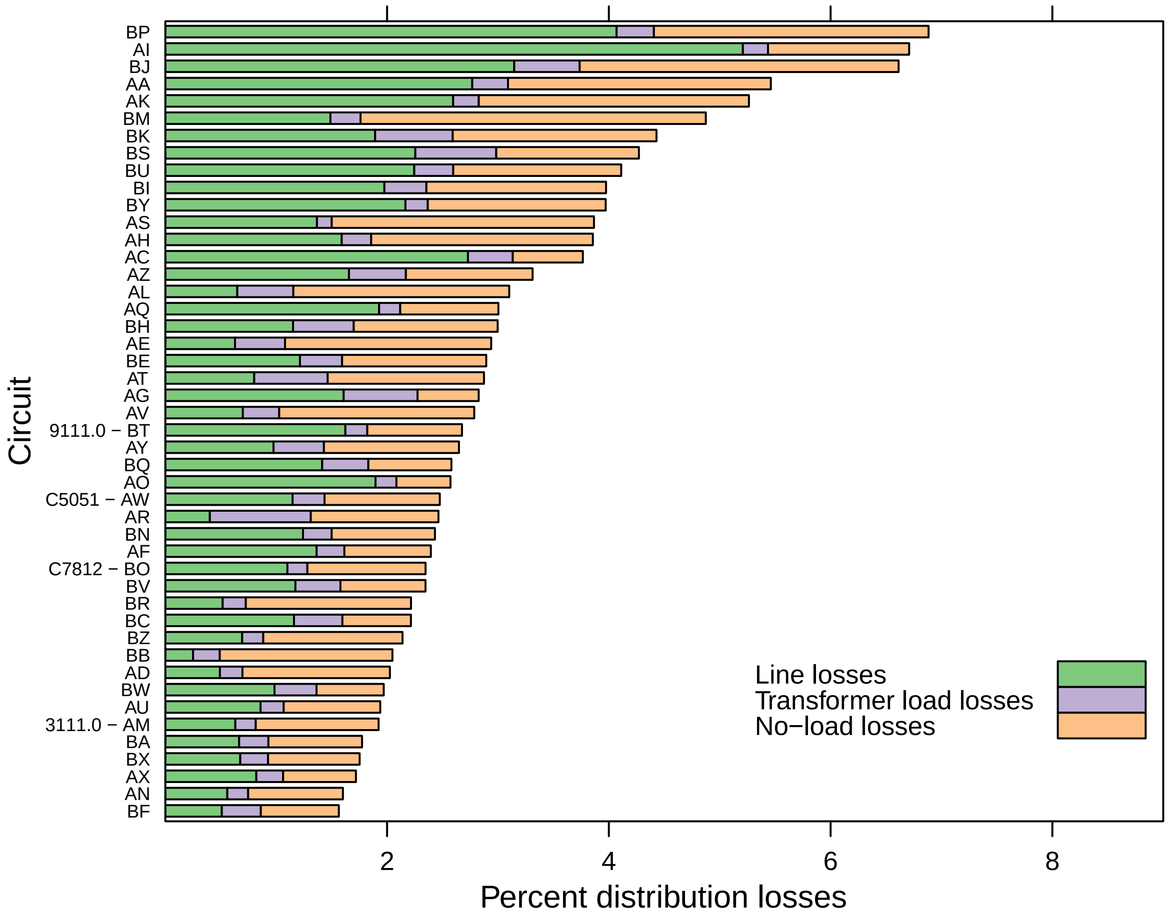


Figure 3-10
Circuit Loss Breakdowns

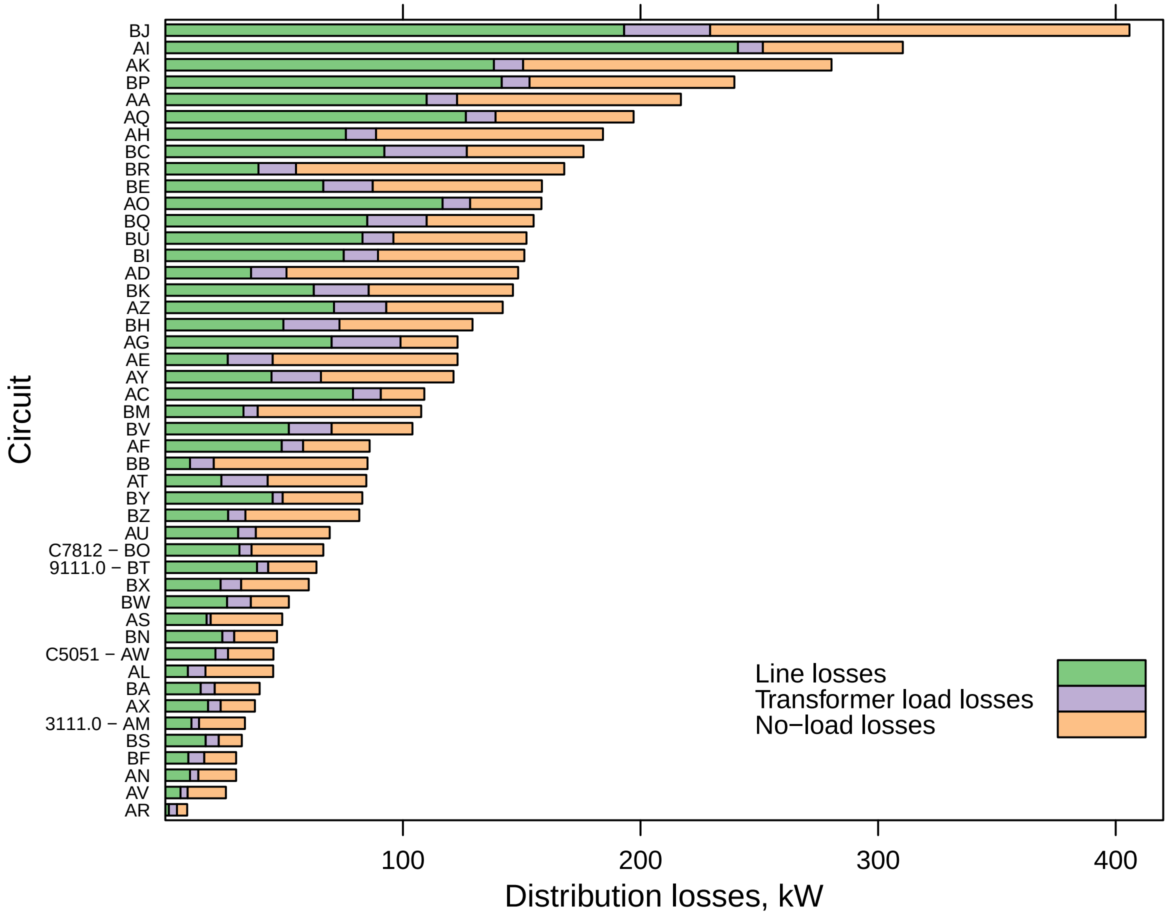


Figure 3-11
Circuit Loss Breakdowns in Average kW

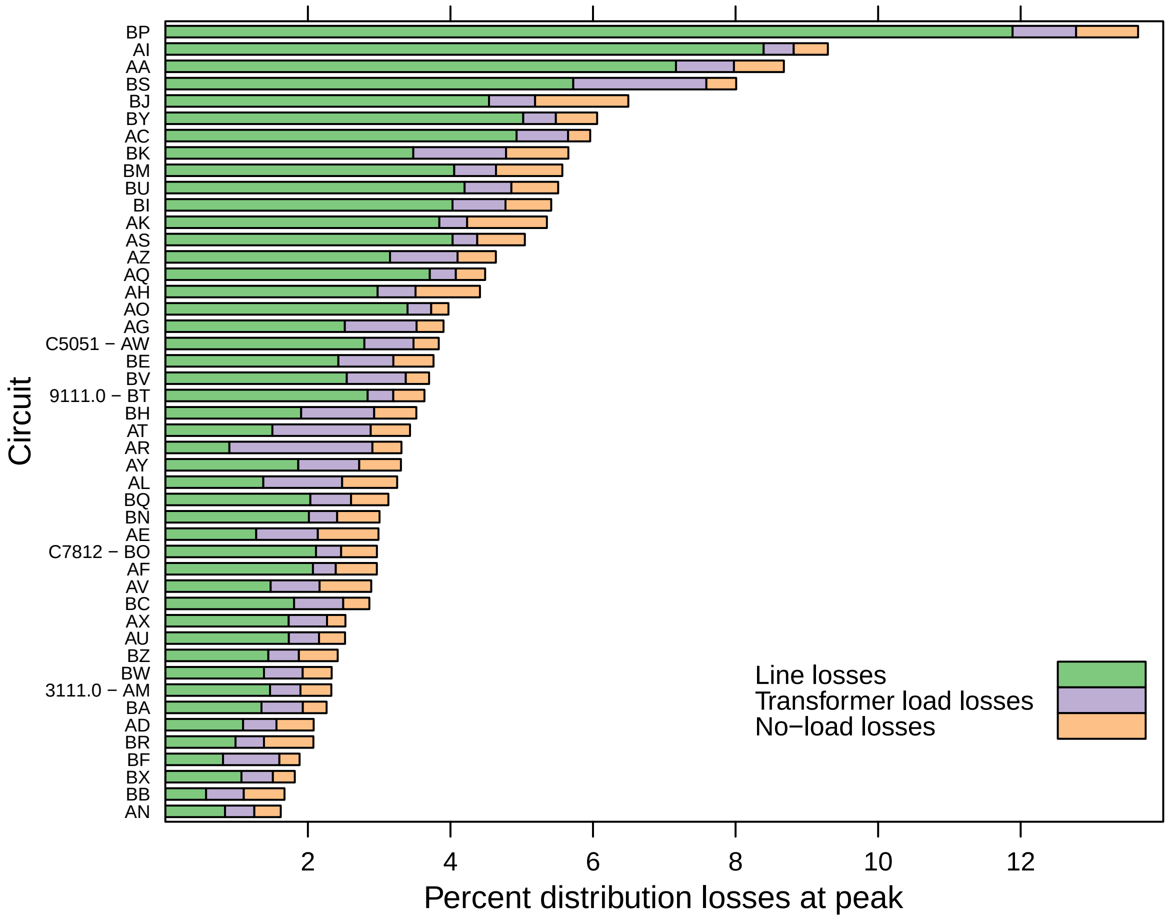


Figure 3-12
Circuit Losses at Peak Load

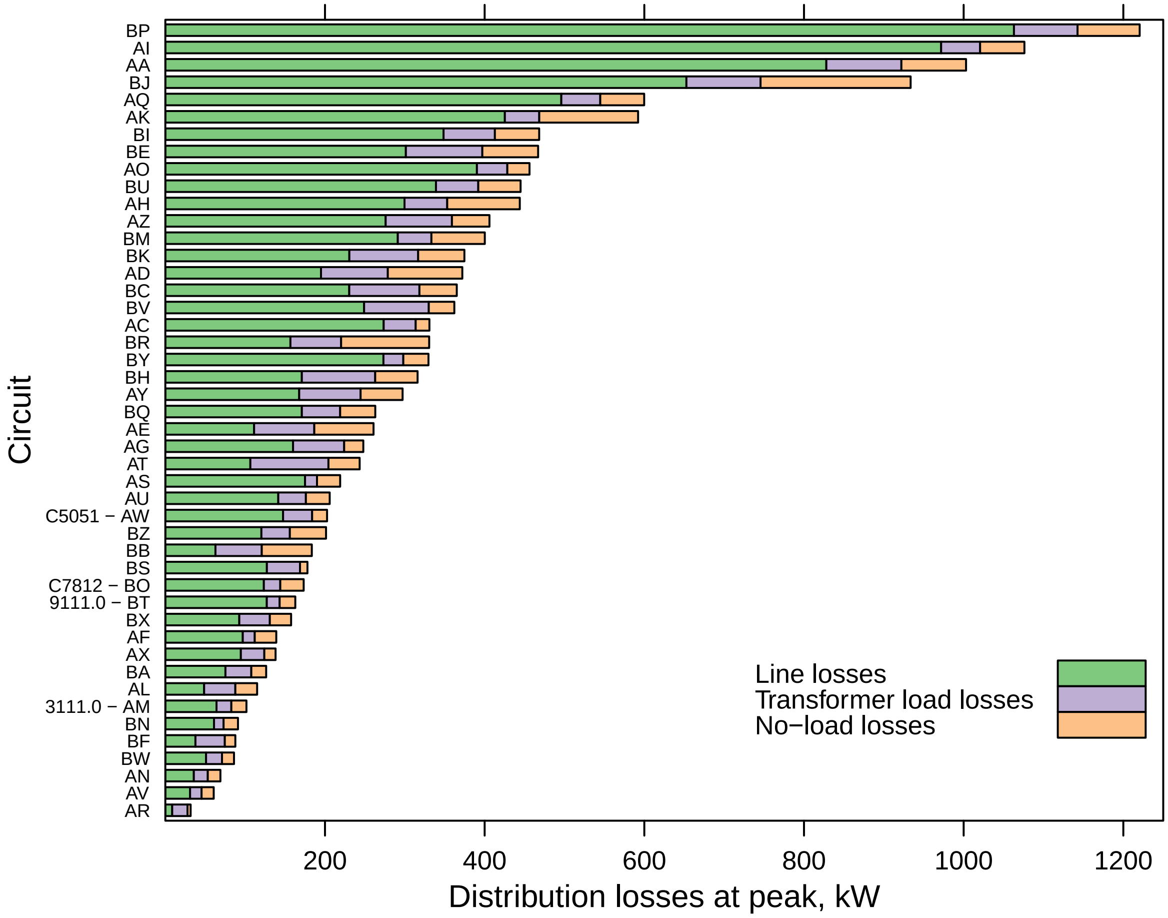


Figure 3-13
Circuit Losses at Peak Load in kW

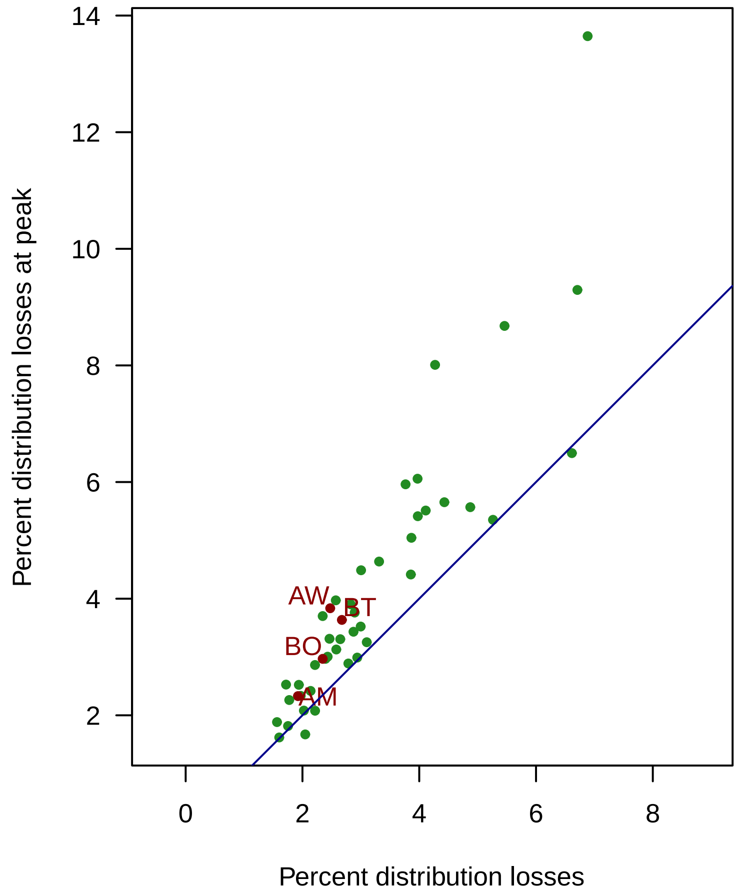


Figure 3-14
Peak versus Average Losses

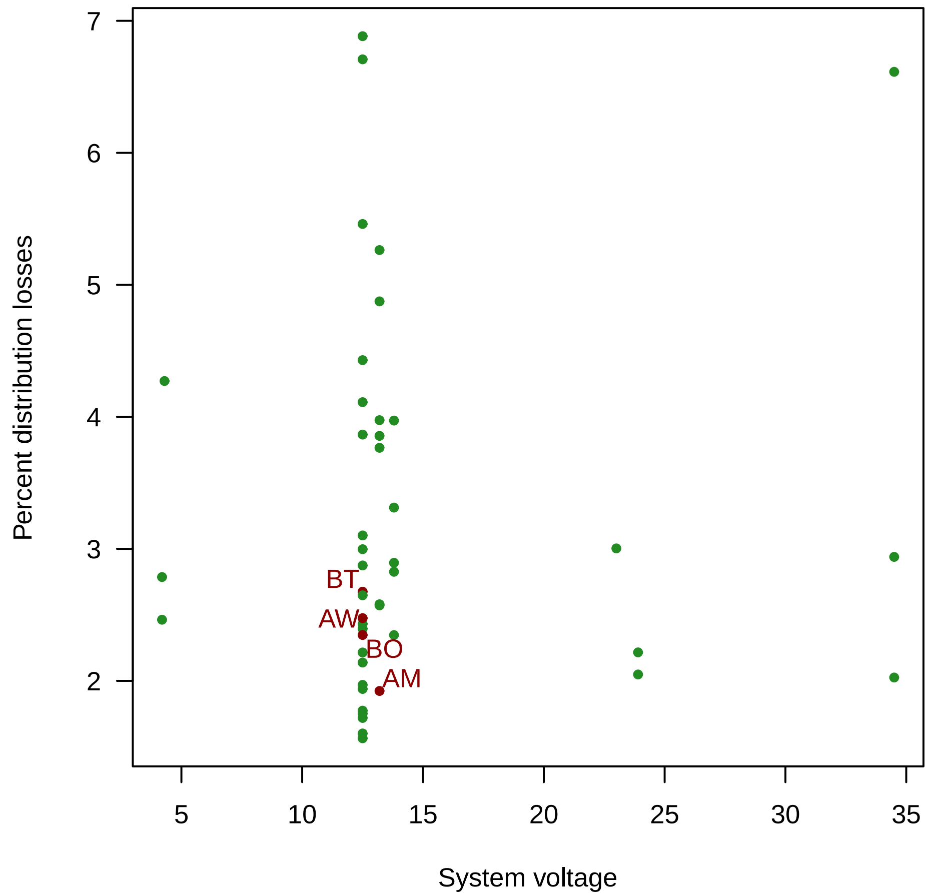


Figure 3-15
Losses by System Voltage

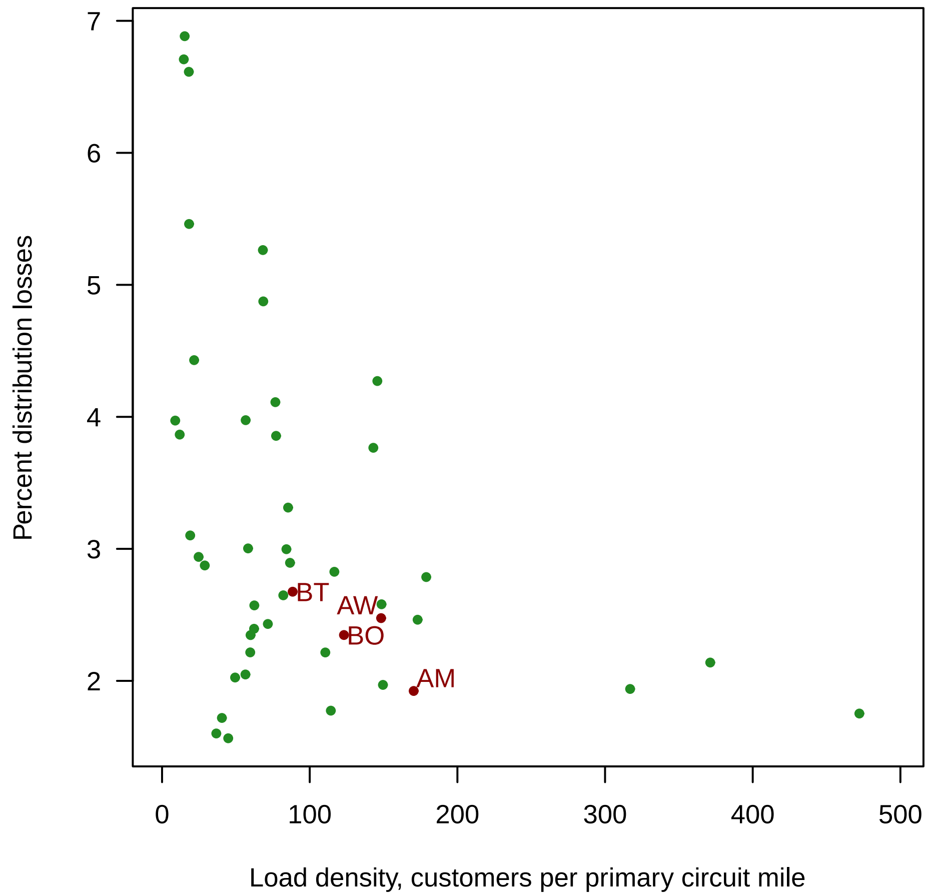


Figure 3-16
Losses by Load Density

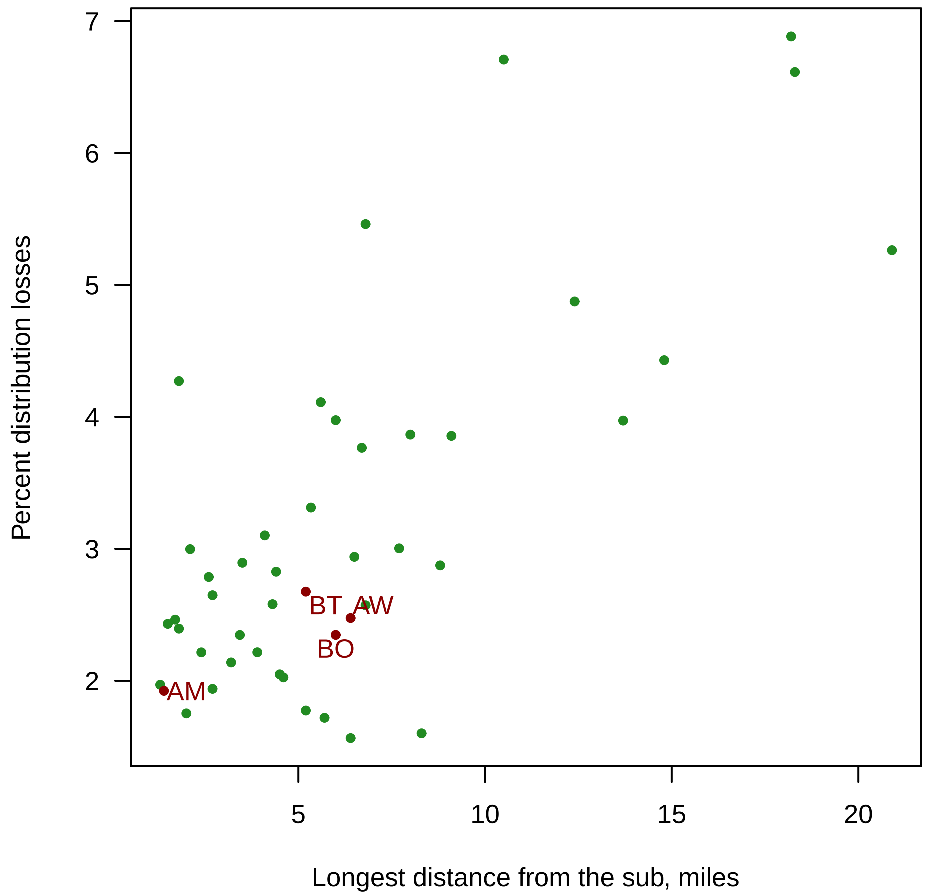


Figure 3-17
Losses by Circuit Length

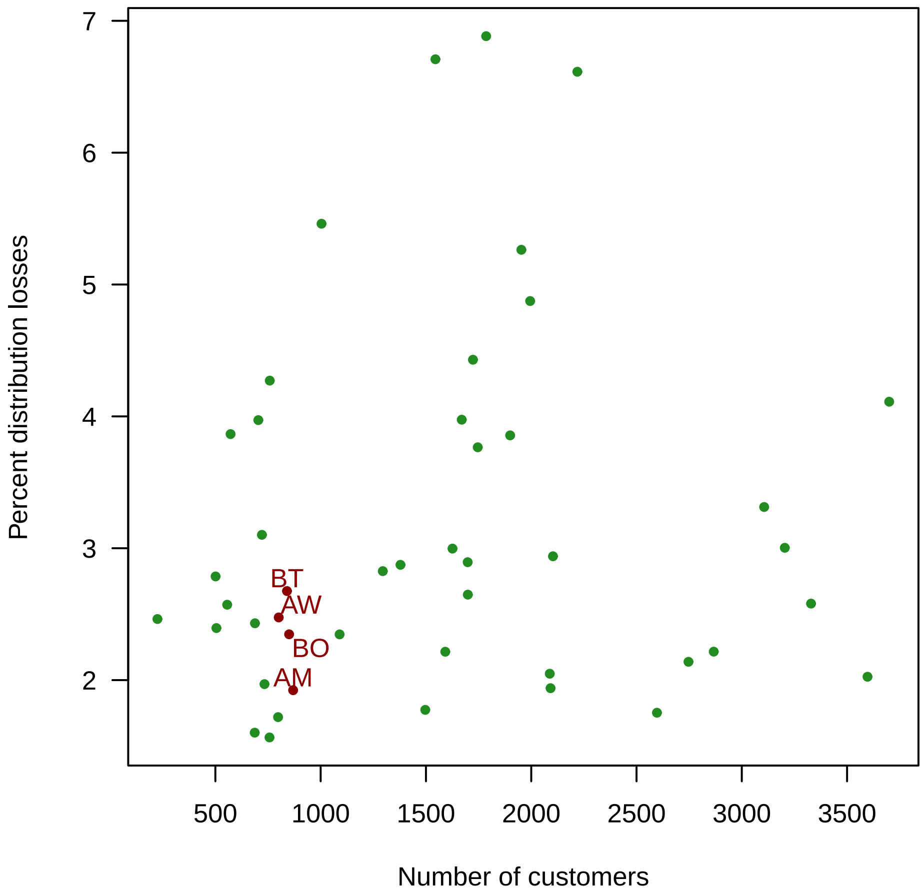


Figure 3-18
Losses by Number of Customers

Improvement Options

The following series of graphs shows how several generic efficiency improvements on the KCPL circuits compare with those of other circuits.

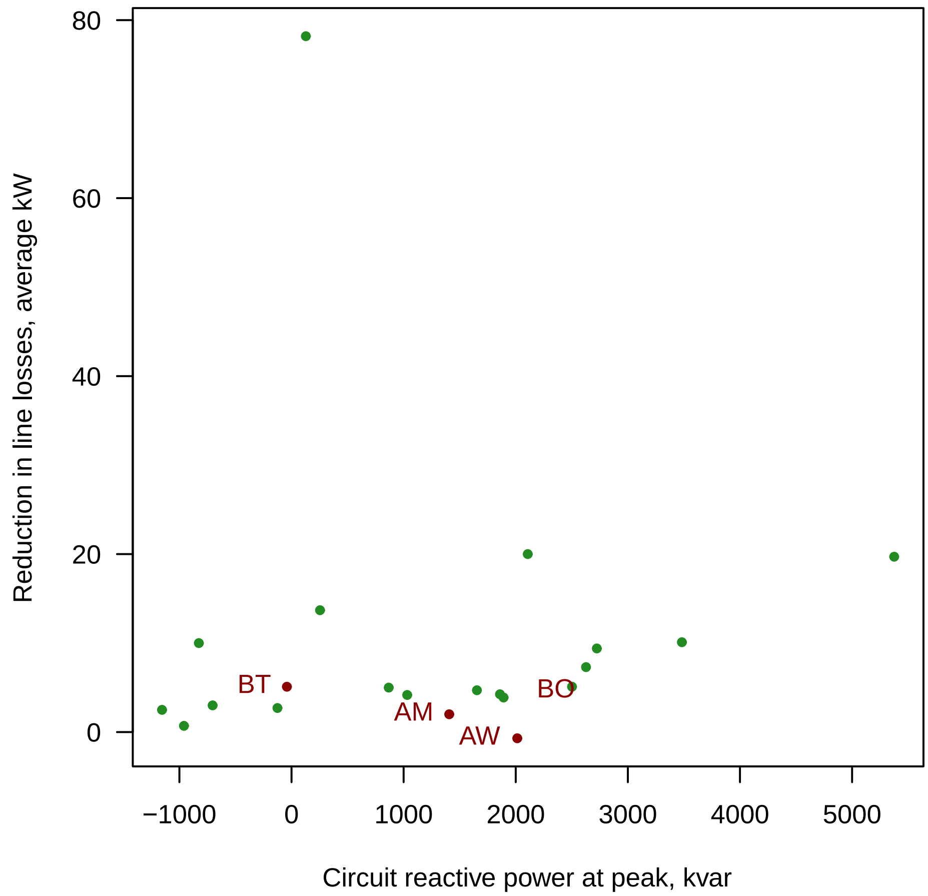


Figure 3-19
Reduction in Line Losses with Ideal VAR Improvement

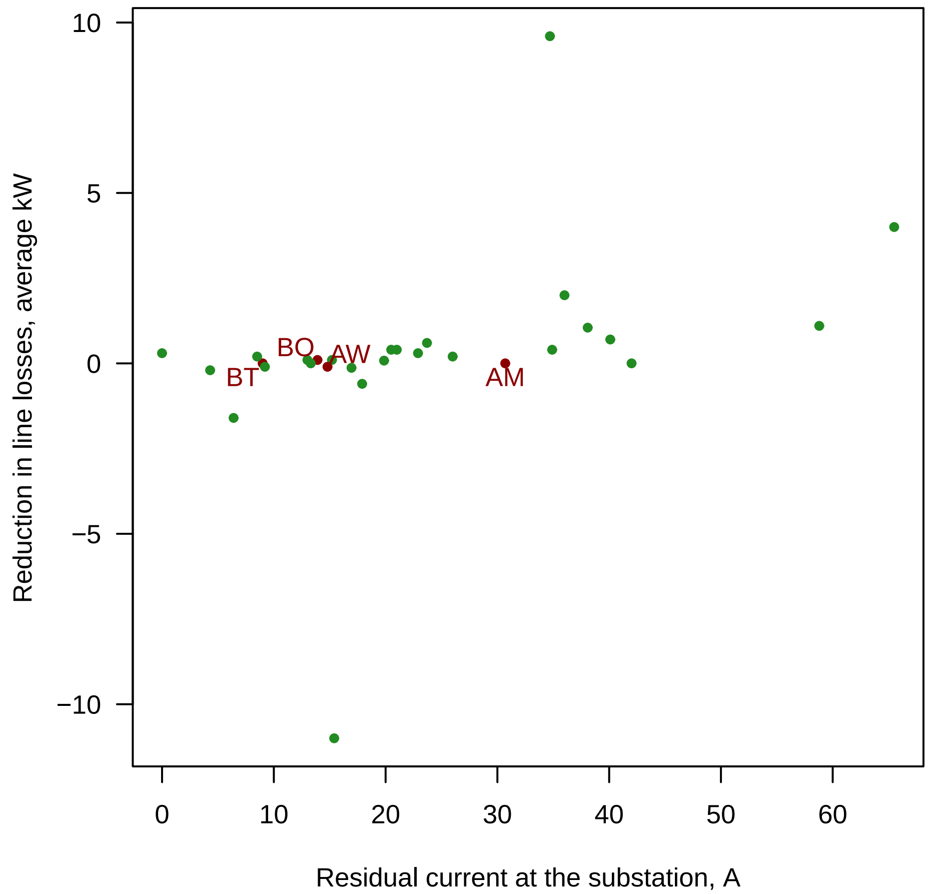


Figure 3-20
Reduction in Line Losses with Ideal Load Balancing

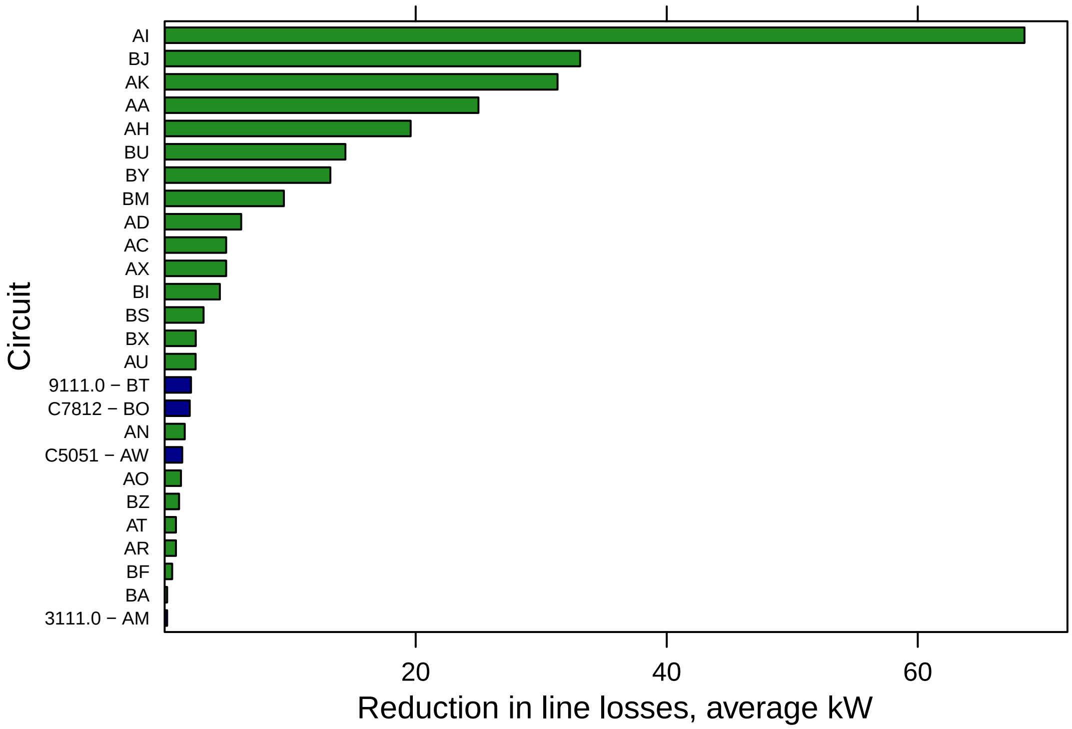


Figure 3-21
Reconductoring Impact on Line Losses

Figure 3-22 shows the reduction in load when voltage optimization is used. Figure 3-23 shows the same information on a kilowatt basis. Figure 3-24 shows similar results but for peak losses.

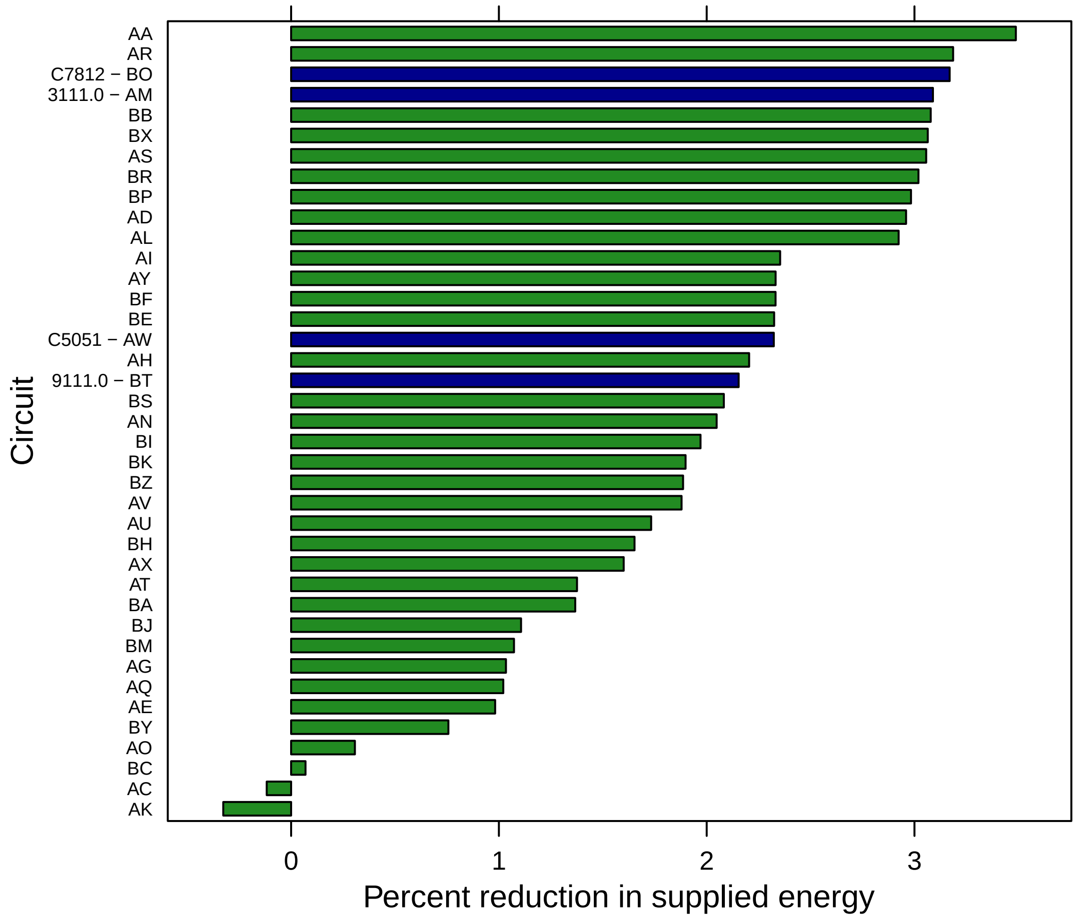


Figure 3-22
Reduction in Energy Supplied with Voltage Optimization

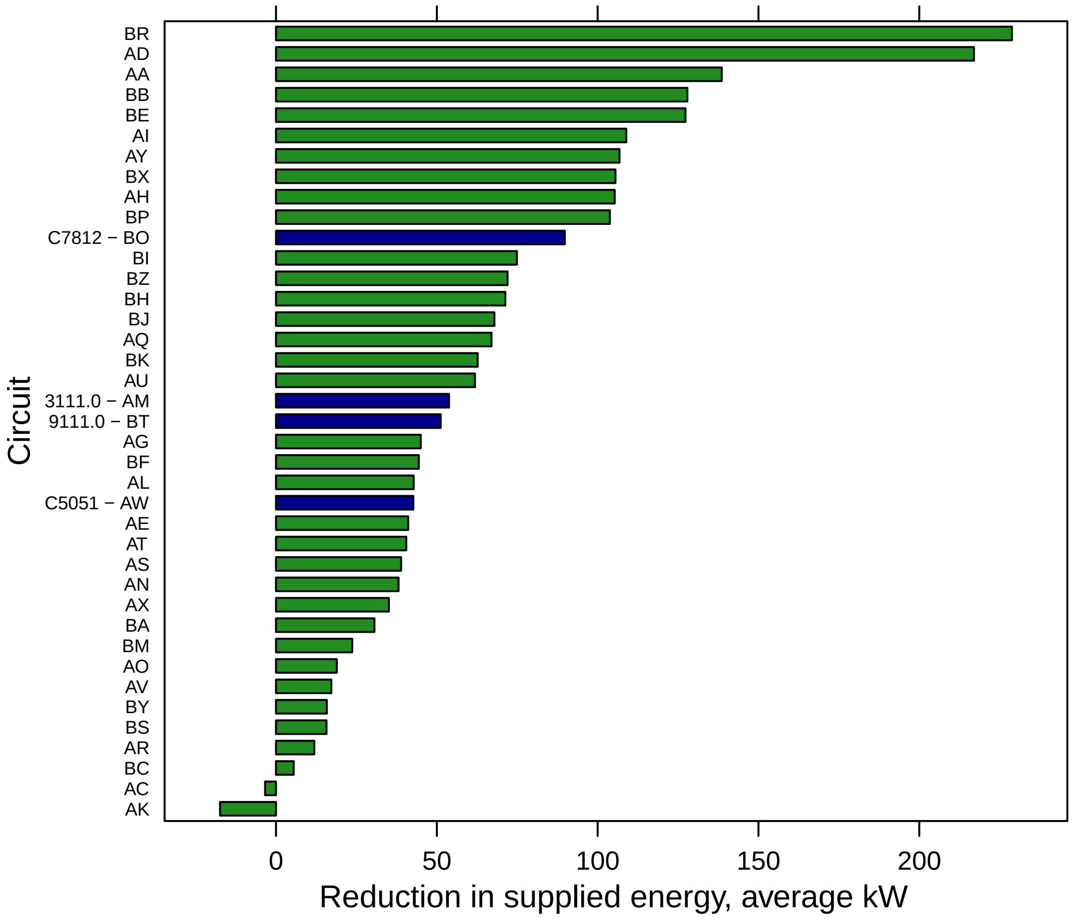


Figure 3-23
Reduction in Average Energy with Voltage Optimization (Average kW)

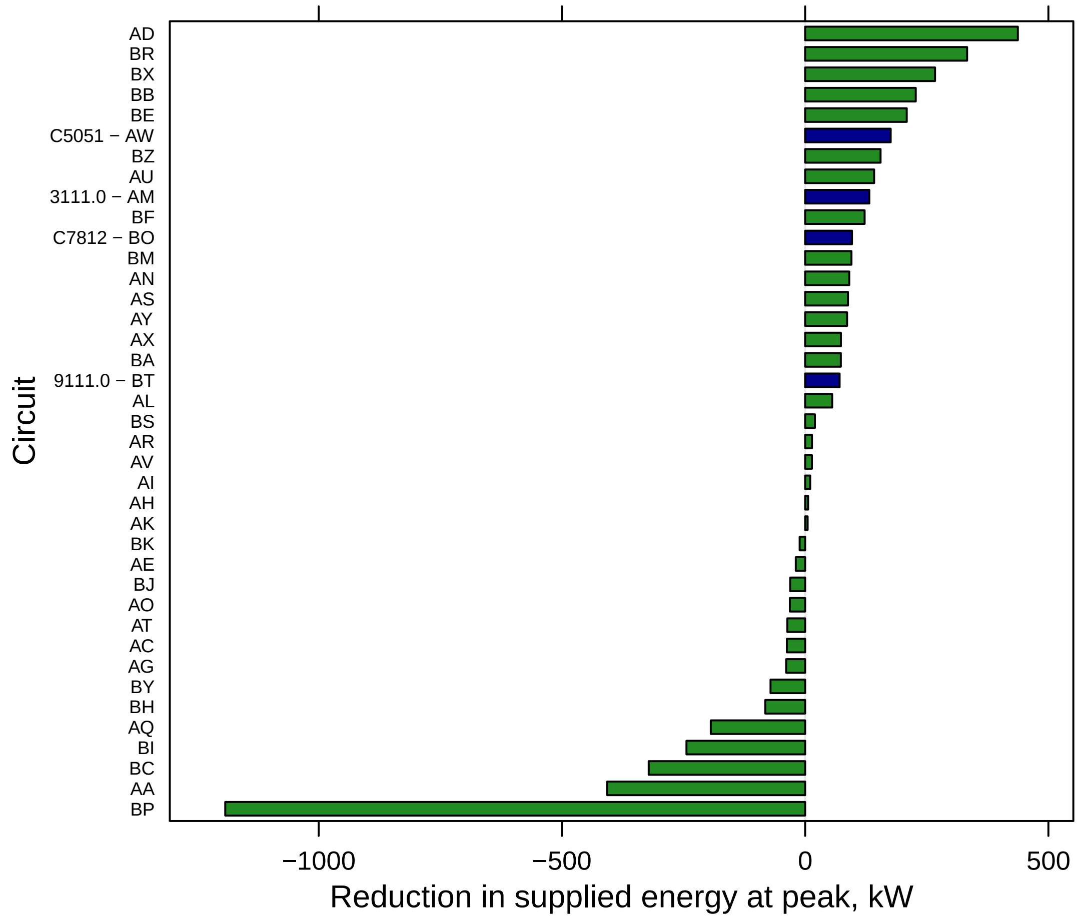


Figure 3-24
Reduction in Peak Loading with Voltage Optimization (kW)

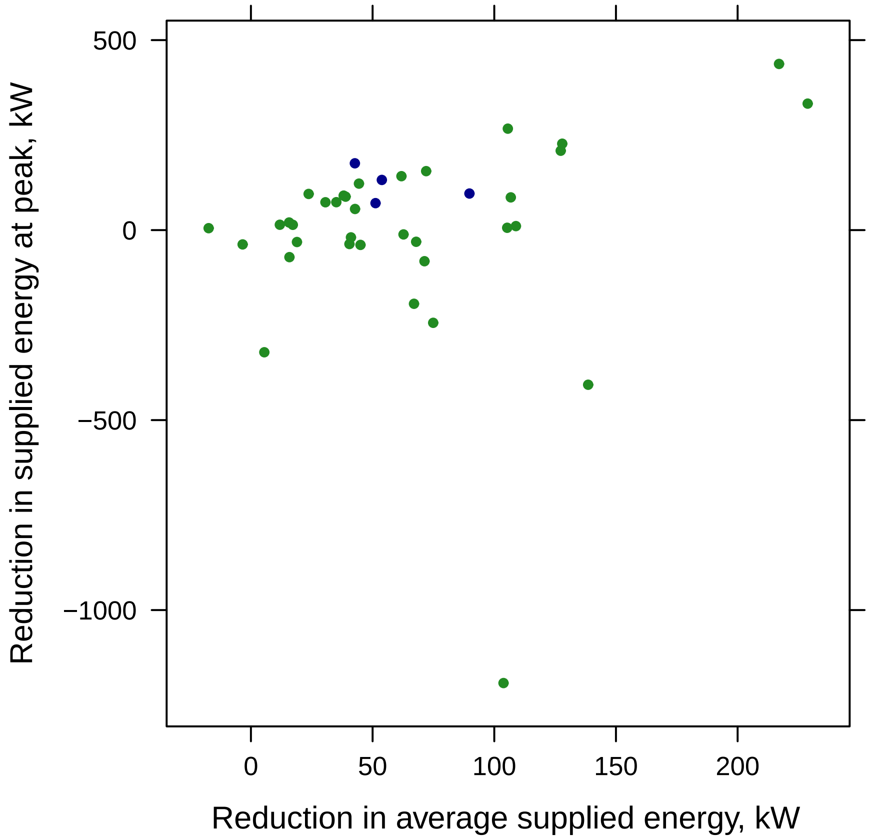


Figure 3-25
Comparison of Reduction in Energy with Reduction in Peak Demand

TITLE OF WORK TO BE PERFORMED

KCP&L GREEN IMPACT ZONE SMARTGRID DEMONSTRATION

PROGRAM AREA OF INTEREST

AREA OF INTEREST 1: SMARTGRID REGIONAL DEMONSTRATIONS
TRANSMISSION AND DISTRIBUTION (T&D) INFRASTRUCTURE

SUBMITTED TO:
U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

SUBMITTED BY:

KCP&L energizing life

KANSAS CITY POWER & LIGHT
A SUBSIDIARY OF GREAT PLAINS ENERGY INCORPORATED
1200 MAIN STREET, KANSAS CITY, MO 64105

WITH TEAM MEMBERS AND PARTNERS:
SIEMENS ENERGY, INC
OPEN ACCESS TECHNOLOGY, INC.
ELECTRIC POWER RESEARCH INSTITUTE
INTERGRAPH CORPORATION
LANDIS+GYR
GRIDPOINT, INC.
KOKAM AMERICA, INC.
HONEYWELL INTERNATIONAL, INC.

IN RESPONSE TO:
DE-FOA-0000036

AUGUST 26, 2009

PROJECT NARRATIVE

TABLE OF CONTENTS

PROJECT NARRATIVE

1. INTRODUCTION

Kansas City Power & Light (KCP&L or the Company) is a firm believer in the need to advance our energy infrastructure and the critical role that SmartGrid technologies and solutions will play in industry progression. Throughout its history, KCP&L has been at the forefront of designing, testing, implementing, and operating new technologies, business models, systems and protocols to improve the delivery of energy to customers. The Company also has a strong record and history of community and customer involvement and views its infrastructure investments as a means to provide benefits to its service territory by:

- Deferring the need for more costly generation;
- Positively impacting our environment and reducing emissions;
- Helping our customers reduce their energy costs;
- Enabling economic investment and job creation in both the local and national economy through job training and workforce development; and
- Reducing our reliance on fossil fuels, which leads to increased energy independence.

This approach is nothing new to KCP&L as the Company has a strong track record of community and customer service involvement. Since 2005, the Company has advanced a number of energy efficiency programs that have helped us to realize significant value for our customers and community. As a result of these efforts, we believe that our modest $25 million of program-to-date investments have created 115 MWs of resource capacity, generated $80 million of local and national economic activity, created over 70 new jobs (60 within the Kansas City metropolitan area) and reduced CO_2 emissions equivalent to the removal of nearly 7,000 cars from the road. KCP&L believes that developing an integrated approach to SmartGrid will provide a valuable foundation upon which to realize these benefits.

KCP&L‘s new approach is being driven by rising environmental awareness and increasingly price sensitive consumers that will require the energy industry to become more responsive to the need for timely energy usage and pricing information, more tailored energy options and greater individual customer control. The utility of the future involves a shift from a model in which electricity is generated and controlled centrally to one in which energy is generated at a local level and integrated into the grid to improve energy efficiency and reduce transmission losses while taking advantage of renewable energy sources. Recognizing this paradigm shift, KCP&L is planning to design and deploy a demonstration program to develop, operate, test and report on a complete, end-to-end regional SmartGrid demonstration (the SmartGrid Demonstration) in a socially and economically diverse area of Kansas City, Missouri (the Demonstration Area). The SmartGrid Demonstration will be critical not only for developing and proving concepts, technologies, and protocols, but also for serving as a blueprint for capturing, understanding and demonstrating economic costs and benefits.

KCP&L‘s project complies with the DOE‘s funding guidelines and introduces commercial innovation with a unique approach to SmartGrid development and demonstration:

- First, it truly creates a complete, end-to-end SmartGrid – from SmartGeneration to SmartEnd-Use – built around a major SmartSubstation. This approach will enable detailed analysis and testing to demonstrate the benefits of optimizing energy and information flows and utility operations across supply and demand resources, T&D operations, and customer end-use programs. Done successfully, this demonstration will serve as the prototype for SmartGrid implementations across the country.
- Second, it introduces new technologies, business models, applications, and protocols that can be tested and refined in this ―laboratory" to demonstrate the optimal approach to achieving the project goals of increased efficiency with reduced cost and environmental impact.
- Third, it involves a best-of-breed approach to the SmartGrid. Rather than focusing on a packaged

approach, KCP&L will leverage the best solutions from leading players to maximize the benefits captured. KCP&L will work with these technology and solution providers to select the best technologies for a given application and then integrate these applications into a holistic, end-to-end optimal SmartGrid solution.

- Finally, KCP&L‘s demonstration project will integrate with a wider urban revitalization effort--the Green Impact Zone. The Green Impact Zone is designed as a means to use Federal funds to redevelop an urban core. Key to this redevelopment is the provision of a modern energy infrastructure. The Green Impact Zone has significant political and community support, which will provide the catalyst for high customer engagement to better demonstrate our integrated view of the SmartGrid.

Working with the City of Kansas City, Green Impact Zone participants and its solution partners, KCP&L will invest in and deploy an end-to-end SmartGrid that will include advanced generation, distribution and customer technologies and solutions to the Demonstration Area‘s electrical infrastructure. This ―SmartGrid" program will provide area businesses and residents with enhanced reliability and efficiency through real-time information about electricity supply and demand. It will also enable customers to manage their electricity use, and save money, by providing useful information about electricity prices. Co-located renewable energy sources, such as solar and other parallel generation, will be placed in the Demonstration Area and seamlessly feed into the energy grid. By demonstrating this end-to-end solution rather than specific components such as Distributed Management System (DMS) or Automated Metering Infrastructure (AMI) technologies alone, KCP&L will be able to test and evaluate the solution‘s ability to achieve a complete suite of prospective SmartGrid benefits - greater energy efficiency, reduced cost, improved reliability, more transparent information and an improved environmental footprint.

KCP&L believes that the SmartGrid Demonstration qualifies as a demonstration for the purposes of this funding opportunity as it involves the combination, integration and testing of best-of-breed emerging technologies across the entire electricity supply chain. This development and testing of a holistic end-to-end solution that integrates multiple technologies and programs can serve as a blueprint for future integrated SmartGrid demonstrations and implementations throughout the country.

The promise of the SmartGrid Demonstration project has attracted the interest of companies around the globe. We have conducted a structured evaluation and are very pleased to have the strong team of partners shown below:

Project Component	Partner(s)
SmartSubstation	Siemens Energy, Inc.
DMS	Siemens Energy, Inc.
Advanced Distributed Automation	Siemens Energy, Inc.
Utility-Based Distributed Resource Management	Open Access Technology, Inc. (OATI)
AMI	Landis+Gyr AG
Customer-Based Resource Management	GridPoint, Inc.
Grid Connected Battery Storage IED	Kokam America, Inc.
Technical Project Assistance	Electric Power Research Institute (EPRI)
DR Thermostats and Local Customer Service	Howeywell International, Inc.

The proposed SmartGrid Demonstration would require $48.1 million in funding requirements, of which $13.8 million (29%) are KCP&L contributions, $10.2 million (21%) are partner contributions and $24.1 million (50%) are federal funds. The SmartGrid Demonstration and its Green Impact Zone applications will provide an opportune model for the DOE to understand the potential for targeted urban SmartGrid applications in the future.

2. PROJECT OBJECTIVES

The primary objective of the SmartGrid Demonstration project is twofold: (1) to demonstrate, test and report on the feasibility of combining, integrating and applying existing and emerging SmartGrid technologies and solutions to build innovative SmartGrid solutions and (2) to demonstrate, measure, and report on the costs, benefits, and business model viability of the demonstrated solution. The proposed technologies and solutions will be evaluated both individually, and as part of a complete end-to-end integrated SmartGrid system in a defined geographical area. The project will demonstrate certain operational, economic, consumer, and environmental benefits that can be enabled by single SmartGrid technologies and further enhanced by integrated solutions as proposed for this demonstration. For specific parts of the solution, KCP&L intends to demonstrate the potential for innovative and flexible business models that can be employed in the integration of its solutions.

The objectives of individual initiatives are focused on implementing a next-generation, end-to-end SmartGrid that will include Distributed Energy Resources (DER), enhanced customer facing technologies, and a distributed-hierarchical grid control system.

2.A. Transmission & Distribution (T&D) Infrastructure

2.A.1) SmartSubstation

The primary objective of the SmartSubstation program is to develop and demonstrate a fully automated, next-generation distribution SmartSubstation with a local distributed control system based on IEC 61850 protocols. The new SmartSubstation will enable the following benefits that will be quantified throughout the demonstration period:

- Improved real-time operating data on critical substation equipment
- Reduced O&M costs of relay maintenance, and
- Improved reliability by enabling distribution automation

By achieving these objectives, we expect to demonstrate Advanced Distribution Automation (ADA) capabilities such as the ability to monitor and capture real-time transformer temperature and gas data; the enablement of real-time equipment ratings; full substation automation with intelligent bus throw-over; and all the benefits of intelligent electronic relays such as peer-to-peer communication, fault recording, fault location, circuit breaker monitoring and increased ease of maintenance.

2.A.2) SmartDistribution

The primary objective of the SmartDistribution program is to develop and demonstrate a fully automated, next generation Distributed Control and Data Acquisition (DCADA) controller that incorporates a Customer Information Management (CIM) based model of the local distribution network and performs local grid assessment and control of individual intelligent electronic device (IED) field controls. The DMS and Smart-Substation™ Controllers will provide the operational backbone of the system supporting significant levels of automation on the feeders, complex and automated feeder reconfiguration decisions, and tightly integrated supervision with the Control Centers. The DMS serves as the primary point of integration for the grid facilities and network management functionality including Distributed System Control and Data Acquisition (D-SCADA) systems, Distributed Network Architecture (DNA) systems, Outage Management Systems (OMS), Distributed Energy Resource Management (DERM) systems, Geographical Information Systems (GIS) and other supporting systems.

The new SmartDistribution implementation will enable the following benefits that will be quantified throughout the demonstration period:

- Improved service reliability by reducing the frequency and duration of sustained outages.
- Reduced frequency of momentary outages.
- Reduced operational expenses as many functions will occur automatically without human intervention or be performed remotely without a field crew.

- Reduced maintenance expenses by providing rich data to enable predictive and proactive maintenance strategies

In achieving the above objectives, we expect to demonstrate a family of automatic, distributed ―first responder" distribution grid monitoring and control functions:

- Sub and Feeder Load Profile Metering at 15-minute intervals
- Circuit outage and faulted section identification and isolation switching
- Sub and Feeder VAR Management
- Sub and Feeder Voltage Management
- Sub and Feeder Integrated Volt/VAR Management
- Sub and Feeder Overload Management w/ Dynamic Voltage Control (DVC & CVR)
- Distributed DER monitoring & management
- Sub and Feeder Overload Management w/ DER
- Feeder Overload Management with Ambient & Duct Temperature
- Digital Fault Recording on Breaker Relays
- Incipient Fault Detection and Reporting

We also expect to demonstrate time-synchronized voltage and current from strategic points on the circuits, which will improve the accuracy of capacity planning models and will enable better load balancing and improved decision-making for capacity additions.

2.A.3) SmartMetering

The primary objective of the SmartMetering program is to develop and demonstrate state-of-the-art integrated AMI & meter data management (MDM) capabilities that support two-way communication with 14,000 SmartMeters in the Demonstration Area and provide the integration with CIS, DMS, OMS, and DERM. The SmartMetering infrastructure will provide the technology basis for recording customer and grid data that will be used to measure many SmartGrid benefits. The new AMI/MDM implementation will enable the following operational benefits that will be quantified throughout the demonstration period:

- Improved accuracy of meter reads, frequency of reads and flexibility of read scheduling by enabling customers to select dates for turn on/turn off requests without associated field visits.
- Improved accuracy of meter inventory and reduction in untracked meters.
- Increased percentage of automated reads and reduced amount of stale reading within the existing automated one-way meter reading system.
- Increased percentage of near real-time outage notifications and power restoration that would be supplied by a two-way metering system, and:
- Provided real-time, two-way communication for Demand Response (DR) program control initiation and verification of program participation

The SmartMetering technology will also provide advanced meter-to-HAN communications to facilitate in-home display, home energy management systems, and other consumer-facing programs.

2.B. SmartGeneration (Distributed Energy Resource Technology)

2.B.1) Smart DR/DER Management

The primary objective of the Smart DR/DERM program is to develop and demonstrate a next-generation, end-to-end DERM system that provides balancing of renewable and variable energy sources with controllable demand as it becomes integrated in the utility grid, coordination with market systems, and provision of pricing signals. We expect to demonstrate a number of capabilities including:

- The ability to manage and control diverse types of Distributed Energy Resources (e.g. DVC, DG, bulk and mobile storage)
- The ability to manage and control various DR programs including dispatchable/direct load control programs.
- The ability to manage price-based and voluntary programs with market-based and dynamic tariffs

similar to those described under SmartEnd-Use

- The ability to manage various market and transmission operation support products such as mapping DR/DER capabilities to wholesale energy products and managing energy and ancillary services capacity
- The interoperability with the DMS to monitor distribution grid conditions and manage distribution grid congestion, and
- The ability to track and manage renewable portfolio standards (RPS) and greenhouse gas (GHG) reduction capabilities of distributed and demand side resources

By achieving these objectives, KCP&L expects to demonstrate advanced capabilities in demand side resource management, including the ability to leverage those capabilities for operational and environmental efficiencies as well as the ability to aggregate and use such capabilities in support of wholesale market operations.

2.B.2) SmartGeneration

KCP&L's primary objective in its SmartGeneration program is the implementation of DER technologies and DR programs sufficient in quantity and diversity to support the DERM development and demonstration. To achieve this objective, the demonstration program will include:

- Installation of a variety of roof-top solar systems on a mix of residential and commercial buildings (a larger scale, 100kw, installation is planned for a school or public building)
- Installation of a 1MWh grid-connected battery to provide grid support.
- Integration of the existing EnergyOptimizer DR thermostat program in the demonstration area
- Integration of the existing MPower load curtailment program customers in the demonstration area
- Implementation of public accessible plug-in hybrid electric vehicle (PHEV) charging stations to demonstrate smart-charging strategies.

In addition to the primary objective, KCP&L expects to demonstrate the ability to offset fossil-based generation with renewable sources as well as the potential for flexible, alternative business ownership models. With respect to PHEVs and charging stations, KCP&L expects to demonstrate an intelligent, two-way communication between plug-in vehicles, charging stations and the utility grid while controlling the flow of electricity to plug-in vehicles, balancing real-time grid conditions with the needs of individual drivers.

2.B.3) SmartEnd-Use

The primary objective of the SmartEnd-Use program is two-fold. The program will achieve a sufficient number of consumers enrolled in a variety of consumer-facing programs to 1) support the DERM development and demonstration; and 2) measure, analyze, and evaluate the impact that consumer education, enhanced energy consumption information, energy cost and pricing programs and other consumer-based programs have on end-use consumption. We have identified several secondary objectives for the suite of SmartEnd-Use programs expected to be deployed in the Demonstration Area:

- First, we intend to improve customer satisfaction by increasing awareness and reducing costs through energy efficiency and demand response program execution.
- Second, we expect to improve KCP&L productivity through increased knowledge of customer behavior and usage patterns.
- Third, we expect to improve peak load profiles, reducing the need for capacity expansion, as customers are incented to utilize energy in off peak periods.
- Fourth, we expect to pilot alternative time-of-use (TOU) rate programs designed to provide the incentives to reduce energy usage during peak periods.

By achieving these objectives, we expect to demonstrate how the integration of a broad suite of efficiency and innovative rate programs into a complete SmartGrid solution can enhance the overall benefits of the solution and optimally leverage the additional technical and operational capabilities that the investment will enable.

3. PROJECT DESCRIPTION

KCP&L is proposing a SmartGrid Demonstration that truly creates an end-to-end SmartGrid – from SmartGeneration to SmartEnd-Use – built around a major SmartSubstation. It introduces new technologies, business models, applications, and protocols that will be tested and refined in this "laboratory". The project will include detailed analysis and testing to demonstrate the benefits of optimizing energy and information flows and utility operations across supply and demand resources, T&D operations, and customer end-use programs. Done successfully, this demonstration will serve as the prototype for SmartGrid implementations across the country.

3.A. PROJECT SCALE & IMPACT

Our Team seeks to demonstrate the value of using SmartGrid technology and communications to manage distributed energy resources within a utility's service territory. In particular, we are targeting edge-of-grid resources using a comprehensive SmartGrid platform in order to integrate and manage distributed grid assets, according to the project scale defined below:

- The Team will design, develop, and deploy a next generation end-to-end (or top-to-bottom) distribution grid management infrastructure. The grid management systems proposed will be based on distributed-hierarchical control concepts, an emerging technology, and will include:
  - DR/DER Management Systems (centralized, back office)
  - DMS - Distribution Management System (centralized, back office)
  - AMI Command Center (centralized, back office)
  - MDM-Meter Data Management System (centralized, back office)
  - DCADA-Distributed Control and Data Acquisition (distributed substation controller)
- We will upgrade Midtown Substation, an existing urban substation, to create a next-generation SmartSubstation with IEC-61850 communication protocols and control processors to implement distributed, unattended control with automated "first responder" monitoring and control functions. The existing Midtown Substation consists of:
  - 4 Distribution Power Transformers - 191.7 MVA total
  - 8 Distribution Busses
  - 32 Distribution Circuit Breakers
  - 16 Distribution Tie Breakers
- Multiple distribution circuits will be upgraded with a variety of feeder based monitoring and control IED to evaluate the impact of a variety of Advanced Distribution Automation (ADA) functions (described further in the project objectives section). Current plans for circuit automation and demonstration are:
  - 1 Green Impact Zone control circuit with concentrated EE programs
  - 2 Green Impact Zone circuits with advanced automation, circuit ties & EE programs
  - 1 Green Impact Zone circuit with advanced automation and 1MW battery
  - 1 control circuit
  - 2 circuits with advanced automation, circuit ties & EE programs
  - 1 circuit with advanced automation with converted stand-by to parallel generation
  - 2 UMKC circuits (potential for future micro-grid implementation)
- The demonstration will include the following SmartEnd-Use initiatives to provide consumers with enhanced information on energy use and cost and to measure the impact on SmartGrid automation on end-use consumption:
  - 14,000 accounts outfitted with two-way AMI communications and SmartMeters

- 14,000 accounts with access to AccountLink, KCP&L's Web-based customer portal, with access to historical interval usage data aimed at educating customers on their usage patterns.
- Up to 1,600 households outfitted with in-home displays aimed at educating homeowners in real-time about their energy consumption and costs.
- 400 households with a web-based customer Energy Management System (EMS) portal, Home Area Network (HAN), and basic home automation components, including displays for energy consumption, educational tools, and dynamic pricing signals for indirect load control
- Three (3) commercial buildings/schools with new EMS SmartGrid enabled systems.
- Ten (10) public PHEV/PEV charging stations

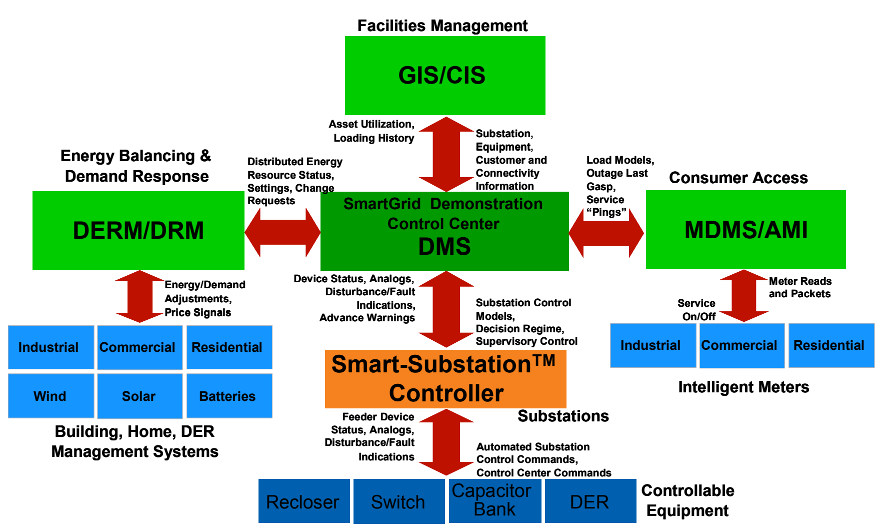
- SmartGeneration initiatives will be deployed to provide the field devices required to test the SmartGrid management components and measure the grid impacts of the technologies.
  - Up to 1,600 households outfitted with SmartGrid enabled DR thermostats
  - Four (4) substation transformers with dynamic voltage control (DVC) controlled by the SmartSubstation
  - 15 distributed photovoltaic (PV) roof-top generation assets (180kW)
  - One (1) stand-by generator converted to parallel generation and SmartGrid enabled.

3.B. TRANSMISSION & DISTRIBUTION (T&D) INFRASTRUCTURE

The proposed T&D SmartGrid Infrastructure demonstration will implement a regional grid control system that will consist of four major components as shown in Figure 1 below. The components include:

- Distribution Network Management. This provides all the necessary systems and applications for the KCP&L Control Center Operators to manage the distribution network reliability; quality of supply; coordinate with substation controllers and field automation; and enhance efficiency of the operations, crew and maintenance staff.
- Distribution Network Automation. This supports the arming of the feeder network with telemetry units and controllers for reclosers, switches, and capacitor banks to support communication with Smart-Substation™ Controllers for automated feeder reconfiguration.
- Advanced Metering Infrastructure and Meter Data Management. This supports two-way communication with electronic meters for consumer billing information, verification of electrical service status, and remote service on-off capabilities.
- Distributed Energy Resource Management. This provides balancing of renewable and variable energy sources with controllable demand as it becomes integrated in the utility grid, coordination with market systems, and provision of pricing signals to consumers.

Figure 1: SmartGrid T&D Grid Control Infrastructure



This combination of functions will create the next-generation grid monitoring and control platform that will be used to manage the KCP&L Green Impact Zone Demonstration grid for project duration.

The DMS and Smart-Substation™ Controllers provide the operational backbone of the system supporting significant levels of automation on the feeders, complex and automated feeder reconfiguration decisions, and tightly integrated supervision with the Control Centers. The DMS serves as the primary point of integration for the grid facilities, electrical system load, and real-time substation and feeder information. It includes Distribution Supervisory Control and Data Acquisition (D-SCADA), Distribution Network Analysis (DNA), Outage Management (OMS) and integration with KCP&L's existing Mobile Work Force Management system, Geographic Information System (GIS), and other supporting systems.

The Smart-Substation™ controller establishes an intelligent substation IT infrastructure with the ability to make feeder and substation reconfiguration decisions, control field equipment, verify operations, track local grid capacity, and coordinate with the DMS. This ―proactive" management of the distribution grid is a necessary step in preparing for the integration of significant levels of renewable and variable energy resources, controllable demand, and demand response. With the addition of distributed energy resources the DMS and Smart-Substation™ become essential to, managing Volt/VAr conditions, adaptively modifying protection equipment settings, and managing crew safety.

The AMI/MDMS provides access, collection, and management of meter asset information and the consumer metering information for billing, consumer awareness and consumer participation in demand management/response programs or the market. It will be deployed to all customers in the KCP&L Green Impact Zone SmartGrid Demonstration area, including residential, commercial and industrial consumers. It will collect the customer's 15-minute interval consumption data required to support many of the SmartGrid analysis to be performed and for the experimental TOU rates and other EE/DR incentives to be evaluated. Additionally, the MDMS will manage the flow events and other data flows between the legacy CIS and OMS and the demonstration DMS/OMS, DERM system and provides an avenue for integration with selected Home Area Network (HAN) management systems.

The DERM system provides all the necessary functions to balance distributed energy resources with available dispatchable (―controllable") demand to make the most efficient use of existing energy options while optimizing economic value for consumers in the market. It aggregates distributed energy resources and controllable load groups for dispatch and market participation with group and, potentially, demographic leverage. It assesses balancing within a defined future time period (i.e. five minutes) and issues commands to participating resources to adjust their output and/or demand where appropriate. Excess resource can be bid into the market. The system tracks aggregate and individual resource commitments and settles accounts. It uses available load models and network conditions from the DMS as constraints to ensure reliable network operation, request network control changes and verify resource participation. It accepts requests from the DMS to suspend dispatch of energy resources in areas where operational safety conditions are at risk. It will use consumption information from the AMI/MDMS system to verify demand management/response participation. It will track, retain, and report all information necessary to quantify resource and related economic participation.

All these systems assume an underlying standards-based infrastructure of communications, field automation, and end-to-end cyber-security. The demonstration systems will be fully integrated using the standards defined by the NIST SmartGrid Interoperability Framework, where applicable, and will interface with existing production systems at KCP&L at clearly defined and controlled integration points to maintain the security and integrity of KCP&L enterprise systems. As a whole, the program will verify a full range of NIST and other standard modeling and information exchange protocols necessary to implement a functional, cost-effective, secure intelligent grid. The project will define, validate, and verify the necessary parameters and potential solution adjustments for KCP&L, and the industry, to plan and implement a system-wide roll-out of the successful SmartGrid technologies and processes.

In parallel, KCP&L will develop a significant ―change management" program to guide and manage its transition to a SmartGrid business paradigm. This will begin with the assignment of a select team to implement this project and identify the business, market, and customer service process changes necessary for a complete implementation. The result will be a comprehensive staged plan to modify the necessary business processes; retrain its business, operations, engineering and planning, market, and maintenance staff; and educate its customer base.

Several fundamental aspects of next generation SmartGrid T&D Infrastructure will be demonstrated and verified in this project, including:

- Upgrading a multi-transformer, multi-bus distribution substation to a state-of-the-art SmartSubstation deploying the IEC61850 communication protocols over a secure IP Ethernet substation LAN.
- Implementing a highly-integrated, distributed hierarchal control solution between a centralized DERM system, DMS/SCADA system, a distributed DCADA controller within the SmartSubstation, and individual IED field controls.
- Implementing numerous ―ifst responder" distributed automated decision making through intelligent substation controllers and enabled feeder devices
- Implementing dynamic equipment ratings based on field conditions
- Integrating supervision of automation and filtering of field information to improve distribution operations situational awareness
- Integration of significant distributed and renewable energy resources and controllable demand
- Enabling demand response, price signals, and market participation
- Enabling two-way accessibility of the customer meter, availability of current energy usage information, and customer participation in energy programs
- Creating a pervasive SmartGrid communications infrastructure
- Implementing end-to-end cyber security

3.B.1) SmartSubstation

The Midtown SmartSubstation will consist of new numerical protective relays, substation controllers, communication system, local DCADA and applications, which will operate KCP&L's substation with advanced functionality to provide more reliability, efficiency and security.

The existing electromechanical relays will be replaced with new microprocessor relays (IEDs). These IEDs will have communication capabilities utilizing IEC61850 in the protection and automation system. The IEC61850 will allow KCP&L to minimize wiring in the substation and provide automation such as interlocks through this digital system.

Siemens will provide protective relays on the distribution level. This includes the feeders, the tie connections, bursars and transformer protection. Protective relays will provide protection and circuit breaker monitoring. Transformer relays will measure temperatures, in order to detect incipient faults in the substation. The system will proactively send warnings and alarms to a central site to inform about these circumstances.

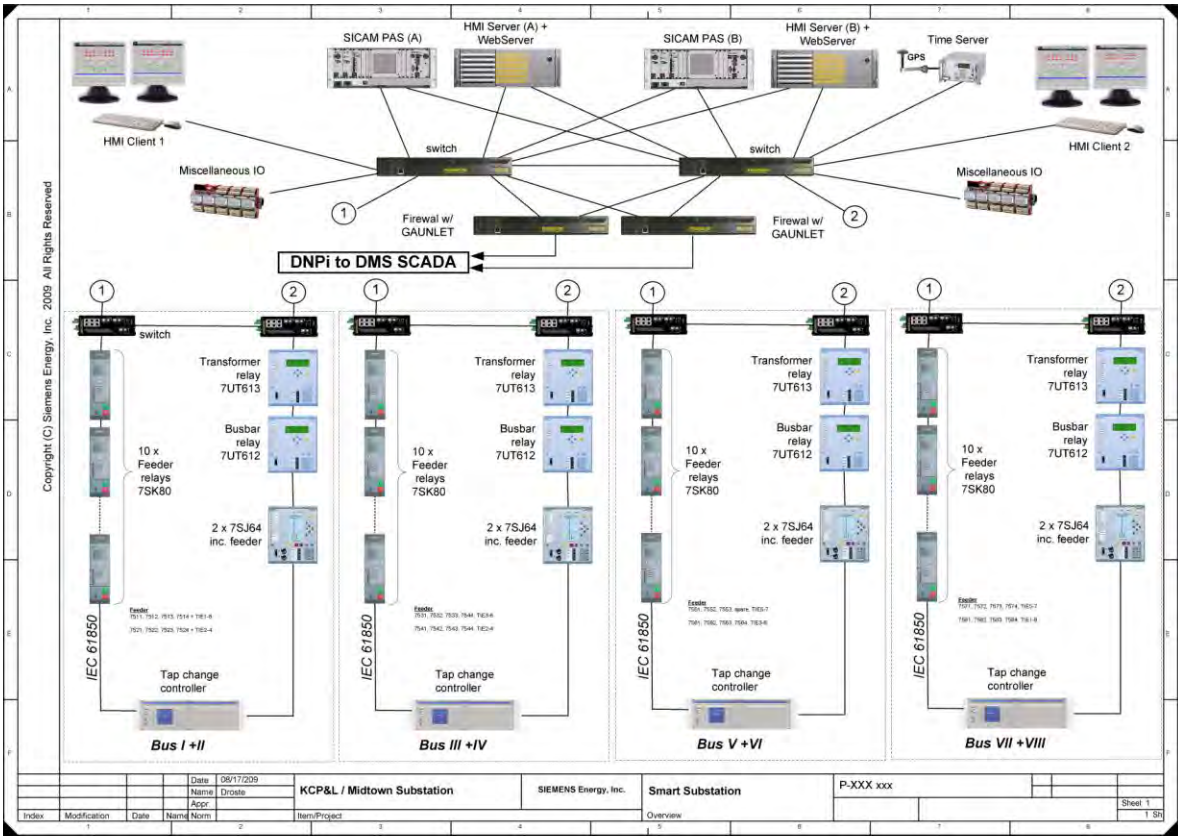
Each power transformer feeds two busbars, with one IEC61850 communication loop for each transformer and its associated busbars and feeders. All four of these IEC61850 loops are interconnected through a substation LAN, which combines the communication loops. The substation controller and a local HMI (Human Machine Interface) system are connected to this substation LAN to interface to the relays in the substation and provide protocol conversion from the substation to the DMS SCADA system.

Figure 2 provides an overview of the substation automation and protection system that will be implemented.

Through the protective relay system, tap changes and some miscellaneous I/O, KCP&L is able to deploy the function of a SmartSubstation. This will include:

- Peer-to-peer communication between IEDs over IEC61850
- Controlling the tap changer of the transformers over IEC61850
- Protection of substation devices, assets and feeders
- Redundant data collection concentration in the substation

Figure 2: SmartSubstation Control Infrastructure



- Redundant local HMI
- Cyber Security with firewall and access control and NERC-compliant logging tools
- Redundant Connection over DNP3i (TCP/IP) to the DMS SCADA system
- Other legacy protocols are available in the substation
- Retrieval of fault records automatically over IEC61850 communication and storage on a local computer
- Access for remote diagnoses, maintenance and programming
- Smart applications in the substation that use the mode Automatic, Verify or Monitor to make sure it fits into the KCP&L operations strategy
- Real-time transformer rating with oil temperature by using the transformer relay for the measurements, or an additional small I/O device built into the control cabinet of the transformer. Logic in the I/O device or the relay (PLC) will provide for the fan controls
- Metering through the relay includes the calculations of P,Q, S, etc.
- The substation controller is also connected over DNP3i to devices on the feeder (DA controls). The application FISR (Fault Indication and Server Restoration) will automatically calculate the switching procedures to isolate faults on the feeders and provide service restoration.
- Volt/Var Management using the tap changers and the capacitor controls
- Feeder Overload Management with Dynamic Voltage Control will be done locally in the substation to respond to those states quickly. This also can be a combination of an application that runs on the enterprise bus with the local substation control.
- DER monitoring and management
- Fully CIM- and IEC61850-compliant
- Arc Flash Mitigation through local redundant HMI system

3.B.2) SmartDistribution

The following paragraphs give a brief description of the SmartDistribution functionality, which will be performed by the DCADA system in the Midtown SmartSubstation. These applications, running on a redundant system, are enhancements to the basic substation automation system. As part of the project, KCP&L will implement local ―first responder" applications that greatly improve the control of the distribution network, increase supply quality and reliability, ensure optimal use of network equipment, and minimize losses and detection and elimination of overloads at particular points in time.

Distribution Network Analyses (DNA) provide tools to simplify and improve the analysis of situations, providing more reliable network status information and supporting the network operation for both unplanned situations and planned activities. DNA uses the CIM-based logical and topological data model of the distribution network of the real-time database. This data model will be downloaded from the central DMS SCADA system into the substation DCADA system.

Distribution Network Analyses comprise several components, mostly independent of each other:

- Topology functions
- Fault location (FLOC)
- Distribution System Power Flow (DSPF)
- Fault Isolation And Service Restoration (FISR), including DSPF

3.B.3) Distribution Management System (DMS)

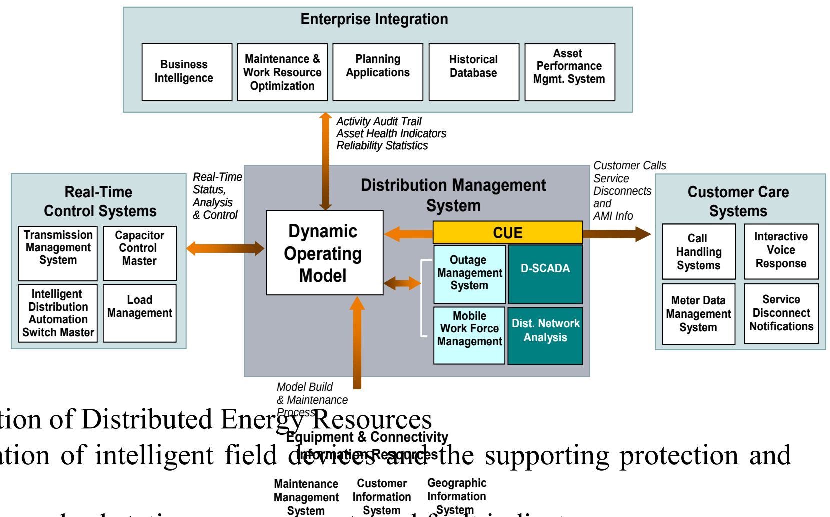
Siemens Distribution Management Systems (DMS) enable the user to evaluate the state of the electrical distribution system, efficiently manage day-to-day construction and maintenance efforts, and proactively guide operators when the system is needed most; during storms and related restoration activities. As utilities come under greater pressure to more fully utilize existing equipment, a DMS is an essential element in maintaining and improving delivery reliability while reducing complexity and automating related work processes. The recent acceleration in Distribution Automation, Substation Automation and AMI in the industry has created additional impetus to establish DMS as a solid foundation to leverage these aspects of the emerging ―SmartGrid".

For KCP&L, the demonstration DMS will be composed of a number of tightly integrated tools and systems addressing different aspects of the Distribution Operator‘s work tasks, including:

- <u>Distribution SCADA (D-SCADA):</u> Provides real-time device and automation information to keep the operating model as close as possible to the real conditions in the field. D-SCADA provides all real-time data services and control agent capabilities for the combined solution.
- <u>Distribution Network Analysis (DNA):</u> Provides equipment loading and complex voltage calculations to help the operators understand the voltage and loading of the distribution feeders and individual equipment at any point in time. It also provides a variety of Fault Management and Operations Optimization tools to offload the operations staff and improve efficiency.
- <u>Outage Management (OMS):</u> Provides the ability to view the current connectivity of the distribution feeders and safely manage day-to-day and emergency restoration work. The Siemens offering includes the Intergraph InService product as an integral component in the total DMS solution. The OMS provides the basis for all outage information and is uniquely suited for KCP&L‘s needs, minimizing the integration costs with the existing GIS and Mobile Work Force Management systems. The OMS is integrated at a product level with the Siemens DNA and D-SCADA products to provide a complete solution with ―best of breed" product functionality.

These systems are tightly integrated to automate the user‘s workflow as much as possible and enable efficient transition between major functions. Siemens DNA and D-SCADA components of a DMS System are integrated with Outage Management and Mobile Work Force Management systems. The interfaces enable lower implementation and maintenance costs for its customers and directly support cost-effective rollout of the demonstration project. Figure 3 outlines a general DMS solution.

Figure 3: Full Generalized DMS Solution



Key Features:

- Provides a single highly efficient user interface for all DMS functions
- Visually correlates and integrates large amounts of field information
- Supports management of outage restoration and mobile work crews
- Utilizes all available information from Distribution Automation (DA) and Automated Metering Infrastructure (AMI) sources
- Provides modeling and simulation of Distributed Energy Resources
- Provides modeling and simulation of intelligent field devices and the supporting protection and control schemes
- Incorporates all available feeder and substation measurements and fault indicators
- Establishes a time-smoothed granular feeder load model for more accurate solutions
- Rapidly and accurately determines fault locations and automatically provides isolation and restoration plan options
- Tracks system/feeder load reduction capacity on an on-going basis
- Supports various optimization objectives, including Voltage, VAr, Loss, and Load Capacity management
- Establishes a generalized model-based integration platform for simplified integration with other enterprise systems

Siemens will provide all associated integration efforts related to the DMS and the associated systems pertinent to operations. Siemens is proficient in real-time and extended business integration efforts leveraging operations systems, models, and information, as well as maintenance, customer, meter management systems, and operations asset management solutions.

3.B.4) Smart Metering

The Landis+Gyr Gridstream SmartGrid communication system and SmartMeters provides the capability for AMI, Advanced Distribution Automation (ADA) and a meter to Home Area Networking (HAN) gateway over a common two-way communication infrastructure. The system supports the acquisition of load profile, time-of-use and demand meter data, and meter and site diagnostic information from electric meters that perform these measurements. The system also supports —under-glass” remote physical disconnect and Home Area Network communication via the ZigBee Smart Energy Profile standard with meters equipped with these capabilities. Electric meters also support outage and restoration reporting and real-time on-request reads.

3.B.4.a) Command Center – The AMI Head-End System

Command Center is the leading advanced metering software platform that brings everything together – from data reporting to system control – in a single application. The system is highly scalable and feature rich. It enables users to remotely program meters; schedule time-of-use periods and rates; handle remote disconnects; analyze critical peak usage; view load control indices; and perform other critical, day-to-day functional operations. Command Center simultaneously manages the meter data collected from millions of endpoints, validating each data element, and integrating it throughout the system. Built to interoperate with meter data management (MDM) systems, as well as key billing, customer service, engineering, accounting and field service software programs, Command Center delivers unmatched energy resource management, collaboration and productivity.

Command Center ensures immediate productivity with an intuitive interface and easy integration. Command Center is MultiSpeak® compliant and follows IEC CIM 61968 standards. An extensive Web Service library offers 100 pre-built techniques ready to use. In addition to Web Service APIs for common interface points, Command Center delivers pre-built data extracts, flexible data extracts and formats, CSV file imports, and support for XML templates. Web Services are based on Service Orientated Architecture (SOA), and Command Center simultaneously processes and validates meter readings, and also inserts database records for millions of devices quickly and efficiently. Comprehensive integration with billing, CIS and engineering software enables Command Center to provide a seamless link between metering data and the applications that use it.

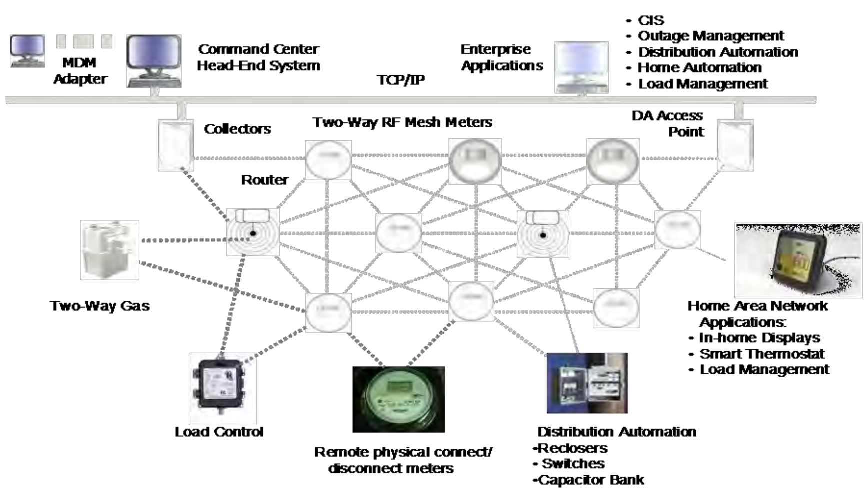
3.B.4.b) Gridstream Wireless Field Area Network (FAN)

The Landis+Gyr Gridstream SmartGrid communication system provides full two-way wireless mesh communication and functionality to electric meters, direct load control devices, advanced distribution automation (ADA) devices and Home Area Network devices enabled with a ZigBee communication module.

Advanced metering and diagnostic information that electric meter provides can be communicated over the network to the Command Center head-end operating system and displayed, reported and interfaced to a utility's Meter Data Management (MDM) system, Customer Information System (CIS), Outage Management System (OMS) and other enterprise applications.

Below is a schematic of the Gridstream System for AMI, ADA and Meter to HAN Gateway.

Figure 4: The Landis+Gyr Gridstream SmartGrid two-way Communication System



3.B.4.c) Smart Meters

Some of the features of the L+G SmartMeters with the Gridstream AMI System include:

- Full two-way Mesh Radio AMI Communications
- Variable Output Power 100 to 425 milliwatts
- Auto-registration
- ANSI C12.19 Tables support
- Forward, Reverse, Net, Total Energy

FOCUS AX-SD Meter
With Remote Connect
and ZigBee HAN

- Voltage/Power Quality Information
- Downloadable Firmware
- Advanced Metering: Demand/TOU/Load Profile
- 5/15/30/60-minute Interval Data Recording
- Data Storage
- Outage and Restoration Notification
- Integrated Service Disconnect
- Load limiting
- ZigBee Smart Energy Profile HAN Interface
- Reactive Energy & Power Factor (commercial meter only)

3.B.5) Advanced Distribution Automation (ADA) via the Gridstream FAN

The Landis+Gyr Gridstream network can support both AMI and ADA communications over the same network. The Gridstream network has been integrated to a number of ADA device control suppliers via both serial and IP interface connections using standard protocols such as DNP3.

Typical Advanced Distribution Automation (ADA) applications include:

- Automatic feeder sectionalizing and restoration with intelligent switches
- Automatic circuit recloser monitoring and control
- Voltage regulator monitoring and control
- Distribution feeder capacitor bank monitoring and control
- Network protector relay monitoring and control
- Faulted circuit indicator monitoring
- Monitoring of Smart Transformers

3.B.6) Meter to HAN Gateway via Gridstream Communication System

The Landis+Gyr Gridstream system supports meter to HAN gateway applications via the ZigBee Smart Energy Profile standard using the meter as the HAN gateway. This allows the AMI network to communicate with any ZigBee compliant in-home device: applications include in-home displays (usage information, price, text messages), Smart thermostats and potential other future devices. A diagram displaying the main components of the Landis + Gyr Gridstream solution is shown below.

Figure 5: Communication Flow from Utility, through Gridstream, to the HAN via the Meter Gateway

3.C. SmartGeneration

KCP&L is proposing to work with its partners, in a fully integrated team approach, to implement and demonstrate key SmartGrid technologies in the areas of demand response, distributed and renewable resource management, integration and management of demand side resources for improved grid economics, reliability and environmental compliance, including full coordination with distribution automation capabilities for voltage, VAR, PQ management and three-phase balancing requirements, as well as system operations for improved system scheduling and market operations, and balancing variable generation. The proposed solution and capabilities are presented in the following subsections:

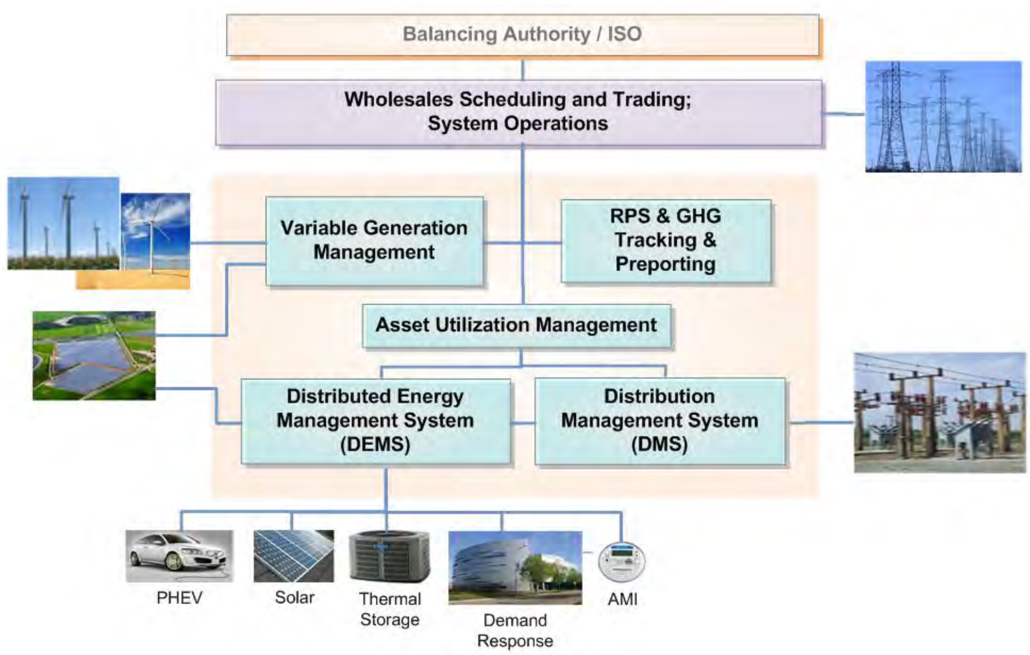
3.C.1) Smart DR/DER Management

OATI webSmartEnergy is a comprehensive suite of software products for end-to-end integration of demand-side, distributed and renewable resources with transmission, distribution and energy market operations for both reliability and economic considerations. These products are specifically designed to enable utilities to best realize the new Smart Grid benefits while considering existing business practices, regulatory and operational constraints, and technical requirements. They provide the capabilities needed to support high penetrations of renewable and variable generation resources, and provide for integration of demand response and demand-side resources with system operations to address, and to improve, system reliability, supply economics and operational efficiency.

The key components of the webSmartEnergy suite are shown in Figure 6 and include:

- Distributed Energy Management System (DEMS) – The industry‘s most comprehensive product for management of demand-side and distributed resources.
- Asset Utilization Management – For management of distributed and renewable assets‘ capabilities and operating information
- Renewable Portfolio Standards (RPS) and Greenhouse Gas (GHG) emissions tracking and reporting Modules
- Variable Generation Management Tools – For management, optimization and automation of wind generation scheduling, trading and operations

Figure 6: Distribution Energy Management System



The webSmartEnergy products are built on a proven platform that is designed for large scale deployments. The scalability considerations are applied to the database design to manage a large number of customers and resources; to the user interface for a large number of users; and to external interfaces to handle large volumes of data transactions. webSmartEnergy is built on standard interfaces and external legacy and third party systems. webSmartEnergy provides a high-performance workflow manager to handle large volumes of concurrent data collection.

OATI applications adhere to stringent cyber security measures including full compliance to NERC CIP requirements. OATI's proven cyber security techniques for application level, system level, database level, user access, and physical security have been successfully deployed and practiced over the years for many utility mission critical applications. All access to webSmartEnergy is secured and encrypted.

The webSmartEnergy is typically provided in a Software-as-a-Service (SaaS) delivery model. As such, the additional costs to the project for implementing computer hardware and the peripheral software, as well as the costs associated with providing the required support infrastructures are reduced. In addition, the SaaS implementation model provides an additional layer of security, or the ―Air Gap", needed to shield utility's internal systems.

The following are more detailed descriptions of components of webSmartEnergy.

3.C.1.a) Energy Distributed Management System (EDMS)

The OATI Energy EDMS is the industry's most comprehensive software solution for demand-side resource management and control. webSmartEnergy EDMS provides the bridge between advanced metering, DR/DER, variable generation, distribution grid, transmission grid, and wholesale markets. In addition to a full complement of conventional Demand Response capability, webSmartEnergy EDMS provides the capabilities needed to optimally manage distributed energy resources for the support of distribution system load relief, and for the transmission and market operations, (e.g., providing ancillary services and balancing energy to support variable generation). By mapping DR/DER to distribution grid locations, and tracking circuit, feeder, and equipment conditions, webSmartEnergy EDMS provides a unique combination of capabilities for integrated Smart Grid operation while considering limitations imposed by transmission and distribution grids.

The webSmartEnergy EDMS solution provides the following advantages:

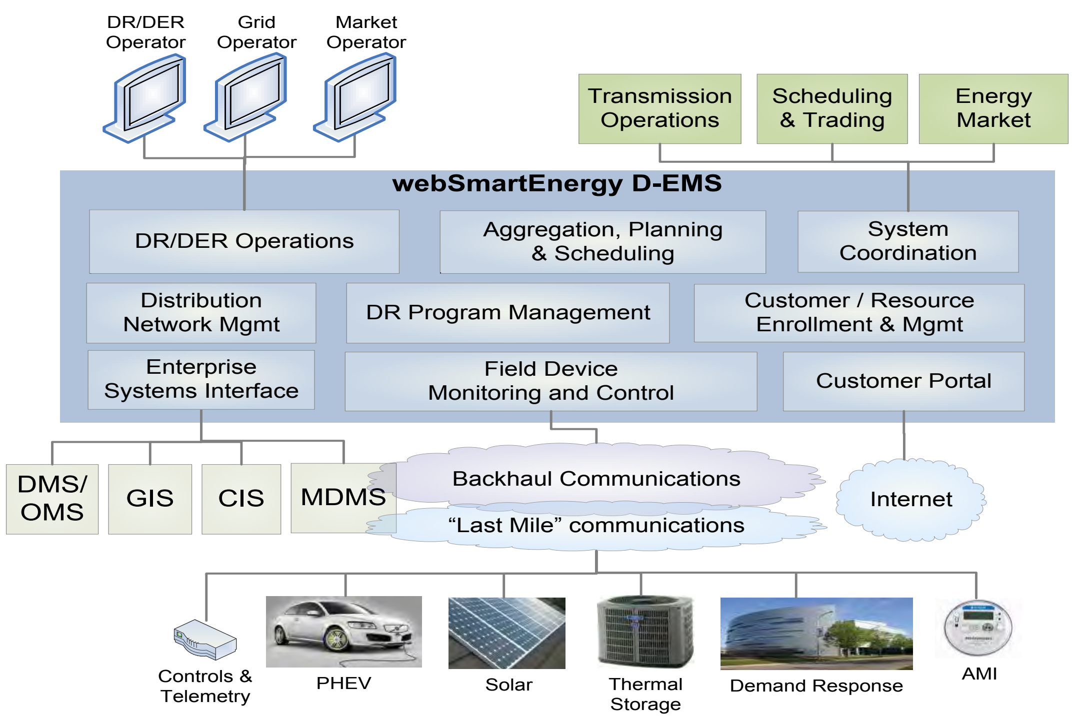
- Managing and controlling diverse types of demand-side resources:
  - Demand Response resources including C&I EMS, HAN devices, home automation equipment, concentrated EE programs
  - Feeder and Substation-level generation and storage resources including, PV roof-top assets, the Green Impact Zone1MW Feeder Battery
  - Customer Stand-by/Parallel on-site displaceable and none-dispatchable generation
  - PEV vehicles and PHEV charging stations
- Creating and Managing various DR programs:
  - Dispatchable/Direct Load Control programs as well as price-based and voluntary programs, including market-based and dynamic tariffs
  - A variety of traditional utility DR programs including TOU, Critical Peak Pricing, AC Cycling and emergency curtailment
- Managing various market and transmission operation support products:
  - Mapping DR/DER capabilities to wholesale energy products
  - Energy, Ancillary Services (Non-spinning Reserve, Spinning Reserve, and Regulation from eligible resources), Capacity (for Resource Adequacy, and where allowed by market)
  - Aggregation at feeder and substation levels, as well as by device type, DR programs, market product, zone, pricing nodes, etc.
- Tracking and managing RPS and GHG contributions of distributed and demand-side resources
- Interfaces and secure integration with AMI/MDMS, field devices, customers, system operations, enterprise, and other external system interfaces:
  - Interfaces with wholesale scheduling and trading functions - ISO operations,
  - Integration with Systems, Operations, and Customer Service systems including MDMS, CIS, SCADA/EMS/DMS,
  - Interfaces with field equipment including Home-Area-Network (HAN) based devices

- User interface and operational support for different user classes/roles including:
  - Demand Response Manager/Curtailment Service Provider/Aggregator
  - Customer services for customer enrollment and customer interactions
  - Merchant Operator– wholesale aggregation and scheduling
  - Customer Portal
- Scalable design with high-performance work flow for DR program execution management. It is designed to support a large number of customers, a large volume of transactions (DR functions), and a large number of simultaneous users (customer portal access)
- Stringent cyber security measures and adherence to NERC CIP and other cyber security standards (levering OATI's experience and capabilities)
- Data privacy and data stringent cyber security measures and access authorization/control by user classes and functional roles
- Web service interfaces for integration and interoperability with utility's system operations and wholesale scheduling systems

3.C.1.b) webSmartEnergy EDMS Functional Overview

webSmartEnergy EDMS provides full visibility into demand-side capabilities, the ability to leverage those capabilities for operational and economic efficiencies, and the ability to aggregate and use those capabilities in support of wholesale market operations. A diagram of the webSmartEnergy EDMS solution appears below:

Figure 7: Energy Distributed Management System Functional Overview



Some of the webSmartEnergy EDMS functional capabilities include:

- Residential, Commercial and Industrial Customer enrollment including business/facility hierarchy and service point connections. EDMS handles the processes required for customer and customer resource enrollment, and association of customers to DR programs
- All access, for both utility personnel and other authorized users, is through standard Web browsers over a secure link that provides customer privacy and information security

- Enrollment and management of demand-side and distributed resource assets. DEMS provides a comprehensive data repository for demand-side asset including geo-spatial mapping
- Creation, administration, and execution of Demand Response programs including voluntary (dynamic price and incentive based) as well as dispatchable (direct load control) programs. EDMS provides a flexible rule-based capability for defining DR programs based on time (e.g., TOU), price (e.g., dynamic tariff), and event parameters, including the KCP&L EnergyOptimizer, DR Thermostat, and KCP&L MPower programs. Demand Response (DR) programs may be designed based on the customer load patterns, available resources and ability to react to DR requests on a day-ahead or same-day basis
- Baseline load calculations based on the NAESB standards. The interval meter data (15 minutes) from AMI/MDM will be used to generate the customers' baseline load.
- Aggregation and mapping of DR capabilities into wholesale products that can support system operations including energy, ancillary services and capacity
- Aggregation, and dispatch of DR/DER based on electrical location (substation, feeder, etc.), DR program participation, and wholesale product eligibilities
- Monitoring and control of distributed generation including wind, solar PV, and other on-site generation resources
- Monitoring and dispatch of storage devices, including battery, thermal, and other grid storage.
- Monitoring and management of plug-in electric vehicles (PEV/PHEV) charging and discharging
- The Demand Bidding Strategy & Market Interface function provides the capability to aggregate the controllable load as market products that can be bid directly into the ISO/RTO, including bidding/scheduling strategies for Energy and Ancillary Services
- Displays are provided to support wholesale DR scheduling and associated ISO/RTO interface functions. OATI provides a full set of automation capabilities for interfaces with the ISO/RTO
- Interfaces and integration with system operations and enterprise systems including MDMS, CIS, GIS, EMS/DMS, scheduling and trading
- Interface capabilities with Field communications head-end systems, as well as near real-time communications with IP-enabled devices at customer site for DR management
- User Interfaces displays designed to support different user classes including Customer Service representatives, DR operators, distribution grid operator, and wholesale merchant power trader
- Customer portal to support individual C&I and residential customers
- Support for and interfaces with 3rd party Curtailment and Energy Service Providers

3.C.1.c) <u>Asset Utilization Management</u>

OATI webSmartEnergy Asset Utilization Management module is a tool for managing information associated with distributed, demand-side and renewable assets, and their operating characteristics and conditions. With the increased numbers and diversity of distributed and renewable generation and storage assets, demand response and demand-side resources, and their interconnection topology with the distribution and transmission grid, it is important to maintain a well structured database to provide a consistent, accurate and timely view of the assets capabilities.

OATI webSmartEnergy Asset Utilization Management module is designed to meet the utility operational requirements, including planning and forecasting, scheduling and dispatch, balancing and real-time operations, as well as settlements and billing. It maintains individual asset information for different classes of resources, including wind, solar, and other renewable generators, energy and thermal storage, distributed generation, demand-response equipment and PEV/PHEV resources. Also, it maintains the asset's grid connection information, operating constraints, operating condition, and availability information. It also provides for maintaining the asset condition monitoring sensors as-operated (metering) information associated with the asset operations. In addition to maintaining device characteristics, the webSmartEnergy Asset Utilization Management module also maintains the geo-spatial coordinates of individual assets, to provide for an easy and flexible presentation of system information on geographic maps and displays.

3.C.1.d) Distributed Resource Schedule Optimization

This advanced application provides for economic dispatch of resource portfolios dominated by distributed and intermittent generation resources. The resource portfolio may include wind and solar generation, storage resources, dispatchable demand-side and demand response resources and dispatchable on-site and other thermal generation.

- Integration with OATI's energy trading, tagging, and the dispatch application is designed with the following characteristics:
- Execute automatically every few minutes to produce an optimal portfolio generation/demand-response schedule with five minute resolution over a dispatch time horizon up to 90 minutes, while utilizing a rolling wind generation forecast over the scheduling time horizon
- Capability to also execute on-demand
- Capability to execute in what/if study mode
- Callable contracts are modeled as dispatchable resources
- The five minute dispatch set-points will be provided to webSmartEnergy EDMS, utility SCADA and other unit control systems for implementation
- Handling of various constraints for thermal and other dispatchable resources including high and low capability limits, up and down ramp rates, maximum startup times, minimum up and down times, transmission and area constraints, etc.
- Handling of Ancillary Services and Reserve self provision or priced offer, including Non-spinning (Supplemental), Spinning, and Regulating reserves as allowed in the specific market or reliability jurisdiction for DR/DER.
- Handling of various unit statuses such as: Available, Must Run, Economic, Fixed, and Outaged
- OASIS Transmission reservation tools

3.C.1.e) Distributed Resource Integration with Wholesale Market Operations

OATI's webSmartEnergy operates in conjunction with KCP&L's scheduling/trading system (including OATI's web Trader) to provide for integration of DR/DER into wholesale market products commensurate with prevailing market rules and provisions. Currently, some ISO/RTO markets allow Demand Response to offer a subset of market products. Moreover, rules and limitations apply to aggregation of otherwise dispersed DR/DER resources as market commodities. Under FERC Order 719 issued October 17, 2008, all ISO/RTOs must treat Demand Response and Generation resources on a comparable basis; specifically ISO/RTOs must accept bids/offers from DR resources for Ancillary Services (A/S) comparable to any other A/S capable resources. There may be specific metering or telemetry requirements on DR/DER to allow these resources to participate in Ancillary Service markets. Of particular relevance to this project is treatment of DR/DER in the Southwest Power Pool (SPP) market. SPP is incorporating two flavors of Demand Response in SPP's current (EIS) market, namely, Block Dispatch Demand Response (BDDR) and Variable Dispatch Demand Response (VDDR), and is expanding the role of DR/DER in the new SPP markets currently under design and targeted to commence operation in 2012.

OATI's offering has provisions to accommodate different flavors of DR/DER integration into wholesale Energy, Ancillary Services, and Capacity markets. An important issue related to participation of DR/DER in wholesale markets is the extent to which the ISO/RTO market operator (or system operator) has visibility into these resources. This is important for the resource operations planning, scheduling, dispatching, performance monitoring and settlement processes of ISO/RTO. OATI will work with KCP&L to integrate OATI's webSmartEnergy platform with KCP&L's scheduling/trading and dispatch/control systems to provide for a hierarchical information and control mechanism whereby information from distributed resources is aggregated and presented to SPP, and dispatch instructions from

SPP are disseminated either directly (e.g., to Customer Driven MicroGrid) or indirectly through the KCP&L distribution dispatch/control service.

Generally for the dispatch of aggregated DR/DER resources, what the ISO/RTO (in this case SPP) is interested in is to make sure the requested MW (or MW change) is realized within pre-defined boundaries (DR/DER zone) that are usually agreed upon between the ISO/RTO and the DR/DER provider in the aggregate DR/DER resource registration process. These may be resources physically connected to distribution feeders and laterals emanating from a transmission or sub-transmission substation, or a wider geographical area (a collection of pricing nodes recognized by the ISO/RTO).

The manner in which dispatch signals from SPP are distributed to individual constituents of DR/DER aggregated resource can be determined by the webSmartEnergy optimal resource dispatch algorithm. This algorithm recognizes distribution congestion and can allocate the required MW (or MW change) so as to avoid or relieve distribution congestion.

In the context of the current project, these functionalities will enable KCP&L to bundle and offer DR/DER as energy resources into the SPP's EIS market, and receive and implement real-time DR/DER dispatch instructions from SPP optimally with a view to distribution circuit limitations. KCP&L can also include DR/DER as Ancillary Services in its Resource Plan to SPP, and use them towards meeting Resource Adequacy obligations.

The new SPP market will go into operation towards the tail end of this demonstration project. However, webSmartEnergy will enable KCP&L to participate effectively during the new SPP market trial period that is expected to start towards the middle of the timeline for this project. This will enable KCP&L to test participation of its DR/DER resources in new SPP markets (Day-ahead Energy, RUC, Contingency Reserve, and Regulation) markets far in advance of the start of the new markets.

3.C.2) Utility Controlled DER/DR Demonstrations

KCP&L will make use of a variety of distributed energy resources in the project area, including demand response programs and dynamic voltage control. Working in concert with other SmartGrid technologies, these programs will serve to create a ―virtual power plant" that can dynamically respond to changing system conditions. The net effect of this virtual power plant is to defer the need to build additional fossil-fuel-fired generating resources as well as helping to defer distribution system upgrades. Benefits of such deferrals flow through directly to customers in the form of lower costs, increased reliability and lower environmental impact.

3.C.2.a) <u>DR Thermostats</u>

As part of the proposed project, KCP&L will leverage the EnergyOptimizer DR thermostat program to demonstrate enhanced grid operational benefits. The AMI FAN will provide the two-way communication between the customer premise and the back office DERM webSmartEnergy application, DEMS and DMS, and other grid management systems. By using circuit, substation, and system level indicators the DR thermostats can be aggregated and operated based on grid connectivity (small or wide scale) as needed to provide the desired locational load relief.

The project will assess the DR Thermostats capabilities for providing ―fast DR" emergency and ancillary service products, e.g., non-spin and balancing energy. The demonstration will include design and execution of specific evaluation test to assess the capabilities of the remote Thermostats control for providing short-term ancillary services in support of system operations and variable generation management.

3.C.2.b) <u>DR Customer Load Curtailment</u>

KCP&L will extend its existing commercial curtailment program, MPower to the project area. MPower is a load curtailment program designed to help manage system, or circuit-level peak demands. Program participants are paid up to $45 per kW of curtailable load just for agreeing to be ―on-call" to reduce load to a predetermined level at KCP&L's request. They are paid an additional payment of $.35

per kW when they are called upon to reduce load and successfully do so. This program serves to defer the need to build additional fossil-fuel-fired generating resources while contributing to grid stability and reliability.

Also, capabilities for supply of ―fast DR", i.e., ancillary services, from demand-side resources will be provided. DR load curtailment programs will be evaluated to specifically demonstrate the aggregated ability of demand-side resources to supply ancillary services such as spin and non-spin energy in support of grid operations, e.g., balancing variable generation from solar and wind resources. Similar to the DR Thermostats programs, by mapping and tracking the DR load curtailment capabilities against circuit, feeder and substation connectivity, locational energy products can be made to support grid operation and variable generation balancing.

3.C.2.c) Distribution Voltage Control (DVC)

The capabilities of the Green Impact Zone DR/DER will be integrated with the existing KCP&L DVC program. This will include:

- Voltage regulation at substation and feeder level using tap-changing transformers and voltage regulators;
- Demand-side load adjustments using DR and DER management capability;
- Changes in load and distributed generation levels, and possible Power Factor regulation at solar panel inverter / on-site generation interconnection point.

The proposed Smart Grid infrastructure will provide the capabilities needed to monitor voltage levels at the end of distribution lines and customer service points. This will provide the capability for regulating the voltage levels at substation and feeder levels while maintaining the end-of-the-line voltage within the target operating limits. Also, the capability for managing feeder/substation load based on voltage regulation will be demonstrated.

3.C.2.d) Roof-top Solar Photovoltaic Generation

KCP&L will install roof-top solar photovoltaic systems on both residential and commercial properties, including a 100kW installation on Kansas City Missouri School District's Paseo High school. The project will demonstrate the opportunity of distributed generation utilizing current PV technologies. KCP&L will examine the options of either leasing customer roof-tops for a monthly fee or the opportunity to net-meter the installation at the customer's premise. In either case, KCP&L intends to own and manage the equipment for the duration of the demonstration. The location of individual generating units will be mapped based on feeder and substation connectivity to support feeder load forecast, and forecast updates based on weather conditions. The PV generation capabilities will be used to assess the following:

- Impact of solar generation/inverter operation on the distribution circuit voltage and power quality
- Metering of renewable generation and tracking that against Renewable Portfolio Standards (RPS) targets for the Green Impact Zone.
- Building a historical database of PV panel performance in the Green Impact Zone for support of distribution planning, system and merchant operations
- Assess issues associated with two-way power flows. Special evaluation program and metering will be designed and deployed for this purpose. The existing interconnection rules in Kansas support net-metering of on-site renewable generation at 25kW for residential customers and 200kW for non-residential customers.
- The capability of aggregating, managing and potentially dispatching (controlling) a high penetration of PV solar panels with Net Metering capability will be implemented and demonstrated. The proposed webSmartEnergy will serve as the platform for this evaluation.

- Display of PV locations, generation levels, circuit loading and operating conditions on a web-based geospatial map accessible by PV owners and other authorized users.

3.C.2.e) Grid-Connected Battery Storage

Kokam, KCP&L's partner to develop an advanced and economically viable grid storage solution uses Superior Lithium Polymer Battery (SLPB) technology. The patented SLPB technology is proven, is already in production in the U.S., and is being used in numerous applications around the world. Many U.S. companies and agencies have adopted SLPBs as the primary power and energy source for equipment in industries ranging from medical, aerospace and defense to high-end industrial tooling.

The proven SLPB cell design increases energy density to as high as 200 Wh/Kg in high energy cell configurations and power densities as high as 2400 W/Kg can be achieved with minimum optimization on a high power cell design. The Kokam SLPB meets all performance standards of the U.S. Advanced Battery Consortium (USABC) and has been commercially sold into multiple applications for over eight years.

Kokam has offered and delivered fully integrated multi-cell modules of robust energy storage units that provide safe, maintenance-free performance for the life of the application. The high level of repeat business with customers is a strong indication that Kokam batteries meet or exceed industry standards for cost, energy capacity, pulse power, abuse tolerance, and calendar and operational life.

The Grid-Scale Energy Storage Demonstration Project will implement a 1MWh, 1MW-capable Superior Lithium Polymer Battery Storage (SLPB) system connected into a single 13.2kV distribution feeder circuit on the KCP&L system.

Lithium polymer batteries are significantly more powerful for their size and weight than other types of batteries such as Lead Acid and NiCd. SLPB can store up to three times more energy and generate twice the power as the nickel-metal hydride batteries. Prismatic lithium polymer batteries provide greater volumetric and gravimetric energy density than other battery technologies such as cylindrical lithium ion, lithium phosphate, nickel metal hydride, nickel cadmium, or lead acid.

Based on an advanced battery design, it has been proven that the Kokam SLPB technology can improve power density, energy density, cold temperature performance and safety over commercially available rechargeable Li-ion batteries available today. Over the past 18 months Kokam has built the only U.S. highly automated lithium polymer battery manufacturing facility. The Kokam SLPB has numerous technical advantages over a typical lithium cell:

- Higher Power Density – can reach higher W/Kg
- High Energy Density – lighter weight
- High Rate Charge Capability – up to 3C (up to 6C continuous with nanotechnology)
- High Discharge Rates – can be designed up to 30C continuous
- Long Cycle Life – able to get greater than 2500 cycles at 80% depth-of-discharge (up to 6000 cycles at 100% depth-of-discharge with nano technology)
- Wider Operating Temperature – can operate between -30ºC to +60ºC
- Improved safety over conventional Li-ion due to lower impedance cell design that reduces heat generation in operation
- Highly automated process developed by Kokam over 10 years yields lower cost of production

Additionally, SLPB technology provides benefits that are considered to be among the best in class for a Smart Grid battery solution including the following:

- Extended run time
- 10+ years operational life
- Safe low-impedance prismatic design
- Full-scale production within 18 months in the United States with supply from offshore today
- Reduced need for complex cooling systems
- Operation over a wide range of temperatures
- Highly automated manufacturing, contributing to affordable production of battery cells

The SLPB technology also involves patented folder-to-folder (Z-fold like) cell assembly processes. Kokam has developed in-house equipment engineering that supports economical manufacturing of lithium polymer batteries and has focused on the need to produce powerful batteries at the lowest commercial price. The electrochemistry behind the cell is similar to that of a lithium cell, but provides improvements in safety and performance by using the SLPB cell manufacturing process. The highly automated, unique manufacturing processes coupled with the advantages of polymer cell configurations keep cell impedance lower and maintain consistency in performance. Lower internal impedance results in lower heat generation which means improved safety, cycle life, and charge/discharge performance.

Kokam has the ability to offer its customers a nano-structured cathode and anode that provide additional benefits of longer cycle life, improved safety, fast charge capability, and the ability to charge at cold temperatures (-30°C). A nano technology cell has the ability to maintain over 90% end-of-life (EOL) capacity after more than 2000 cycles to 100% depth-of-discharge. This data was obtained by testing actual 40Ah cells with a nano structure cathode only. It is Kokam's expectation to reach 6000 cycles at 100% depth-of-discharge at EOL with nano structure anode and cathode electrodes. The typical Li-ion battery drops to 80% of rated capacity after approximately 500 cycles. The Kokam standard SLPB Nickel Manganese Cobalt (NMC) cells can currently deliver 1400 cycles at 100% depth-of-discharge to 80% EOL. This new technology will provide a practical 10-year solution for the EV/HEV market.

In developing the nano technology, Kokam took a phased approach where the first phase only coated the anode electrode with nano material. The resulting product was called ―Nano 0.5" and was able to achieve as high as 3000 cycles. On the second phase of the development, Kokam introduced nano material into the cathode electrode also. This process is expected to yield over 6000 cycles and was called ―Nano 1.0".

The superior performance difference between the nano SLPB and a battery manufactured by any other supplier can be attributed to the manufacturing process; the heart of the facility. A DC/DC converter technology coupled with AC/DC inverter technology, allows Kokam to manage the power demands more effectively.

3.C.3) SmartEnd-Use

While energy efficiency is not a directly controllable distributed resource, the proposed project will implement and evaluate several technologies that facilitates indirect load control by providing customers with energy education tools and in-home displays empowering customers to reduce energy consumption and costs. Energy education and in-home displays also serve the added benefit of preparing customers for dynamic pricing as well as a means for utilities to communicate pricing signals.

A customer Web portal will provide customers with all the necessary system information, customer's load history, pricing data, and other supporting information. Customer-specific log-in capability provides customizable displays, and targeted information while providing for customer-specific information privacy. This will be supported with the capability for sending notifications, e-mail messages and other information to individual customers based on their specified requirements and preferences.

3.C.3.a) Historical Time-of-Use (TOU) Usage Date via AccountLink

KCP&L currently provides historical daily usage to consumers via our AccountLink Web-based customer service portal. This initiative will augment this current capability and provide all customers served by an AMI with historical 15-minute interval usage data. This will be accomplished entirely by the AMI, MDM and other KCP&L back office systems, it does not require additional hardware in the home.

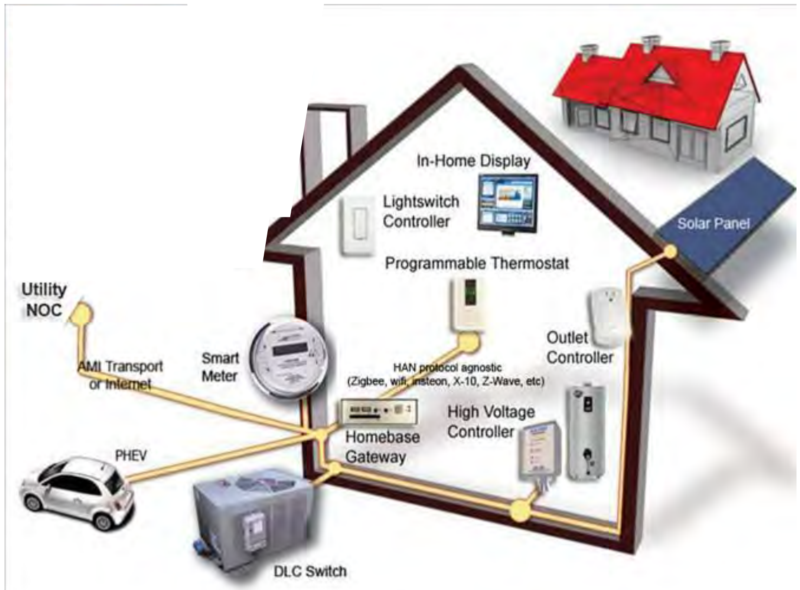
3.C.3.b) In-Home Display Device

KCP&L will be able to provide customers with real-time energy information on a portable presentment device. Component requires a portable device to be registered to the customer's meter. Once registered, it will provide the customer with real-time energy use and cost information along with pricing signals and other messages communicated through the AMI infrastructure.

This will provide the capability to demonstrate an end-to-end integration of pricing signals from the wholesale ISO market to retail dynamic tariff while considering distribution charges and other required conversion factors. This will be accomplished through the integration of the AMI/CIS, webSmartEnergy, and the wholesale markets.

3.C.3.c) <u>Residential HAN with Web EMS Portal</u>

Figure 8: Fully Integrated SmartHome



This initiative provides customers with advanced energy analytics and diagnostics through authenticated real-time information on their energy consumption and cost, including kWhs consumed and the current energy costs for the upcoming bill period. The residential EMS leverages home area network (HAN) communications technology as well as HAN compatible technology, such as thermostats or wireless relay and monitoring devices of circuits and wall plugs, to provide not only whole house consumption data, but also individual load consumption data. In this phase, customers can opt-in to utility SmartGrid programs, enabling customers to manage appliances and other devices via their Web-based portal.

3.C.3.d) <u>PHEV & Public Charging Stations</u>

As part of the proposed demonstration project, KCP&L will explore using SmartGrid technology to manage the charging behavior of plug-in EVs via the GridPoint Platform's Electric Vehicle Management (EVM) System, which establishes intelligent, two-way communication between plug-in vehicles and/or EVSE equipment (e.g. charging stations) and the utility grid. By deploying the EVM system, KCP&L will implement smart charging strategies – controlling the flow of electricity to plug-in vehicles, balancing real-time grid conditions with the needs of individual drivers.

The GridPoint EVM will be interfaced with the webSmartEnergy DR/DER management platform to support forecasting of PHEV load. This load will be mapped to distribution circuits with feeder operating limits assessed and PHEV load coordinated with available DR/DER capabilities.

A fully integrated SmartHome solution is shown in Figure 8 above.

3.D. Interoperability & Cyber Security

KCP&L fully understands that one of DOE's top SmartGrid priorities is the work with NIST and FERC on a framework for interoperability standards. KCP&L and our Team have been active participants in the NIST SmartGrid Interoperability Standards Roadmap effort. To that end, we believe that our project has special merit as we propose to implement five of the six use cases presented in the EPRI's report to NIST on SmartGrid Interoperability Standards [1]. Working in conjunction with the NIST standards acceleration efforts the project offers an ideal opportunity to provide field demonstration and experience of the interoperability standards, thus accelerating the industry adoption of the standards as rapidly as possible.

3.D.1) Interoperability

The Green Impact Zone demonstration project is based on an integrated end-to-end solution that demonstrates interoperability of the key Smart Grid components and the five SmartGrid use cases that provided the basis of the in the proposed NIST Interim Smart Grid Interoperability Standards Roadmap.

- Demand Response
- Electric Storage
- Electric Transportation
- AMI Systems
- Distribution Grid Management

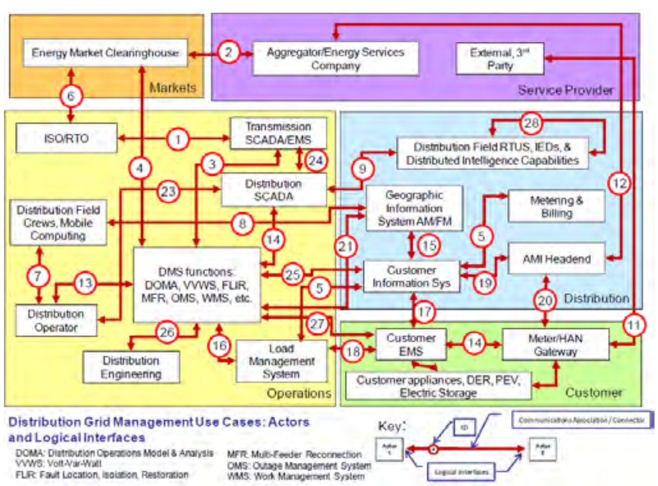
The SmartGrid demonstration will implement bulk power energy management, scheduling and market systems, enterprise systems, distribution network management system, substation, feeder and distribution automation systems, distributed resource and demand-side management systems, advanced metering infrastructure and customer-based energy management and behind-the-meter resources and loads. The proposed solution architecture follows the EPRI IntelliGrid Architecture [3] and GridWise Architectural Council [4] recommendations, as well as the NIST Interim Smart Grid Roadmap.

3.D.1.a) Systems Integration and Interoperability Design

As a member of EPRI's five-year Smart Grid demonstration project, our system integration and interoperability requirements definition and design will be coordinated through EPRI's formalized smart grid demonstration project. We will leverage EPRI's IntelliGrid[SM[2]] methodology to support the technical foundation for a smart power grid that links electricity with communications and computer control to achieve tremendous gains in reliability, capacity, and customer services. The IntelliGrid Architecture is an open-standards, requirements-based approach for integrating data networks and equipment that enables interoperability between products and systems. This methodology provides tools and recommendations for standards and technologies when implementing systems such as advanced metering, distribution automation, and demand response and also provides an independent, unbiased approach for testing technologies and vendor products.

Figure 9 provides a visual depiction of the interoperability and integration defined by the Distribution Grid Management use case EPRI developed for NIST.

Figure 9: Distribution Grid Management Use Case: Actors and Logical Interfaces



3.D.1.b) NIST SmartGrid Interoperability Standards Compliance

The development of the SmartGrid T&D infrastructure involves many standards and numerous levels of integration. One of the objectives of the proposed project is to demonstrate end-to-end interoperability using the following NIST identified "low-hanging fruit" interoperability standards.

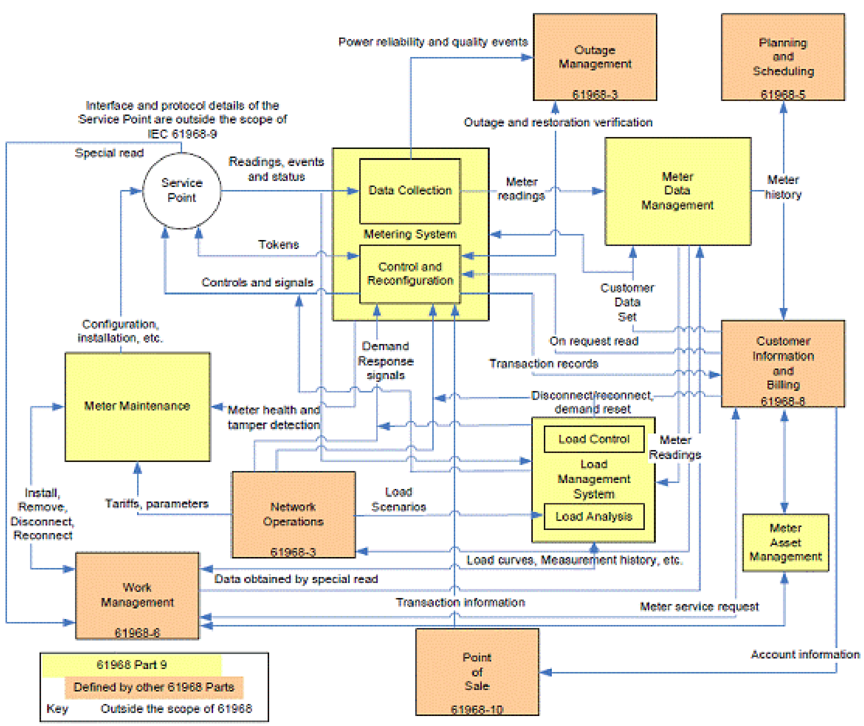
- IEC 61968-1[5] for general systems level application level interface architecture.
- IEC 61968-3[6]/61970[7] for application level interfaces with the DMS
- IEC 60870-6/TASE.2 (ICCP) [8] for real-time control center to control center communications
- IEC 61968-9[9] for application level interfaces with AMI, MDM, CIS, and DMS systems
- IEC 61850[10] for substation automation and communication with distributed resources
- DNP3.0/IP[11] for communication to DA devices over the FAN
- OpenADR[12] protocols for price responsive DR and direct load
- Open HAN[13] for Home Area Network device communication, measurement, and control
- Smart Energy Profile[14] protocol for Home Area Network (HAN) Device Communications

The Project Team will assess the applicability and the gaps of the NIST standards, and will adopt, and extend where necessary, these standards in this project. To the extent feasible, our project will coordinate our implementation efforts with NIST and the Standards Development Organizations acceleration efforts. A diagram of the interoperability components of the IEC 61968-9 NIST standard is shown in Figure 10.

3.D.1.c) Integration and Interoperability with Production Systems

Ideally the SmartGrid demonstration system to be deployed would be electronically isolated from all production systems. With the scope and magnitude of this regional demonstration that is impractical. While the deployed demonstrations systems will be highly integrated, they will have limited integration with production systems at KCP&L. Where the demonstration systems require integration with production systems they will be rigorously defined, tested and monitored. We currently anticipate the following integration points with production systems.

Figure 10: IEC61968-9 Reference Model



- CIS – Daily batch file transfer of billing data from MDM to support billing
- CIS – As-needed batch file transfer of outage incidents from MDM to support OMS
- EMS/SCADA – Establish substation communication controller rules that EMS/SCADA has control authority over existing devices. DMS only has monitoring capability for existing SCADA controlled devices.

3.D.2) Cyber Security

Securing the networked communications, intelligent equipment, and and information is critical to the operation of the future SmartGrid. Due to the complexity and far-reaching aspects of the SmartGrid, planning for physical and cyber security, in advance of deployment, is essential to provide a more complete and cost effective solution. Cyber security is an ever-evolving process and is not static. It takes continual work and education to continue to evolve security processes to keep up with increasing demands on the systems. Security will continue to be a race between corporate security policies/security infrastructure and hostile entities. By definition there are no systems that are 100% secure. There will always be residual risks that must be taken into account and managed.

3.D.2.a) SmartGrid Cyber Security Requirements Definition and Design

As a member of EPRI's five-year Smart Grid demonstration project, our cyber security requirements and design will be coordinated through EPRI's formalized Smart Grid demonstration project. Cyber security is a concept of EPRI's IntelliGrid℠ Architectures' strategic vision and we will leverage this methodology to support our technical approach on cyber security. Cyber security of advanced automation and consumer communications systems is one of the most important and challenging technical issues of our time. Increasing demand for information technology and reliance on advanced automation has created substantial challenges for system administrators as they try to keep their cyber systems secure from attack. Higher levels of integration across the industry and using open systems combine to raise the challenges of securing systems. Security policy implementation, a recommended practice, requires many of the concepts that architectures bring forward including system documentation, and structure. The IntelliGrid Architecture will support identification of impact and aid in the selection of the appropriate security service and technologies.

3.D.2.b) NIST SmartGrid Cyber Security Standards Compliance

The development of the SmartGrid T&D infrastructure will involve cyber security considerations in every aspect and phase of the project and will involve numerous standards at all levels of the IT and grid infrastructure. One of the objectives of the proposed project is to demonstrate end-to-end cyber security and incorporate the appropriate NIST identified "low-hanging fruit" standards. These will include:

- AMI-SEC[15] for AMI System Security Requirements
- NERC CIP 002-009[16] Cyber security standards for the bulk power system
- NIST SP800-53[17] and SP800-82[18] Cyber security standards and guidelines for federal information systems
- IEC 62351 Parts 1-8[19] for information security for power system control operations
- IEEE 1686-2007[20] for security for intelligent electronic devices (IEDs)

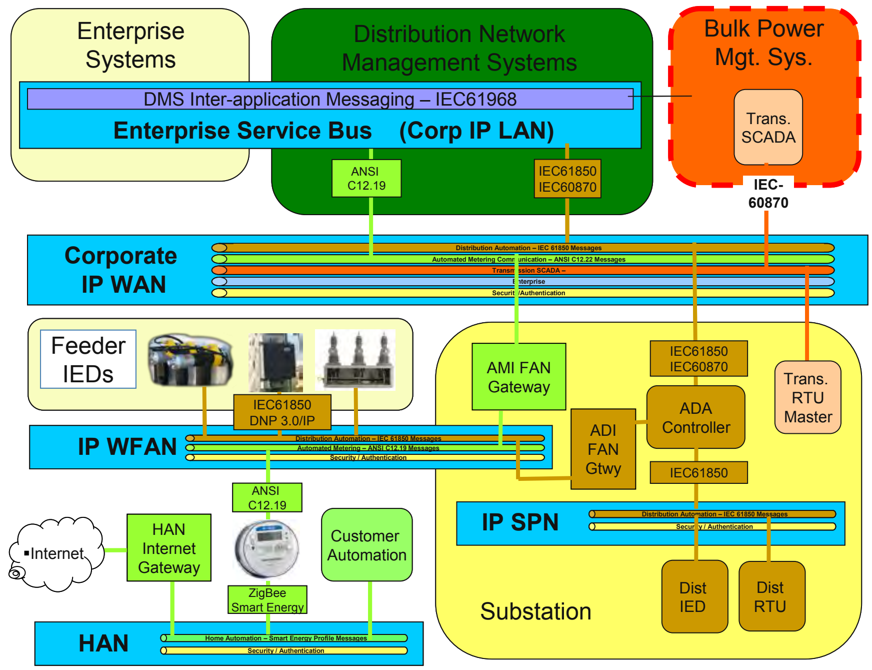
The Project Team will assess the applicability and the gaps of these and other standards, and will adopt, and augment where necessary, these standards in this project. To the extent feasible, our project will coordinate our implementation efforts with NIST and the Standards Development Organizations acceleration efforts.

3.D.2.c) SmartGrid Communications Network

The public Internet is a very powerful, all-pervasive medium. It can provide a very inexpensive means of exchanging information with a variety of other entities. The Internet is being used by some utilities for exchanging sensitive market information, retrieving power system data, and even issuing some control commands to generators. Although standard security measures, such as security certificates, are used, a number of vulnerabilities still exist.

KCP&L has chosen to implement the demonstration using private communications media wherever practical. By using the Corporate IT WAN and utility-owned FAN, the KCP&L SmartGrid system designs can still leverage the vast amount of research and development into Internet Protocols (IP) and technologies. They will just be implemented over a private intranet instead of the public Internet to minimize the exposure to cyber security attacks. The communications and information networks proposed to support the deployment of the Smart Grid demonstration project are depicted in Figure 11.

Figure 11: SmartGrid Demonstration Communications Network



The far-reaching and complex nature of the SmartGrid dictates that no single security policy can be developed to properly secure the SmartGrid. The hierarchical nature of the technologies that will be implemented to create the SmartGrid Communication Network, illustrated in Figure 11, provides for security ―check-points” between control and network layers that may have different security requirements. Therefore, it is a natural extension for the Security Architecture to be constructed around Security Domains.

A Security Domain represents a set of resources (e.g. network, computational, and physical) that share common security requirements and risk assessment. For example; within the 'bulk power system' there are two distinct Security Domains: NERC-CIP and NERC-nonCIP. While having different security requirements, all Security Domains will be secured and managed through a consistent set of security policies and processes. Secure connectivity, data encryption, firewall protection, intrusion detection, access logging, change control and the audit reports associated with these applications will likely be required for all SmartGrid security domains.

3.E. Data Collection, Management, and Presentation

Our Team will collect, organize, and deliver grid performance and customer consumption data throughout the duration of the SmartGrid demonstration project. In the early stages of the project, data will be collected to establish the baseline that will be used as a reference point for the analysis of the impacts of the project. The collected data will be with respect to key performance indicators for the project as indicated below and in the attached Project Management Plan. The key performance indicators will cover the following general categories:

- Impacts on system reliability
- Impacts on energy use and efficiency
- Impacts on the environment
- Impacts on system economics

During the course of the project, as new capabilities are implemented and rolled out, the same set of data will be collected that will be used to analyze the impacts of such capabilities. At the termination of the project, the collected data will be compared with the baseline data, analyzed and reports on the impacts of the project with respect to the key performance indicators will be generated.

3.E.1) Baseline Data Collection

In this task, a range of baseline data will be compiled and/or collected for the project area. This baseline data will be the basis for measuring the impact on grid performance, system efficiencies, and end-use consumption patterns achieved by the demonstrated technologies. KCP&L will collaborate with the DOE to determine the distribution feeder and customer data needed to support the DOE standardized cost-benefit analysis methodology.

- KCP&L has a large amount of historical feeder loading and performance data available for the Midtown demonstration area that has been recorded by the EMS/SCADA and OMS systems. KCP&L will compile and document baseline distribution feeder loading and customer performance statistics for a two-year baseline period.
- Data collected by the existing AMR system will be used to establish two years of historical baseline of customer consumption data that corresponds directly to the historical feeder loading and performance data. Due to limitations of the AMR system, only historical daily consumption information is available.
- KCP&L and L+G will implement and use new AMI SmartMeters to establish baseline daily usage patterns for all customers in the demonstration area. The data will include utility and key customer load data, and will serve as a baseline for comparing the performance of the total integrated configuration.

3.E.2) Project Data Collection

The project team will develop a grid monitoring and test plan for the two-year demonstration. The plan will address various modes of grid, DR and DER operation; validate key operating features of the distributed resources (e.g., stand-alone and parallel operation); validate the key operating and control features of the distributed-hierarchical grid control systems; and confirm the safe and reliable operation of the electric grid with integrated distributed resources. The monitoring plan will provide for compilation of the necessary data to measure improvements in grid efficiency, grid performance, reduced consumer energy consumption and demand reduction.

During the 24-month demonstration, our team will collect the detailed data in different operational modes, including normal and contingency switching configurations. Grid performance, consumption and meteorological data will be collected, compiled and analyzed for the project area. The following tables characterize the types of data that will be collected.

Table 1: Performance Measurement and Analytical Data

Type of Data	Use of Data
Project Performance Data	
Percentage and frequency of the population using the consumer portal	Success of outreach program
Percentage of DR participation vs. users opting out of DR	Success of outreach program
Estimates of energy saved / peaks shaved by our DR events	Overall SmartGrid program success
Number of users changing their behavior in response to price signals or other rate-based incentives	Overall SmartGrid program success
Others as identified in conjunction with DOE	
Grid Performance Data	
Substation Monthly O&M expenditures	Measure reduction in O&M expenditures
Circuit interval KW, KVAR, and KWHR	Correlate to end-use interval load data to calculate grid losses and efficiency statistics under various operating conditions
Outage Occurrence and Duration	Measure change in SAIDI & SAIFI
Transformer DGA and temperature	Possible avoidance of major outage
Others as identified in conjunction with DOE	
End-Use Performance Data	
Whole house 15 minute interval consumption	Customer usage patterns for may analysis

data	
Thermostat settings, schedules, and activity	
Circuit level 15 minute interval load data	Calculate grid efficiency
Average whole house consumption pre- or post-trials	Captured DR versus real DR
Real-Time Amps	Correlate with Environmental Data to calculate dynamic equipment ratings
Others as identified in conjunction with DOE	
Environmental Data	
Temperature	• Draw correlations between consumer energy consumption and environmental conditions • Further correlate this data to execution of DR events • Calculate equipment ratings based on real-time local conditions
Humidity	
Heating-degree days	
Cooling-degree days	
Solar Intensity	
Others as identified in conjunction with DOE	

This data will be compared against the baseline data to measure the impact on grid performance, system efficiencies, and end-use consumption patterns achieved by the demonstrated technologies. KCP&L will submit this data to the SmartGrid Information Clearinghouse.

3.E.3) Data Management

The amount of data being collected or capable of being collected by utilities will increase exponentially with the implementation of the Smart Grid. This rapid expansion of data management results from the fact that more field devices are being installed and that these field devices are becoming more "intelligent" both in what power system characteristics they can capture, and also in what calculations and algorithms they can execute which result in even more data. As distribution automation extends communications to devices on feeders; as substation automation expands the information available for retrieval by substation planners, protection engineers and maintenance personnel; and as more power system asset information is stored electronically in Geographical Information; even more varieties and volumes of data will need to be maintained and managed.

Data management is a complex issue, encompassing many aspects of data accuracy, acquisition and entry, storage and access, consistency across systems, analysis, maintenance, backup and logging, and security. KCP&L proposes to implement a MDM system to meet the data management requirements of the project and provide

- Scalable Meter Data Repository
- Validate, Estimate and Edit Interval and Hourly Data
- Meter Lifecycle Management and Service Orders and Work Flows
- Integration
- Advanced Analytics & Reports

3.E.4) Quantify SmartGrid Benefits

We will leverage expertise from EPRI to apply the DOE cost-benefit analysis (CBA) methodology. Additional CBA framework development and evaluation from EPRI will include evaluating SmartGrid investments for the purposes of ascertaining the value of technologies and systems. The CBA framework will devise a robust and universally applicable means for relating the functional capabilities of SmartGrid projects to specific benefits streams. A functional perspective is essential because many technology configurations can be used in a variety of ways. Specifying the role of a system's function provides a means for establishing how its operation reduces costs or produces more benefits compared to the technology it replaces, or both. In the case where the SmartGrid system or technology is an enhancement to the conventional system design, it is essential to indentify what additional benefits are anticipated.

Once the framework is developed and vetted, EPRI intends to develop protocols to identify, measure, and monetize the benefits attributable and costs associated with investments in resulting system. Benefits include avoided electricity sector capital and operating costs, improved reliability, cleaner air, less reliance on imports of primary energy products, and a contribution to the creation of a sustainably robust economy. The ultimate goal is to establish standards that will inform SmartGrid investment decision-making at all levels throughout the electric sector from technology developers to utilities and other public service entities to consumers, so that the full potential of the SmartGrid concept becomes a reality.

3.E.5) Data Delivery

As a member of EPRI‘s five-year SmartGrid demonstration project, our project data transfer activities will be coordinated through EPRI‘s formalized SmartGrid demonstration project. Specifically, EPRI will coordinate the sharing of field results, lessons learned, architectural challenges, issues impacting standards, key technology gaps, and useful tools to help interoperability of SmartGrid technologies and systems related to the project. Project data including scope, schedule, and results of the project will be supplied to the ―SmartGrid Information Clearinghouse."

3.E.6) Project Analysis and Data Collection Report

EPRI will assess the results of the demonstration program based on data gathered. Data from the demonstration project should characterize:

- Installation and configuration issues for infrastructure to support distributed resource integration
- Operational performance of the distributed resource integration technologies
- Operational performance of the communications infrastructure and protocols to support the distributed resource integration
- Information system integration issues for data collection, data management, and reporting on the distributed resource integration
- Market integration issues (innovative pricing programs, ancillary services, effect on spinning reserves, etc.)
- Security issues identified and solutions implemented for communications and information infrastructure to support the integration
- Customer response and customer preferences for demand response technologies, pricing, etc.

3.F. PUBLIC OUTREACH AND EDUCATION

KCP&L‘s SmartGrid initiative and associated partnerships in the Green Impact Zone create a tremendous opportunity for the region and nation to understand the power of efficiency and reinvestment in an urban setting. In addition to KCP&L‘s interaction with technical partners, this investment allows for enhanced interactions and collaboration between utilities, governments, businesses, neighborhood groups and others.

With the plentiful opportunities also come significant challenges to foster the community engagement needed to make this project the success it can be. The overall strategy KCP&L will employ includes many grassroots methods and non-traditional (at least from a utility perspective) communications options. The key to the strategy will be effective collaboration and partnership with established organizations in the Green Impact Zone, such as neighborhood groups, community development corporations, churches, the city and other governmental entities. Additional details on the strategy are outlined in this section.

Our Team‘s communications and community affairs professionals are experienced in executing business-to-business and business-to-consumer led generation campaigns of all sizes, using a wide array of communications tools. We will provide comprehensive end-to-end services to develop a campaign, including market analysis and segmentation, campaign strategy, planning, creative execution as well as management and lead tracking. Our Team‘s experience with other utility programs and best practices will play an important role in this effort.

KCP&L sees three primary education needs through this demonstration project: sharing information throughout the utility industry; educating and engaging the end recipients in the Green Impact Zone; and, educating the remainder of KCP&L‘s customer base about how SmartGrid investments will ultimately impact them.

3.F.1) SmartGrid Technology Transfer with Utility Industry

As a member of EPRI‘s five-year SmartGrid demonstration project, our technology transfer activities will be coordinated through EPRI‘s formalized SmartGrid demonstration project. Specifically, EPRI will coordinate the sharing of field results, lessons learned, architectural challenges, issues impacting standards, key technology gaps, and useful tools to help interoperability of SmartGrid technologies and systems related to the project. In addition, detailed project information will be communicated via EPRI‘s SmartGrid resource center (www.smartgrid.epri.com) and additional technology transfer activities including workshops, webcasts, and periodic publications. The workshops will include presentations on status of field demonstrations, lessons learned to date, architectural challenges, issues impacting standards, and common interest areas to explore. Technical summaries in the form of presentations and white papers/articles will be prepared for public dissemination. These publications will include a synthesis of contributions to standards bodies and common messages to deliver to industry and public entities such as state and federal agencies.

3.F.2) Green Impact Zone Partnership initiatives

We believe the proposed demonstration program is unique in that most SmartGrid demonstrations have focused primarily on relatively affluent, suburban or small town service areas. We propose this initiative to demonstrate specifically how it will work in an urban setting, understand benefits to individual customers and communities, and determine the parties that need to be involved and the nature of their involvement. To this end, KCP&L is teaming with a number of federal, state and local agencies, including, among others, U.S. Representative Emmanuel Cleaver (D-Missouri), the State of Missouri, local Kansas City government officials, and the Mid-America Regional Council to focus American Recovery and Reinvestment Act (ARRA) funding in an area of Kansas City known as the Green Impact Zone of Missouri. The Green Impact Zone consists of 150 inner-city blocks bordered by 39th Street on the north, 51st street on the south, Troost Avenue on the west and Prospect Avenue to 47th Street over to Swope Parkway on the east. This particular section of Kansas City has been devastated by the economic recession and suffers from high levels of unemployment, poverty, and crime.

The goal of the Green Impact Zone initiative is to demonstrate a focused effort by a number of partners and neighborhood organizations to achieve multiple interconnected goals, all of which center on improving a central-city, urban area to make it an attractive place to live and work. Despite its challenges, the Zone includes some substantial assets, including several strong neighborhood groups; community, cultural and health centers; and proximity to an important health sciences cluster and major roadways. To build on these assets and develop others, the Zone is pursuing a multi-faceted strategy— motivated by stimulus funding opportunities— around enhancing the area‘s sustainability, public safety, stabilization, housing conditions, access to jobs and services, and economic vitality. Efforts in the Green Impact Zone will focus on training and employing area residents to implement weatherization and energy efficiency programs to reduce utility bills, conserve electricity and create sustainable jobs.

Working with the city and other Green Impact Zone partners, KCP&L will invest in and deploy advanced generation, distribution and customer technologies and solutions to the Zone‘s electrical infrastructure. This ―SmartGrid" program will provide area businesses and residents with enhanced reliability and efficiency through real-time information about electricity supply and demand. It will also enable customers to manage their electricity use, and save money, by providing useful information about electricity prices. Finally a SmartGrid will enable renewable energy sources, such as solar and other parallel generation, to be located in the Zone and seamlessly feed into the energy grid. By developing an end-to-end solution rather than demonstrating specific components such as DMS or AMI technologies alone, KCP&L will be able to test and evaluate the solution's ability to achieve a complete suite of prospective SmartGrid benefits - greater energy efficiency, reduced cost, improved reliability, more transparent information and an improved environmental footprint.

To achieve our outreach and education goals, KCP&L will partner with community leaders to raise awareness of the company suite of energy efficiency related products and services. Through these partnerships we will broaden KCP&L community engagement by increasing our involvement and implementing solutions that help our customers reduce their energy consumption.

The demonstration area for SmartGrid will allow KCP&L to team with several key business partners in the surrounding areas. These partners may be able offer demographic information (UMKC), research (Stowers) and funding. We will also leverage our trade ally relationships to reduce the program, implementation and customer contribution costs.

KCP&L has formed a strategic alliance with the Mid America Regional Council (MARC), Brush Creek Community Partners, Congressman Cleaver's organization and many others to coordinate efforts in the Green Impact Zone that will ultimately achieve project goals. KCP&L will participate in outreach programs under the direction of MARC's Coordinating Council to ensure consistency and to avoid redundancies.

The customer demographics of the Green Impact Zone make it necessary to develop a non-traditional marketing/outreach approach to reach customers where they seek information with a message that resonates. Our initial communication plan for the customer outreach and education in the Green Impact Zone is included in the Project Management Plan. It is incumbent upon KCP&L to provide educational opportunities for the rest of its customer base. With the industry working toward most sustainable options, a large number of KCP&L customers are very interested in the progression of energy services. Investments in SmartGrid in the Green Impact Zone provide KCP&L the opportunity to speak authoritatively about the benefits and challenges in this arena. KCP&L will use the opportunity to provide periodic updates in bill inserts, on its web site and through various media outlets and public forums to educate customers about the SmartGrid experience.

4. MERIT REVIEW & CRITERIA DISCUSSION

4.A. PROJECT APPROACH

4.A.1) Comprehensiveness and completeness of the Statement of Project Objectives (SOPO) that describes the proposed interrelated tasks and of the Project Management Plan that includes a schedule with milestones and explains how the project will be managed to achieve objectives on time and within budget

The Company has established an aggressive, yet achievable SmartGrid Demonstration project organized into five phases. These phases along with specific tasks and their associated deliverables are thoroughly described in the Statement of Project Objectives (SOPO) below and in the Project Management Plan (see attached ―pmp.pdf"), which is attached in a separate file to this Application. This plan was developed by the KCP&L SmartGrid Demonstration project team along with the assistance of experienced KCP&L managers and strategic partner experts. This plan is explicitly linked, project by project, to the Project Budget and will be funded in accordance with the Project Funding Profile.

The SmartGrid Demonstration is organized into five distinct, yet interrelated phases, which align with the DOE's expectation with regard to approval stages, operations and reporting. These five stages were specifically designed to manage the SmartGrid Demonstration deployment in the most expeditious and cost-effective manner possible over the expected project time frame.

The SmartGrid demonstration architecture will evolve over time as additional applications, requirements, and technologies evolve. Throughout the execution of the Demonstration, the Company will access the capabilities of industry resources and associates such as EPRI as well as the expertise, capabilities and planning resources of its strategic partners..

4.A.2) Completeness of the proposed demonstration approach to effectively address each of the goals of the SmartGrid Demonstration Initiative.

The SmartGrid Demonstration has been explicitly designed to be a complete end-to-end SmartGrid demonstration program in a geographically defined area of Kansas City. By focusing on the circuits and distribution feeders surrounding its Midtown Substation, the Company will be able to assess the potential benefits of a SmartGrid solution from SmartGeneration through to SmartEnd-Use in a regionally unique, controlled ―laboratory" environment. The goals of this demonstration are in sync with those of the SmartGrid Demonstration Initiative – to quantify SmartGrid costs, benefits and cost-effectiveness as well as verify SmartGrid technology viability, and validate new SmartGrid business models, at a scale that can be readily adapted and replicated around the country. Each of these goals in the context of KCP&L's demonstration is addressed below:

- Quantify SmartGrid costs, benefits and cost-effectiveness**:** A key objective in our SmartGrid Demonstration will be to quantify the costs and benefits of each of our solutions separately and as a complete solution. The Demonstration is designed as a regionally unique effort to display the benefits of single initiatives and the overall synergies and interrelations that can occur as a result of building complete programs. In our budgeting process, we have defined the operating and capital costs of each of the initiatives along with an estimate of potential benefits. These benefits include operational, economic, customer and environmental improvements. Where possible, specific, quantifiable methodologies were developed to translate benefit metrics into potential monetary value. For the overall solution, additional program management costs were included and synergistic benefits were estimated. These costs and benefits will be periodically evaluated during the Demonstration as part of the required DOE reporting process. Additionally, where possible, we will quantify the cost-effectiveness of the technology solutions developed for the demonstration vs. existing and / or alternative technologies and solutions to determine the cost-effectiveness of our demonstration vs. existing and emerging alternatives.
- Verify SmartGrid technology viability: As part of the Demonstration, we are implementing a number of new and emerging technologies and combining and integrating both new and existing technologies in unique ways to form an end-to-end solution. Such technologies include the installation of DCADA/SmartSubstation components, the integration of DER and DR Management systems, the addition of a complete DMS system, an AMI system implementation along with associated smart meters and Field Area Network (FAN), and Smart Home devices including DR thermostats and residential and commercial EMS. Each of these technologies will be tested against anticipated net benefits and their ability to generate sufficient savings or other benefits to justify their cost of implementation and use. Each of these systems will be evaluated separately and as part of a complete solution to determine their most optimal use and application, either as separate systems or as part of the more holistic demonstration.
- Validate new SmartGrid business models: A key reason we designed the Demonstration as an end-to-end solution from SmartGeneration through SmartEnd-Use is to test and evaluate the potential for a variety of business models. For example, with SmartGeneration applications such as roof-top solar, we will test the viability and practicality of eventual customer-owned generation assets and capabilities with the potential to sell excess capacity back to the grid. The Company expects to test this concept in other DER applications as well such as parallel generation and potential PHEV vehicle-to-grid applications.

4.A.3) Adequacy of the proposed demonstration approach to quantifiably advance program metrics.

The SmartGrid Demonstration has been specifically designed to address as many program metrics as possible. The complete solution approach to the SmartGrid Demonstration will allow KCP&L to evaluate, test and report on the program's effect on a wide variety of metrics, including economic (e.g. T&D system losses, % of MWh served by DG), reliability and power quality (e.g. SAIFI, SAIDI, CAIDI, MAIFI), and environmental (% of MWh served by renewables, % of feeder peak load served by renewables). This testing process will be further enabled by focusing on one substation for which substantial historical data already exists. Prior to receiving approval for Final Design and Construction, we will establish a formal baseline of all metrics to be measured.

4.A.4) Validity of the proposed approach and likelihood of success based on current technology maturity and regulatory / stakeholder acceptance of the technology. Innovativeness of the project, including introduction of new technologies and creative applications of new and state-of-the-practice SmartGrid technologies

Our Project Team seeks to demonstrate the value of using SmartGrid technology and communications to manage distributed energy resources within a utility's service territory. In particular, we are targeting edge of grid resources using a comprehensive SmartGrid platform in order to integrate and manage distributed grid assets. In developing the scope, objectives and approach for this project, KCP&L explicitly balanced the inclusion of widely accepted technologies with new and emerging concepts and approaches. We also evaluated innovative combinations and applications of best of breed technologies rather than single solutions or the implementation of single vendor platforms.

The goal of the Demonstration is to design, develop, and deploy a next generation end-to-end (or top-to-bottom) distribution grid management infrastructure, which will be based on distributed-hierarchical control concepts, an emerging technology. Our approach is centered on the upgrade of our Midtown Substation, an existing urban substation, to create a next-generation Smart Substation with IEC-61850 communication protocols and control processors to implement distributed, unattended control with automated ―ifst responder" monitoring and control functions. Ten distribution circuits served by the Midtown Substation will be upgraded with a variety of feeder based monitoring and control IED to evaluate the impact of a variety of Advanced Distribution Automation (ADA) functions and leading edge smart customer initiatives will provide consumers with enhanced information regarding energy use and cost. Finally, SmartGeneration initiatives including emerging photo-voltaic solar technologies and PHEV charging stations and vehicles will be implemented to test the potential for distributed generation and innovative business models. Each of these initiatives utilizes some combination of existing and accepted technologies combined with emerging technologies, protocols or systems. In addition, we believe the combination of best of breed technologies and the unique application of these technologies in an end-to-end, regionally-defined urban application is unique and could serve as an urban renewal blueprint for future applications.

4.A.5) Appropriateness and completeness of the demonstration plan including performance objectives of the demonstration, the criteria and requirements used in selecting demonstration site(s), the data collection and evaluation plan, the metrics for success, and the measurements that will be made to confirm success. Adequacy and completeness of the proposed approach in delivering demonstration project data and information to the SmartGrid Clearinghouse, the DOE and the public.

KCP&L has a rich history of performance data in the region and has begun work on establishing a set of baseline parameters on the economic, operational and environmental performance metrics to be reviewed. As we prepare for the execution of the demonstration, a preliminary performance and cost model will be developed to define a baseline case for this project. A complete range of baseline data will be collected by individual project teams and across projects as defined in the project plan. This will include both operational/performance (reliability, usage, etc.) and financial (cost to serve, rates, etc.) information. This baseline data will be the basis for measuring the impact on grid performance, system efficiencies, and end-use consumption patterns achieved by the demonstrated technologies. KCP&L will collaborate with the DOE to determine the distribution feeder and customer data needed to support the DOE standardized cost benefit analysis methodology.

The defined site for the project – the Company's Midtown substation along with multiple circuits served by the substation – will provide a very efficient testing and demonstration environment. The Company has served this area for many years and has a rich history of data for the region as well as the capabilities to collect and report data to the SmartGrid Clearinghouse on a regular basis. The final demonstration solution will be compared with this baseline case to measure the benefits of the approach and quantify performance relative to expectations.

The project team will develop a grid monitoring and test plan for the two-year demonstration. The plan will address various modes of grid, DR, and DER, operation; validate key operating features of the distributed resources (e.g., stand-alone and parallel operation); validate the key operating and control features of the distributed-hierarchical grid control systems; and confirm the safe and reliable operation of the electric grid with integrated distributed resources. The monitoring plan will provide for compilation of the necessary data to measure improvements in grid efficiency, grid performance, reduced consumer energy consumption and demand reduction.

During the 24 month demonstration, our team will collect the detailed data in different operational modes, including normal and contingency switching configurations. Both grid performance and consumption data will be collected, compiled and analyzed for the project area (see page ___ for detailed examples of the type of data to be collected and utilized to demonstrate project success). This data will be compared against the baseline data to measure the impact on grid performance, system efficiencies, and end-use consumption patterns achieved by the demonstrated technologies.

As a member of EPRI's five-year SmartGrid demonstration project, our project data transfer activities will be coordinated through EPRI's formalized SmartGrid demonstration project. Specifically, EPRI will coordinate the sharing of field results, lessons learned, architectural challenges, issues impacting standards, key technology gaps, and useful tools to help interoperability of SmartGrid technologies and systems related to the project. Project data including scope, schedule, and results of the project will be supplied to the ―SmartGrid Information Clearinghouse."

4.A.6) Suitability and availability of the proposed project site(s) to meet the overall program objectives for scope and scale appropriate for the technology(ies) being demonstrated.

As noted above, the Demonstration Area is an ideal project site for this type of demonstration as it consists of 10 circuits served by one substation across 2 square miles with approximately 14,000 customers comprising both commercial and residential customers with a broad array of demographics, income levels and energy usage and needs. Since this area is explicitly defined and served by one substation, it can provide the ideal ―laboratory" environment from which to demonstrate and test program results.

Part of the Demonstration Area also contains the Green Impact Zone, a wider urban revitalization project designed as a means to use Federal funds to redevelop an urban core. Key to this redevelopment is the provision of a modern energy infrastructure. The Green Impact Zone has significant political and community support which will provide the catalyst for high customer engagement to better demonstrate our integrated view of the SmartGrid.

4.A.7) Adequacy of plans for data collection and analysis of project costs and benefits, including the following aspects:

- **Thoroughness of the discussion of data requirements (including what types of data and their availability) and how that data will be provided to the DOE so that project costs and benefits can be properly analyzed**
- **Logic and completeness of the discussion of how the data can be used by the DOE to develop estimates of project costs and benefits, including the discussion of the Applicant's quantified estimates of project benefits**
- **Comprehensiveness of the plan for determining the baseline against which the costs and benefits will be assessed**

A range of baseline data will be collected by individual project teams and across projects as defined in the Project Management Plan. This will include both operational / performance (e.g. reliability, usage, etc.) and financial (cost to serve, rates, etc.) information. As much as possible, we will include metrics that not only show monetary benefits, but also progress on demonstrating SmartGrid ―characteristics" as defined in the FOA. Based on historical data on our performance in the Demonstration Area, a preliminary performance and cost model will be developed to define a baseline case for this project. The final demonstration solution will be compared with this baseline case to measure the benefits of the approach and quantify performance relative to expectations.

The Company intends to provide a variety of data to the SmartGrid Clearinghouse using the DOE's cost-benefit analysis methodology or an approach that is very similar and provides the input data required for the DOE to evaluate project success along a wide variety of metrics. The Company plans to actively track and measure a complete set of performance data at regular intervals and report results to the DOE versus the project baseline.

4.A.8) The degree of the proposed estimates of project benefits

KCP&L expects this demonstration to show significant improvements in monetary benefits and the progress of the Demonstration Area toward exhibiting SmartGrid characteristics. This information is not all-inclusive and the estimates will be further refined and quantified over the next few months and will be formalized with the DOE after Notice of Award and prior to the Operational Readiness Review Approval. Specific benefits, sources, metrics and potential degree of impact are shown below:

4.B. SIGNIFICANCE & IMPACT

4.B.1) Significance of the proposed demonstration application vs. current practices – Completeness of this assessment to consider benefits in terms of anticipated performance improvements (technical, operational, and environmental aspects) and the cost savings of the proposed application over current practices

This Demonstration effort is designed as a means to test and evaluate a potential step change improvement in KCP&L's electricity distribution system. Specifically, we are designing a system with a communication architecture that will facilitate automated system monitoring and control with open systems that will allow the integration of technologies and components from multiple vendors in a ―best-of-breed" solution along with a new electrical architecture and protection system that will enable an interoperable, secure network of components.

We expect this Demonstration to display significant performance improvements as a result of the technologies and solutions considered. Substation and distributed feeder line automation systems can significantly reduce O&M costs, improve reliability and enhance the environmental footprint through automated fault location detection, automated switch operation, improved voltage control and regulation, improved Outage Management System communications, enabled two-way end-user communication and information flow and the integration of distributed energy resources, allowing for a greater role of renewable energy generation into grid operations.

4.B.2) Degree to which the demonstration project is broadly applicable and adaptable throughout the region or the nation, including the completeness and adequacy of the deployment plan for large-scale deployment in and/or beyond the proposed region

As noted above and throughout this Narrative, the Demonstration Area is a self contained distribution network anchored by KCP&L's Midtown Substation within the Green Impact Zone. The Demonstration will design, deploy, test and report on the implementation of a complete end-to-end SmartGrid system within multiple circuits served by the Midtown Substation over a 2 square mile area with approximately 14,000 commercial and residential customers. Both the commercial and residential customer base is very diverse with large public institutions such as the University of Missouri at Kansas City and the Midwest Research Center as well as a residential population from virtually all demographics and income groups.

By designing this Demonstration as a complete end-to-end SmartGrid research and testing project in a geographically defined area, the Company has effectively designed a demonstration program that could either be scaled up as a large scale SmartGrid ―Investment" program or deployed in different urban areas of the United States. It is truly a transferable and scalable solution.

4.B.3) Adequacy and impact of the public outreach and education plan on public acceptance of SmartGrid transformation

In order to promote this Demonstration in the Green Impact Zone and the Demonstration area in general, we have worked with our partners to design a comprehensive marketing, education and training program. In addition, as part of the Demonstration, we have designed a number of end-use programs.. In order to demonstrate the full value of these programs, KCP&L has developed both a business-to-business and business-to-consumer marketing and education campaign.

KCP&L will serve as the primary point-of-contact for our Demonstration Partners and will manage and coordinate all resources required, including KCP&L marketing and customer service professionals and third-party service providers (i.e., advertising agency, call center and printer). KCP&L will also work with our Demonstration Partners' marketing teams to create a highly targeted customer enrollment program that achieves goals and meets brand objectives and preferences for interacting with customers.

For more information and description of the Company's public outreach and education plan, please see Section 3 (Project Description) above.

4.B.4) Completeness of the proposed commercialization strategy for the technology(ies) being demonstrated

In designing this demonstration, KCP&L's initial goals are similar to those under this Application – to quantify SmartGrid costs, benefits and cost-effectiveness, verify SmartGrid technology viability, and validate new SmartGrid business models, at a scale that can be readily adapted and replicated around the country. We have explicitly incorporated the advanced digital technologies that support the SmartGrid Regional Demonstration Initiative, as described under section 1304 (b) (2) (A)–(E) of the Energy Independence and Security Act (EISA) of 2007. As such, we believe that this is a demonstration project and not a commercial endeavor. However, certain solutions that are developed as part of this demonstration could be commercialized in the future, particularly by our strategic partners, and also may become readily transferrable and applied as use cases for national implementation and replication.

4.B.5) Extent to which demonstration advances research and demonstration objectives of the program

The SmartGrid Demonstration is explicitly designed to advance the research and demonstration objectives of the SmartGrid Demonstration Initiative. Specifically, we have developed a proposed

SmartGrid architecture that employs and integrates emerging technologies being developed for use in the planning and operations of the electric power system. Such technologies include microprocessor-based measurement and control, advanced two-way communications, and next generation computing and information systems. These systems (e.g. electronic substation relays, DA automation circuits, electronic capacitor controls, communicating faulted circuit indicators, voltage monitors and two-way communication devices throughout the distribution test area) will be combined in a unique and innovative manner to enable distribution automation and facilitate the integration of end-use and SmartGeneration add-ons to form a self contained complete "SmartGrid". This regional "laboratory" will serve as a research and demonstration site for the explicit testing of these advanced technologies as specified under the EISA.

4.B.6) Viability and practicality of the proposed technology to meet the needs of the target market in a cost effective manner.

The SmartGrid Demonstration is explicitly designed to advance the research and demonstration objectives of the SmartGrid Demonstration Initiative. Specifically, we have developed a proposed SmartGrid architecture that employs and integrates emerging technologies being developed for use in the planning and operations of the electric power system. Such technologies include microprocessor-based measurement and control, advanced two-way communications, and next generation computing and information systems. These systems (e.g. electronic substation relays, DA automation circuits, electronic capacitor controls, communicating faulted circuit indicators, voltage monitors and two-way communication devices throughout the distribution test area) will be combined in a unique and innovative manner to enable distribution automation and facilitate the integration of end-use and SmartGeneration add-ons to form a self contained complete "SmartGrid". This regional "laboratory" will serve as a research and demonstration site for the explicit testing of these advanced technologies as specified under the EISA.

4.C. INTEROPERABILITY & CYBER SECURITY

4.C.1) Adequacy and completeness of approach to address interoperability, including the description of the automation component interfaces (devices and systems), how integration is supported to achieve interoperability, and how interoperability concerns will be addressed throughout all phases of the engineering lifecycle, including design, acquisition, implementation, integration, test, deployment, operations, maintenance and upgrade

KCP&L fully understands that one of DOE's SmartGrid priorities is to use its work with NIST and FERC on a framework for interoperability standards. KCP&L has been an active participant in the development of the NIST SmartGrid Interoperability Standards Roadmap and believes that this SmartGrid Demonstration provides an ideal opportunity to field test the interoperability standards.

The SmartGrid Demonstration project is based on an integrated end-to-end solution that demonstrates interoperability of key Smart Grid components and will provide a commercial application for five (5) SmartGrid use cases – Demand Response, Electric Storage, Electric Transportation, AMI Systems, and Distribution Grid Management – that form the basis of the proposed NIST' Interim Smart Grid Interoperability Standards Roadmap.

The SmartGrid Demonstration will implement bulk power energy management, scheduling and market systems, enterprise systems, distribution network management system, substation, feeder and distribution automation systems, distributed resource and demand-side management systems, advanced metering infrastructure and customer-based energy management and behind-the-meter resources and loads. We will leverage EPRI's IntelliGrid℠ methodology to support the technical foundation for a smart power grid that links electricity with communications and computer control to achieve tremendous gains in reliability, capacity, and customer services. The IntelliGrid Architecture is an open-standards, requirements-based approach for integrating data networks and equipment that enables interoperability between products and systems. This methodology provides tools and recommendations for standards and technologies when implementing systems such as advanced metering, distribution automation, and demand response and also provides an independent, unbiased approach for testing technologies and vendor products.

The Project Team will assess the applicability and the gaps of the NIST standards, and will adopt, and extend where necessary, these standards in this project. To the extent feasible, our project will coordinate our implementation efforts with NIST and the Standards Development Organizations acceleration efforts.

4.C.2) Adequacy and completeness of approach for cyber security concerns and protections and how they will be addressed throughout the project, including the adequacy of the discussion of the integration of the new SmartGrid application into the existing environment, and how any new cyber security vulnerabilities will be mitigated through technology or other measures.

Securing the networked communications, intelligent equipment, and information is critical to the operation of the future SmartGrid. Due to the complexity and far reaching aspects of the SmartGrid, planning for physical and cyber security, in advance of deployment, is essential to provide a more complete and cost effective solution.

As a member of EPRI‘s five-year Smart Grid demonstration project, our cyber security requirements and design will be coordinated through EPRI‘s formalized smart grid demonstration project. KCP&L intends to leverage EPRI‘s IntelliGrid[SM] Architectures‘ strategic vision to support our technical approach on cyber security.

The development of the SmartGrid T&D infrastructure will involve cyber security considerations in every aspect and phase of the project and also numerous standards at all levels of the IT and grid infrastructure. One of the objectives of the proposed project is to demonstrate end-to-end cyber security and incorporate the appropriate NIST identified "low-hanging fruit" standards. The Project Team will assess the applicability and the gaps of these and other standards, and will adopt, and augment where necessary, these standards in this project. To the extent feasible, our project will coordinate our implementation efforts with NIST and the Standards Development Organizations acceleration efforts.

KCP&L has also chosen to implement the demonstration using private communications media wherever practical. By using the Corporate IT WAN and utility owned FAN, the KCP&L SmartGrid system designs can still leverage the vast amount of research and development into Internet Protocols (IP) and technologies. They will just be implemented over a private Intranet instead of the public Internet to minimize the exposure to cyber security attacks.

The far reaching and complex nature of the SmartGrid dictates that no-single security policy can be developed to properly secure the SmartGrid. The hierarchical nature of the technologies that will be implemented to create the SmartGrid Communication Network provides for security ―check-points" between control and network layers that may have different security requirements. Therefore, it is a natural extension for the Security Architecture to be constructed around Security Domains.

These Security Domain represent a set of resources (e.g. network, computational, and physical) that share a common security requirements and risk assessment. For example; within the 'bulk power system' there are two distinct Security Domains: NERC-CIP and NERC-nonCIP. While having different security requirements, all Security Domains will be secured and managed through a consistent set of security policies and processes. Secure connectivity, data encryption, firewall protection, intrusion detection, access logging, change control and the audit reports associated with these applications will likely be required for all SmartGrid security domains.

4.D. PROJECT TEAM

4.D.1) Completeness and qualifications of the proposed project team, with defined roles and responsibilities for each team member and with appropriate members committed to the demonstration or technology verification

The implementation of the Smart Grid Demonstration will be executed using a disciplined Program Management methodology and approach. This approach will involve a coordinated effort between program management, leadership, cross functional, and individual project areas. The Smart Grid Demonstration leadership will be comprised of a Program Management Director from KCP&L, various KCP&L subject matter experts, members of a Partner Leadership Team and members of the KCP&L Executive Advisory Team.

Each cross functional and individual project area will have an assigned Project Area Lead that reports to the Program Management Director. Each program will be required to utilize a disciplined project management approach to provide integration into the overall program management responsibilities and deliverables. The Program Management Director will provide project management requirements, guidance, oversight, and have overall responsibility for the direction and performance of the project. The Program Management Director and Project Area Leads will provide periodic updates to the Partner Leadership Team and KCP&L Executive Advisory Team. The primary role of the Program Management Director is to:

- Provide overall day-to-day leadership, including determining project priorities, setting meeting and project discussion agendas, determining roles and responsibilities and managing the overall Project Management Plan
- Provide overall quality control oversight and manage the activities of various Partner and internal KCP&L project teams

The primary role of the Partner Leadership Team is to:

- Guide and provide leadership on the technical and process aspects of the project, including the selection and review of results of pilot technologies, and the conduct of the project meeting future energy industry needs; and
- Ensure that the project‘s vision is brought to bear through the collaboration of the projects partners and stakeholders.

The primary role of the KCP&L Executive Advisory Team is to:

- Provide overall leadership to the project and assumes primary responsibility for the project to assure project budget, resources are available and supporting project scope and vision, and
- Periodically review project risk plan, project milestones, and quality of project deliverables to assure project performance.

4.D.2) Demonstrated level of corporate commitment to the proposed project and proposed cost share as evidenced by letters of intent from all proposed team members

KCP&L and its strategic partner team have each provided a substantial commitment to the proposed project. KCP&L has provided a cash commitment of approximately $___ million over the next five (5) years to develop and implement the SmartGrid Demonstration. KCP&L has also committed extensive executive, engineering, marketing, customer service, IT and other resource time to the project.

Additionally, the strategic partner group has provided substantial ―in-kind" project contributions in the form of discounted services, labor and equipment. Altogether total in-kind partner contributions and investments total $___ and represent approximately ___% of total project value. Many of the partners will also commit significant senior project management and subject matter expertise, both from the dedicated resources shown above as well as from other individuals within their organizations. These resources have worked and will continue to collaborate with KCP&L in determining project direction, goals, timelines and overall project management services

Each of the proposed partner contributions is outlined in the letters of commitment letters attached to this Application.

4.D.3) Demonstrated level of corporate commitment to commercialization of the proposed technology by providing convincing examples of the Applicant's efforts to commercialize the technology in addition to the proposed project

As noted throughout this Narrative, the SmartGrid Demonstration is a regionally-focused, complete effort to demonstrate, test and report on the feasibility of combining, integrating and applying existing and emerging SmartGrid technologies into one holistic solution and to demonstrate, measure, and report on the costs, benefits, and business model viability of the demonstrated solution. The SmartGrid Demonstration is explicitly designed as complete, stand-alone best-of-breed solution that can be replicated in other geographies or scaled up to service a larger distribution territory. Hence, we expect that there will be several potential commercial applications resulting from our efforts.

While we are initially focused on demonstrating the net benefits and advancement of SmartGrid characteristics resulting from the solution, we will work with our partners to advance and commercialize any potential technologies that could arise from the Demonstration. To that end, we have engaged with strategic partners who will play critical roles in developing such applications and solutions and expect to negotiate specific commercial terms and conditions with them after this Application filing and / or Notice of Award. A component of such terms and conditions will address the mechanisms and procedures whereby KCP&L will work its partners and other specific entities to ensure the technologies have the greatest potential impact on SmartGrid development and their associated net benefits are realized by as many industry participants and stakeholders as possible.

5. RELEVANCE AND OUTCOMES / IMPACTS

5.A. Relevance

KCP&L's Green Impact Zone SmartGrid Demonstration initiative is a collaborative effort by all parties focused on addressing prevalent challenges with integrating distributed resources in grid and market operations as well as in system planning. Multiple demonstration components will be designed and implemented to address the variety of barriers and incompatibilities associated with the integration of distributed resources (e.g., local storage, demand response, distributed generation, renewable resource, and grid management) into system operations. These barriers include lack of appropriate technical operations and decision-aiding models, insufficient communication and control infrastructure, incompatible market and pricing structures, and the lack of interoperability standards. The project will demonstrate a variety of approaches for overcoming these barriers and identify appropriate standards and best practices for distributed resource integration.

Electric utilities around the world are assessing the technical issues and the related benefits and costs of modernizing the grid. Many are already investing in the communication and information infrastructure that is expected to be the backbone of the SmartGrid. These infrastructures will require tens of billions of dollars of capital investment in equipment and new technologies. Investors and regulators want to know if the investments will be a technical and financial success. Customers want to understand if benefits will justify the costs that may ultimately be borne by them as ratepayers. Our project contributes to addressing these concerns by leveraging the investments in communication infrastructure to demonstrate effective integration of multiple components and systems.

The scope of the demonstrations encompasses numerous SmartGrid network component, grid management and control systems, and distributed resources that operate together including:

- AMI - Advanced Metering Infrastructure including RF mesh FAN providing IP based AMI and ADA field communications
- MDM – Meter Data Management for management and analysis energy consumption patterns.
- DMS – Distribution Management System with D-SCADA and OMS functions
- ESB – Enterprise Service Bus providing IEC61968 integration for all distribution management systems components
- SA – Distribution Substation Automation with IEC61850 protocols and advanced IEDs
- ADA – Advanced Distribution Automation with automated "first responder" monitoring and control functions with substation DCADA controller.
- Adopting distributed, hierarchical control methods between DCADA, DMS, and DERM
- DERM – Distributed Energy Resource (DR/DER) Management system that interoperates with DMS, MDM
- DER – A variety of utility managed DER components will be integrated including DVC, DR thermostats, roof-top solar, grid-connected battery, and conversion of stand-by to parallel generation.
- DSM- A variety of consumer demand side management technologies will be integrated including In-home Display, EMS-Web Portal, HAN, experimental TOU rates, PHEV charge management and critical peak signals.

Enabling widespread penetration of SmartGrid systems and technologies in support of grid operations requires overcoming prevalent integration barriers. Integration barriers range from technical and economic to institutional and customer-driven barriers. Technical barriers relate to lack of infrastructure, accepted standards and processes/protocols to aggregate and automate distributed resources in a fashion that meets system operator requirements. The requirements themselves need to be carefully defined to achieve system operator confidence in relying on distributed resources on the one hand, yet not overly burden the demand-side and thereby discourage aggregation and demand-side participation. Economic type barriers include establishing justification for integration costs and designing retail incentive structures to incent sufficient response from distributed resources in support of grid needs. Institutional barriers surround the need to better connect wholesale with retail electricity markets and to bridge organizational silos to better achieve end-to-end integration, from wholesale to retail markets and down to end-use.

The Smart Grid project will demonstrate a variety of approaches for overcoming these barriers and identify appropriate standards and best practices for distributed resource integration. Lack of standards and associated high integration costs are prevalent challenges in enabling widespread penetration of distributed resources. Other challenges include lack of appropriate decision-aiding models, insufficient communication and control infrastructure, incompatible market and pricing structures, and the lack of interoperability standards. EPRI's IntelliGrid methodology will be applied to identify approaches for interoperability and integration. Methods, processes, and technologies will be researched, developed, and applied to demonstrate and measure project effectiveness in overcoming integration barriers.

5.B. OUTCOME/IMPACTS

The primary outcome/impact of the SmartGrid Demonstration project will be multifaceted:

- (a) When combined the individual project components will implement and demonstrate a next-generation, end-to-end SmartGrid that will include Distributed Energy Resources, enhanced customer facing technologies, and a distributed-hierarchical control system of a significant regional distribution grid serving 14,000 customers, the Kansas City Green Impact Zone, and UMKC with 69.5 MVA demand.
- (b) Demonstration, measurement, and reporting on the costs, benefits, and business model feasibility of the demonstrated solution. The project will demonstrate certain operational, economic, consumer, and environmental benefits that can be enabled by single SmartGrid technologies and further

enhanced by integrated solutions as proposed for this demonstration.

- Our project will use existing and emerging integration technologies and standards for implementing the T&D SmartGrid Infrastructure. By applying NIST identified SmartGrid interoperability, the project can help NIST and relevant SDOs identify issues and gaps associated with the standards (e.g., common object models, communications interfaces, etc.). This effort is focused on an accelerated timetable for the development of a standards development roadmap and a process for getting standards for interoperability in place as rapidly as possible.

In addition to the above specific Smart Grid metrics and impacts, the project will demonstrate the following key capabilities:

5.C. SmartGrid Metrics

The following table lists the relevant SmartGrid statistics that have been established by the DOE to measure the progress SmartGrid adoption and what will be demonstrated and or quantified by our project related to each of these statistics

Table 2: DOE SmartGrid Statistics

Relevance and Outcomes/Impacts	What will be demonstrated
Transmission and Distribution Infrastructure	
• D.3.1 - T&D system reliability: duration and frequency of power outages	• Using DR/DER capabilities to relieve load on distribution equipment and facilities
	• Utilizing DR/DER for balancing variable generation (solar PV), e.g., dispatching the proposed 1MW storage capability.
	• Provision of ancillary services from demand-side DR/DER • DMS real-time information and model will be used to track SAIDI/SAIFI and provide before/after comparison using 12 months of data for demonstrating the magnitude of improvements.
• D.3.2 - T&D automation: percentage of substations using automation	• Rate of feeders automated for the selected substation will be measured as a model for further deployment.
• D.3.3 - Advanced meters: percentage of total demand served by advanced metered customers	• The ability for the substation and control center to track and manage demand based on improved load models and Distribution Network Management will be measured/assessed per feeder.
• D.3.5 - Capacity factors: yearly average and peak-generation capacity factor	• By utilizing DR/DER including storage, the project will be able to flatten the Load Factor and thus improve the capacity factors of the generating resources serving the load.
• D.3.6 - Generation and T&D efficiencies: energy conversion efficiency of electricity generation, and electricity T&D efficiency	• Line losses will be optimized through better monitoring and management of feeder/circuit Voltage/VAr and phase balances. This will be achieved in part through scheduling and dispatch of DR/DER on distribution circuits.

• D.3.7 - Dynamic line ratings: percentage miles of transmission circuits being operated under dynamic line ratings	Dynamic line/facility rating will be demonstrated on distribution feeders through monitoring of the equipment loading and environmental conditions.
• D.3.8 - Power quality: percentage of customer complaints related to power quality issues (e.g., flicker), excluding outages	• PQ will be improved through proper planning, deployment, interconnection and operation of distributed energy resources (DER)
Information Networks and Finance	
• D.4.2 - Open architecture/standards: Interoperability Maturity Level – the weighted average maturity level of interoperability realized between electricity system stakeholders	• Interoperability between DMS and DR/DER Management using IEC 61968/61970 application integration & IEC 60870/TASE.2 (ICCP) communications
	• Integration of DR/DER Management with AMI system using applicable IEC 61968/61970 protocols
	• Adaptation and extensions of IEC 61850-7-420 for interfaces and management of DER
	• Adaptation and demonstration of NERC CIP and applicable AMI SEC cyber security for DR/DER management
	• Integration
	• Adaptation and extensions of the Open ADR protocols for demand response.
Interoperability:	• Demonstrates an end-to-end interoperable solution that supports a general architecture with product component options. The number, type and system level of interoperable applications and devices communicating through standard protocols to achieve the defined solution functionality will be measured as the project progresses. This will be expressed as a number and a percentage of total components within the proposed project.
Cyber Security:	• Demonstrates an end-to-end solution that extends cyber security methodology and protection to ensure required security
Distributed energy resources technology	
• D.2.1 - Load participating based on grid conditions: fraction of load served by interruptible loads, utility-directed load control, and incentive-based, consumer-directed load control	• This will be extensively demonstrated through the implementation of the DR programs in the Green Impact Zone, including utility-directed load control, incentive-based and customer-directed load control
• D.2.2 - Load served by microgrids: fraction of entire load served by microgrids	• The project will assess microgrid potential in the Green Impact Zone including self-sustainable building with local generation/storage.

• D2.3 - Grid-connected distributed generation (renewable and non-renewable) and storage: percentage of all generation capacity that is distributed generation and storage	• The demonstration project will include both renewable (solar PV) and non-renewable (customer distributed generation) resources. Also included will be a 1MW Feeder level storage capability.
• D.2.4 - EVs and PHEVs: percentage shares of on-road, light-duty vehicles comprised of EVs and PHEVs	• The demonstration project will include a representative set of PEVs and PHEV Charging stations. These capabilities will be fully integrated with the proposed solution in a scalable manner. The demonstration will include all aspects of managing the charging process, tracking the state of charge, monitoring the distribution network loading, as well as assessing the utilization of the PEV storage capability for grid support.
• 2.2.5 - Grid-responsive, non-generating, demand-side equipment: total load served by smart, grid-responsive equipment (smart appliances, industrial/commercial equipment including motors and drivers)	• The project will include integration of HAN based devices as well as in-home displays. Also included are integration of commercial/industrial customer demand-side resources and on-site energy management systems.

6. ROLE OF PARTICIPANTS

KCP&L has developed a ‗distributed' solution partnership model – rather than working with a limited number of end-to-end SmartGrid solution providers, working with a set of best-in-breed partners. The vision for the SmartGrid Demonstration is to bring these partners and their capabilities together to develop leading edge, scalable SmartGrid solutions. In selecting partners, KCP&L has partnered with leading companies with either U.S. headquarters or significant operations in the country.

To further the cause of SmartGrid technology development, partners who have agreed to contribute in-kin to the effort have been classified and treated as ‗strategic partners'. In addition to these strategic partners, KCP&L will work closely with selected vendors to ensure a successful deployment of the demonstration. These strategic partners and vendors are shown in Figure 12 and described below.

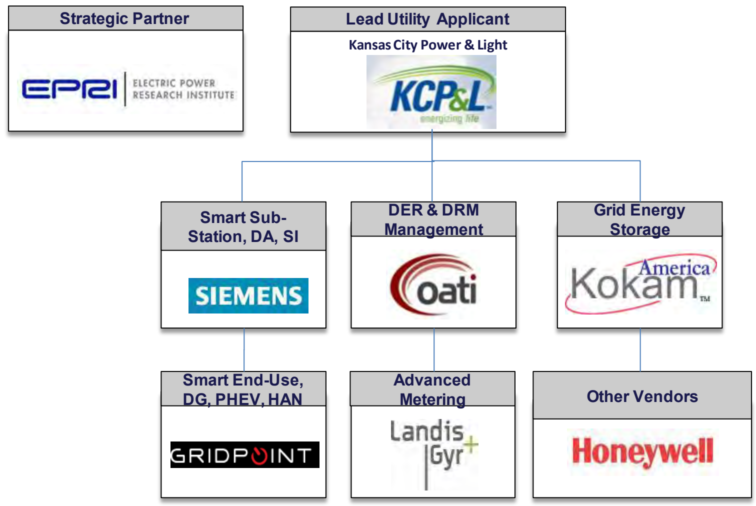
6.A. Kansas City Power & Light Company (KCP&L)

KCP&L has a long history of being a progressive industry leader in the area of distribution automation. These long standing efforts are evident in KCP&L's Tier-1 standing in reliability performance when KCP&L was named the most reliable electric utility nationwide and awarded the 2007 and 2008 Reliability One™ National Reliability Excellence Award by the PA Consulting Group.

Since 2001, EPRI has managed a collaborative research, development, and demonstration process that has accelerated the industry's migration towards a SmartGrid. KCP&L has been an active funder and participant in this RD&D effort. KCP&L has leveraged EPRI's extensive work in developing a SmartGrid vision and roadmaps for other utilities in developing the SmartGrid Architecture Vision for KCP&L.

In this application, KCP&L is the lead (and only) utility that is leading the SmartGrid Demonstration effort.

Figure 12: Selected Strategic Partners and Vendors



6.B. SubAwardees

6.B.1) Siemens

Siemens' is a multi-billion dollar provider of products and services whose experience spans the entire energy network, including generation, transmission, distribution, and the market. We focus on reliable, efficient, and practical innovation and implementation in each segment. For KCP&L we focus on the automation of the distribution network, Smart Substation controllers, and integration with Distribution SCADA, full Distribution Management System (DMS) capabilities as well as integration with the existing Geographic Information System (GIS), Advanced Metering Infrastructures (AMI), Meter Data Management Systems (MDMS), Distributed Energy Resource Management (DERM) Systems, and Demand Response Management (DRM) Systems.

Siemens extensive expertise, experience, and leadership in the energy industry directly correspond to SmartGrid advancements. Overall, Siemens has embraced the SmartGrid paradigm shift and is dedicating significant resources to create lasting products and solutions for its customers.

6.B.2) OATI

Open Access Technology International (OATI) Inc. has been serving the Energy Industry since 1995 and has had steady growth since its inception and currently has more than 400 staff members. Today, the privately owned OATI, headquartered in Minneapolis, Minnesota with branch offices in San Mateo, California, and Houston, Texas, provides innovative solutions and services to the electric and gas industry to meet challenges in energy scheduling, trading, and risk management; transmission reservations, scheduling, and congestion management; compliance monitoring. In addition, OATI offers a variety of products under its web SmartEnergy suites of applications which are modular solutions to address the requirements for the emerging SmartGrid. OATI web SmartEnergy products include software and services for Demand Response and Distribution Resources Management, Renewable Management, and Asset Management

6.C. Contractors & Vendors

6.C.1) Electric Power Research Institute (EPRI)

EPRI conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent more than 90 percent of the electricity generated and delivered in the United States, and international participation extends to 40 countries.

The EPRI will provide technical expertise and advice on defined portions of the project. In addition, we are a member of the five-year EPRI SmartGrid Demonstration Initiative, which is focused on SmartGrid projects that integrate distributed energy resources (www.smartgrid.epri.com). One of the main objectives of this initiative is to identify approaches for interoperability and integration that can be used on a system-wide scale to help standardize the use of DER as part of overall system operations and control. As part of this Initiative, EPRI will support this project in several areas including, but not limited to cost-benefit analysis efforts, use case documentation per the IntelliGrid methodology, data analysis and benefits estimation, CO2 impact assessment and technology transfer.

6.C.2) Intergraph

Intergraph provides a suite of electric industry specific solutions to address work design, network asset management, outage management, and integrated mobile work force management. The foundational component, a Geographic Information System (GIS) is a comprehensive, enterprise-capable, network asset infrastructure management platform that houses a connected data model of the entire energy network or communications infrastructure. This project will leverage an existing Intergraph (GIS) model in the development of the proposed advanced grid monitoring and control environment.

6.C.3) Landis+Gyr

Landis+Gyr has over 100 years of history in the energy space, including 60 years of direct load management expertise and 25 years of smart metering innovation. It is also a leader in integrated energy management solutions, with a commitment to improving energy efficiency and environmental conservation. L&G operates in more than 30 countries on all five continents, having over 15 million endpoints actively managed in long-term contracts

6.C.4) GridPoint

GridPoint will provide a residential Energy Resource Management (ERM) and Home Area Network (HAN) platform to grid which will provide energy consumers and utilities an intelligent network of distributed energy resources that can control load, store energy and produce power. The platform aggregates distributed energy resources and provides consumer and utility control through a single Web-based interface, thereby providing the equivalent performance of central station generation.

6.C.5) Kokam America

Kokam America, will leverage existing lithium polymer battery technology development and manufacturing expertise to develop and deploy a grid-scale energy storage system to supply peak-shaving, demand-management, and Micro-Grid restoration capabilities to the KCP&L grid. The installation will function as a part of a larger Distribution Management System, controlled remotely and programmed to function automatically in conjunction with other SmartGrid components.

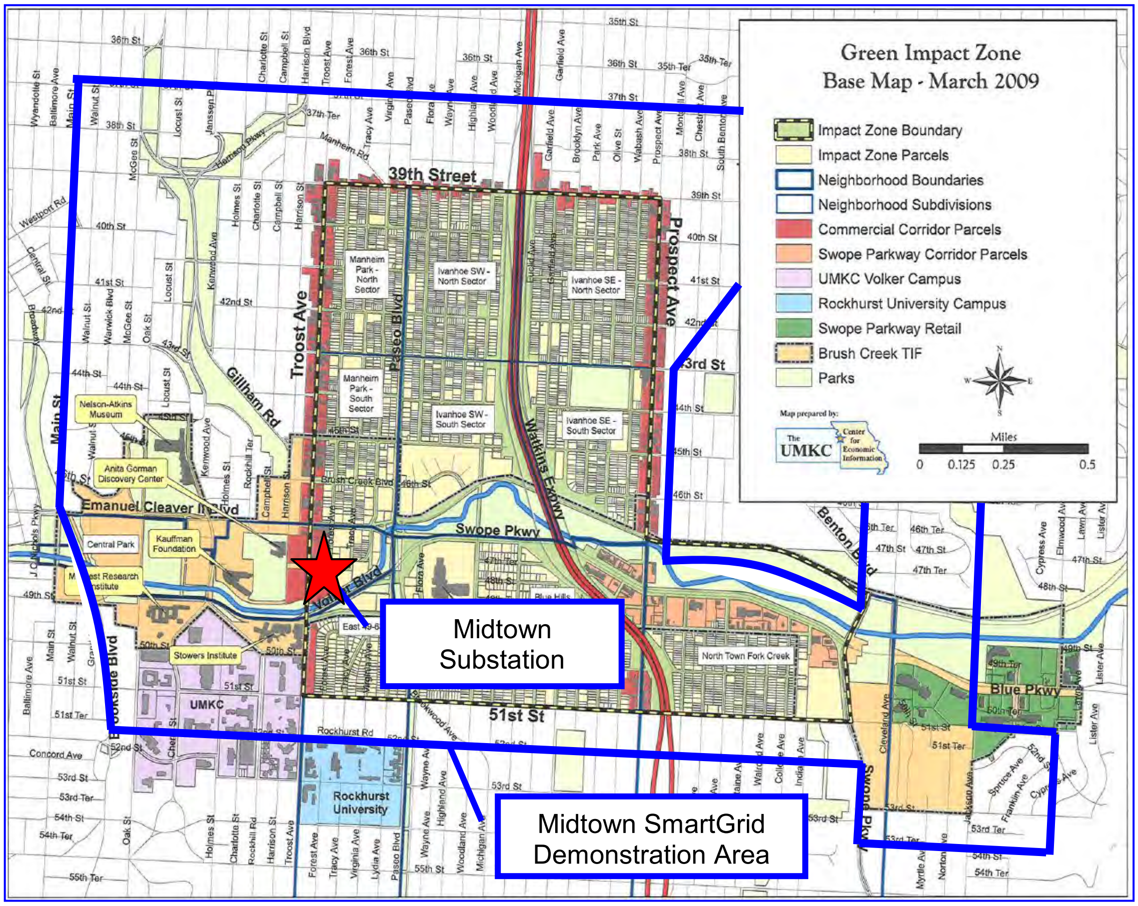
6.C.6) Honeywell

Honeywell will provide a ZigBee-enabled programmable communicating thermostat that will be used for executing demand response events and controlling peak system load. The thermostats will be installed in residential and small commercial applications. Honeywell will also provide field installation services, coordinating the receipt of applications, setting appointments, coordinating vendors and installing thermostats, home area networks and in-home displays.

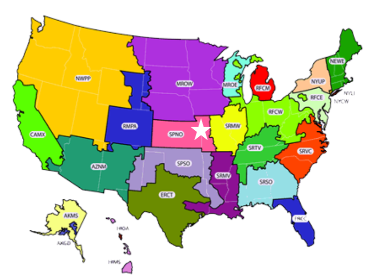
7. PROJECT PERFORMANCE SITE

7.A. Primary Work Location

The proposed site for the proposed SmartGrid Demonstration Project is the KCP&L Midtown Substation and the immediately surrounding distribution circuits. The following graphic depicts the geographic location of the SmartGrid Demonstration Project and its relationship to the Kansas City Green Impact Zone.



- NERC Regional Entity: Southwest Power Pool
- eGrid Subregion: SPNO
- Latitude, Longitude: 94:34:16.689, 39:02:21.292
- Street Address of Substation:
  1223 E, 48th Street, Kansas City, MO, 64112-1312
  Corner of 48th and Tracey, 2 blocks East of Troost
- The proposed demonstration location is within the Kansas City urban core and is bounded by Main Street on the West; Swope Parkway on the East; 37th Street on the North and 52nd Street on the South.



- The Midtown Substation is conveniently located with easy access from Troost Ave and the new Climate Sustainability Center is planned for the property adjacent to the substation. Additionally UMKC and Rockhurst campuses are within a few blocks of the substation.

7.B. Additional KCP&L Work Locations

KCP&L will provide project engineering and administrative services from the following company offices located in metropolitan Kansas City, Mo.

- Corporate Headquarters Office – 1201 Walnut, Kansas, City MO, 64106-2124
- T&D Engineering Office – 4400 E. Front St. Kansas City, MO, 64120-1039
- T&D Operations Dispatch Center – 801 Charlotte, Kansas City, MO, 64106-3032

7.C. SubAwardee Work Locations

7.C.1) Siemens Energy, Inc.

Siemens will provide technical project support and administrative services from their company offices at the following locations:

- Orlando Facility - 4400 Alafaya Trail, Orlando FL 32826-2399
- Minnetonka Facility - 10900 Wayzata Boulevard, Suite 400,Minnetonka, MN 55305-1534
- Wendell Facility - 7000 Siemens Road, Wendell, North Carolina 27591-8309

7.C.2) Open Access Technologies, Inc. (OATI)

OATI will provide technical project support and administrative services from their company offices at the following locations:

- Corporate Office – 2300 Berkshire Lane North, Minneapolis, MN 55441-4540

7.D. Consultant, Vendor, and Contractor Work Locations

7.D.1) Electric Power Research Institute (EPRI)

EPRI will provide technical project support and administrative services from their company offices at the following locations:

- Knoxville Office - 942 Corridor Park Blvd, Knoxville, TN 37932-3723

7.D.2) Landis+Gyr

L+G will provide technical project support and administrative services from their company offices at the following locations:

- Network Operations Center - 11146 Thompson Ave., Lenexa, KS 66219-2301 CD-KS-003

7.D.3) Intergraph Corporation

Intergraph will provide software implementation service, technical project support and administrative services from their company offices at the following location:

- CG&I Division Office – 170 Graphics Drive, Madison, AL 35758, USA CD-AL005

7.D.4) GridPoint, Inc.

GridPoint will provide software development, technical project support and administrative services from their company offices at the following locations:

- Operations Office – 2801 Clarendon Blvd., Suite 100, Arlington VA, 22201 CD-VA008

8. STATEMENT OF PROJECT OBJECTIVES

TITLE OF WORK TO BE PERFORMED

KANSAS CITY GREEN IMPACT ZONE –
SMARTSUBSTATION & SMARTGRID DEMONSTRATION

PROGRAM AREA OF INTEREST

SMARTGRID REGIONAL DEMONSTRATIONS
TRANSMISSION AND DISTRIBUTION (T&D) INFRASTRUCTURE

8.A. PROJECT OBJECTIVES

Working with the City of Kansas City, Green Impact Zone participants and its solution partners, KCP&L will invest in and deploy an end-to-end SmartGrid that will included advanced generation, distribution and customer technologies and solutions to the Demonstration Area's electrical infrastructure. This ―SmartGrid" demonstration project will provide area businesses and residents with enhanced reliability and efficiency through real-time information about electricity supply and demand. It will also enable customers to manage their electricity use, and save money, by providing useful information about electricity prices. Co-located renewable energy sources, such as solar and other parallel generation, will be placed in the Demonstration Area and seamlessly feed into the energy grid. By developing an end-to-end solution rather than demonstrating specific components such as DMS or AMI technologies alone, KCP&L will be able to test and evaluate the solution's ability to achieve a complete suite of prospective SmartGrid benefits - greater energy efficiency, reduced cost, improved reliability, more transparent information and an improved environmental footprint. To this end, KCP&L is proposing to implement an innovative demonstration project through five project phases, each with the following objectives:

Phase 1 – Project Definition and NEPA Compliance objective will be to refine project scope, definition and ongoing project management.

Phase 2 – Project Performance Baseline objective is be to compile and/or collect baseline grid and end-use data for the demonstration area.

Phase 3 – T&D SmartGrid Infrastructure Deployment objective is to implement the SmartSubstation, DMS and Advanced Distribution Automation components.

Phase 4 – Distributed Energy Resource Deployment objective will be to implement the SmartEnd-Use, SmartGeneration, and DER/DR Management components.

Phase 5 – Data Collection, Reporting & Project Conclusion objective is to operate the integrated end-to-end SmartGrid demonstration systems and collect 24 months of grid and end-use data.

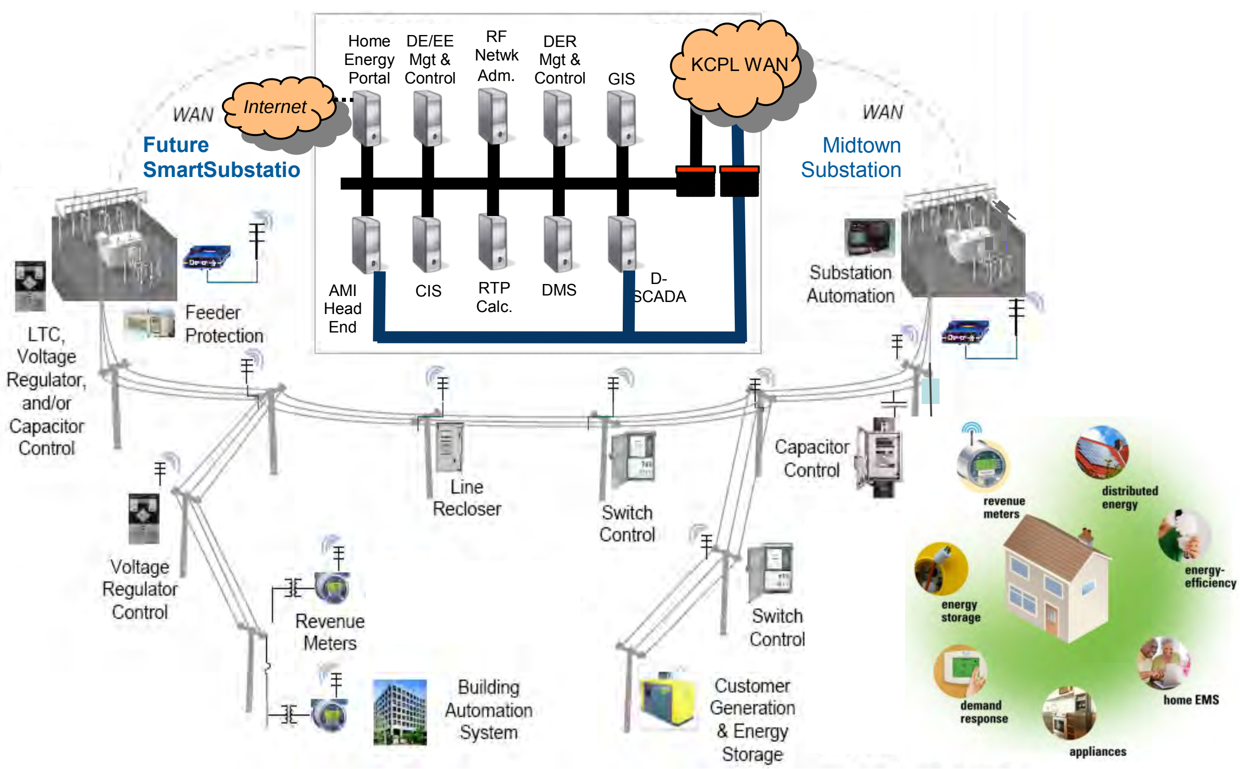
8.B. PROJECT SCOPE (SCOPE OF WORK)

The SmartGrid Demonstration will focus on the Company's Midtown Substation and multiple distribution circuits serving approximately 14,000 customers across 3.75 square miles with total demand of up to approximately 69.5 MVA. Our scope of work, illustrated in Figure 13, will touch every functional area of the electricity supply chain, including:

- SmartGeneration: KCP&L will work with select partners to demonstrate and test renewable energy and distributed generation sources such as rooftop solar, distribution voltage reduction, demand response, stand-by to parallel generation conversion and through a separate grant application, large scale energy storage. Each of the sources will be developed in such a way as to provide benefits to an underserved population while enabling KCP&L and other key stakeholders to better understand and demonstrate the technologies, business models, and prices required to further commercialize the concepts. A Distributed Energy Resource Management (DERM) system will be developed and implemented to manage these resources and provide the needed resource availability to the DMS and energy trading operators.

- SmartSubstation: KCP&L will replace and augment existing electro-mechanical relays with state-of-the-art solid state relays and install numerous other upgrades to the Midtown Substation that will enhance the operating performance, reliability and productivity of this asset. The SmartSubstation will be based on the latest NIST Interoperability Framework Standards; incorporate a high-speed IEC61850 compliant substation LAN; and incorporate leading edge Open Standard IT Network Technologies to ensure accurate operation and the appropriate level of cyber security. The SmartSubstation will implement a Distributed Control and Data Acquisition (DCADA) system through peer-to-peer device communications and enable ―ifst responder" device control operations.
- SmartDistribution: To extend the SmartGrid functionality beyond the SmartSubstation, KCP&L will deploy a 2-way AMI system, a Distribution Management System (DMS) and Advanced Distribution Automation (ADA) components and functionality on selected feeders. The SmartDistribution component will implement a distributed, hierarchical system monitoring and control infrastructure. The DMS will coordinate with the SmartSubstation DCADA system to perform centralized operations monitoring and control functions and will be electronically isolated from the production EMS/SCADA and OMS systems. The AMI communication infrastructure will establish 2-way communication between distribution line devices and the DMS and the SmartSubstation DCADA processors. The ADA component will deploy distributed automation solutions to enable more effective grid monitoring and automated voltage control and self repair functionality. The upgrades to the substation and the surrounding distribution network will also lay the foundation to incorporate the renewable generation solutions and enable new and innovative end-user programs and solutions.

Figure 13: Proposed Solution



- SmartEnd-Use: The key to demonstrating the viability of the wider SmartGrid is developing solutions that will enable end-users to change their energy consumption behavior for the positive. Several Smart Home/Building technologies will be deployed to demonstrate and test several methods of consumer energy usage information communication; several levels of energy management sophistication, and grid operation integration. The systems and technologies deployed will be based on the NIST SmartGrid Interoperability Framework and Standards. It is KCP&L vision that multiple paths will be needed to meet the wide variety of customer expectation. The AMI meter based HAN gateway will provide rudimentary connectivity for all customers. KCP&L will provide additional programs, and tariffs that will be designed to test different dimensions of each solution. The goal will be to identify the most effective solutions that can deliver the hoped for savings in terms of consumption, efficiency and cost. A diagram of the proposed solution is shown in Figure 13 below:

8.C. Tasks to be Performed

As noted above, the proposed project is organized into five phases. In Phase 1, we will further develop our project approach, install a formal project management structure and ensure we meet NEPA compliance requirements. In Phase 2, implementation of the AMI solution will take place, which will be foundational to gather baseline information around operational and financial performance of the network area covered by the SmartGrid demonstration. In Phase 3, we will deploy the T&D SmartGrid infrastructure components, including building our SmartSubstation implementing the ADA capabilities. Phase 4 is focused on deployment of DER applications such as SmartGeneration components, end-user incentive programs and the DERM systems implementation. Phase 5 will involve the actual operation, testing and demonstration of the solution and is expected to last approximately two years from mid 2012 to mid 2014. Specific tasks and milestones associated with each phase are discussed below:

Figure 14: Demonstration Project Phases

Phase	Task Name	2010				2011				2012				2013				2014			
		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
PHASE 1	**Project Definition and NEPA Compliance**																				
Task 1.0	Update PMP for SmartGrid Demonstration																				
Task 2.0	National Environmental Protection Act (NEPA) Compliance																				
Task 3.0	SmartMetering Implementation																				
Task 4.0	Project Management, Administration & Reporting																				
PHASE 2	**Project Performance Baseline**																				
Task 5.0	Project Integration Architecture Definition & Design																				
Task 6.0	Public Outreach and Education Planning																				
Task 7.0	Performance Baseline Data Collection																				
PHASE 3	**T&D Smart Grid Infrastructure Deployment**																				
Task 8.0	SmartSubstation Implementation																				
Task 9.0	Distribution SmartGrid ADA Implementation																				
PHASE 4	**Distributed Energy Resource Deployment**																				
Task 10.0	Smart EndUse Implementation																				
Task 11.0	Smart Generation Deployment																				
Task 12.0	Smart DER/DR Management Implementation																				
PHASE V	**Commissioning & Operations**																				
Task 13.0	Integrated System Operational Test & Demonstration																				
Task 14.0	Operate Integrated Solution																				
Task 15.0	Program Data Collection																				

8.C.1) Phase I – Project Initiation and NEPA Compliance

Task 1.0 – Update Project Management Plan (PMP)

After Notice of Award, the KCP&L SmartGrid Program Management Office (PMO) will meet with the NETL Project Officer and staff to review the proposed PMP. As a result of these discussions and negotiation, the PMP will be revised and a baseline PMP will be created to reflect the details from the contract negotiation process with the vendors, updates on risk management plans, resource plans and related items. The updated PMP will be submitted to DOE within 60 days of the Notice of Award.

Task 2.0 – National Environmental Protection Act (NEPA) Compliance

In reviewing the NEPA Compliance Checklist, KCP&L believes that the DOE will determine that our project qualifies for Categorical Exclusion under the NEPA regulations. If, however, the DOE determines that the proposed project requires an Environmental Assessment (EA) or Environmental Impact Statement (EIS), KCP&L will work with the DOE to complete the NEPA process including performing further assessment, evaluation, analyses, and documentation to complete the EA or EIS. If needed, KCP&L will work with any assigned 3rd party contractor as prescribed by the DOE.

Decision Point 1 – Project Management Plan and NEPA Compliance Review (go/no-go decision point): Approval to proceed with Project Detail Design & Performance Baseline. (Tasks 4, 5, 6 & 7)

Task 3.0 – SmartMetering Implementation

The task includes the complete design, implementation and testing of the 2-way AMI system for the demonstration area. The AMI system vendor will be responsible for continuing to provide billing and outage information to existing production systems.

Task 3.1 – Design, Construct, & Test AMI Field Area Network
Task 3.2 – Deploy AMI SmartMeters
Task 3.3 – Implement & Test Production Billing & Outage Interfaces
Task 3.4 – Commission SmartMeter Subsystem
Task 3.5 – SmartMetering Implementation Report

Task 4.0 – Project Management, Administration, and Reporting

The Project Management Office (PMO) will be centrally responsible for the management and delivery of the SmartGrid demonstration project and the PMO tasks will be ongoing through the length of the demonstration. The following tasks will be discussed more fully in Section E below and in the Project Management Plan. (pmp.pdf)

Task 4.1 – Maintain Project Management Plan
Task 4.2 – Semi-Annual Project Review Meetings
Task 4.3 – Semi-Annual PMP Updates
Task 4.4 – DOE Peer Reviews & Reasonableness Review
Task 4.5 – Project Administration
Task 4.6 – Periodic Reporting
Task 4.7 – Topical Reporting
Task 4.8 – Technical Presentations
Task 4.9 – Final Project Technical Report
Task 4.10- Project Wrap-Up & Final Project Reporting

8.C.2) Phase II – Project Performance Baseline

Task 5.0 –Project Integration Architecture Definition & Design

In this task, the requirements for the SmartGrid Demonstration will be further defined and finalized. It will include finalizing the functional, IT, and business requirements and the data collection and reporting requirements to support the DOE SmartGrid cost benefit analysis.

Task 5.1 – Project Definition and Objectives Review and Refinement
Task 5.2 – Apply IntelliGrid Methodology for Use Case and Requirements Development
Task 5.3 – Data Collection Requirements and Data Reporting Review and Refinement
Task 5.4 – Integration Requirement Review & Refinement
Task 5.5 – Cyber Security Requirement Review & Refinement
Task 5.6 – Project Integration Architecture & Design Document

Task 6.0 – Public Outreach and Education Planning

KCP&L's marketing professionals will collaborate with our Demonstration Partners to create a highly targeted public outreach, education, and customer enrollment program that achieves program goals and meets brand objectives and preferences for interacting with customers.

Task 6.1 – Coordinate with MARC and other Green Impact Zone Participants
Task 6.2 – Refine Public Outreach and Education Plan
Task 6.3 – Develop Public Outreach and Education Materials
Task 6.4 – Develop Project Specific Web Site
Task 6.5 – Public Outreach and Education Implementation Report

Decision Point 2 – Detailed Design and Baseline Performance (go/no-go decision point): Approval to proceed with Performance Baseline Data Collection (7ask 7.0) and Phase 3 & 4 Deployments

Task 7.0 – Performance Baseline Data Collection

In this task, a range of baseline data will be collected by individual project teams and across projects as defined in the project plan. This will include both operational/performance (reliability, usage, etc.) and financial (cost to serve, rates, etc.) information. A preliminary performance and cost model will be developed to define a baseline case for this project. The final demonstration solution will be compared with this baseline case to measure the benefits of the approach and quantify performance relative to expectations.

Task 7.1 – Compile Historical System Performance Statistics
Task 7.2 – Collect Consumer Interval Usage Data
Task 7.3 – Compile Consumer Interval Usage Statistics
Task 7.4 – Baseline Data Collection Report

Decision Point 3 – Baseline Data Gathering Complete (go/no-go decision point): Approval to proceed with SmartGrid component testing

8.C.3) Phase 3 - T&D SmartGrid Infrastructure Deployment

Task 8.0 – SmartSubstation Implementation

In this task, KCP&L will replace and augment existing electro-mechanical relays with state-of-the-art solid state relays, install transformer monitors and numerous other upgrades to the Midtown Substation that will greatly improve the reliability and productivity of this asset. In addition, it also involves installing the local substation controller to provide local monitoring and control of substation IEDs.

Task 8.1 – Design, Construct, & Test Substation IEC61850 Local Area Network
Task 8.2 – Interface Substation LAN to EMS/SCADA System via Legacy Protocols
Task 8.3 – Convert Electromechanical Relays to Microprocessor IEDs
Task 8.4 – Implement & Test Distributed Control and Data Acquisition (DCADA) Controller
Task 8.5 – Commission SmartSubstation
Task 8.6 – SmartSubstation Implementation Report

Task 9.0 – Distribution SmartGrid ADA Implementation

In this task, KCP&L will deploy a Distribution Management System (DMS), install Advanced Distribution Automation (ADA) components and implement ‗first responder' monitoring and control functions on selected feeders. This will involve the substation controller communicating in a coordinated manner with the central DMS and with ADA devices over a RF Field Area Network (FAN).

Task 9.1 – Design, Implement & Test the Distribution Management System (DMS)
Task 9.2 – Design, Construct, & Test Advanced Distribution Automation FAN
Task 9.3 – Design, Construct & Test the ADA Distribution Line Devices
Task 9.4 – Design, Implement & Test the ADA Functions on DCADA Substation Controller

Task 9.5 – Commission SmartGrid ADA Subsystem
Task 9.6 – SmartGrid ADA Implementation Report

8.C.4) Phase 4 - Distributed Energy Resource Deployment

Task 10.0 – SmartEnd-Use Implementation

In this task, several SmartEnd-Use technologies will be deployed to demonstrate and evaluate several methods of communicating end-use consumption and control of consumer based DER, thus enabling customers to manage their electric usage more effectively.

Task 10.1 – Design, Build, Test, & Deploy the AccountLink Interval Data Display
Task 10.2 – Design, Build, Test, & Deploy the In-Home Display Device
Task 10.3 – Design and Implement Green Impact Zone TOU Tariffs
Task 10.4 – Design, Build, Test, & Deploy the Home EMS Web Portal
Task 10.5 – Design, Build, Test, & Deploy the Commercial EMS
Task 10.6 – Design, Build, Test, & Deploy Public PHEV Charging Stations
Task 10.7 – SmartEnd-Use Implementation Report

Task 11.0 - SmartGeneration Deployment

In this task, KCP&L will work with select partners to install, demonstrate and test utility controlled renewable energy and distributed generation resources.

Task 11.1 – Design & Deploy Grid Connected Roof-Top Solar
Task 11.2 – Design, Test, & Deploy the DR Thermostat
Task 11.3 – Design, Test, & Deploy the HAN Pricing/Control Signals
Task 11.4 – Design, Convert, & Deploy Customer Parallel Generation
Task 11.5 – Design, Construct, & Deploy Grid Connected Battery Storage
Task 11.6 – SmartGeneration Implementation Report

Task 12.0 - Smart DER/DR Management Implementation

In this task a Distributed Energy Resource Management (DERM) system will be developed and implemented to manage DR/DER resources and provide the needed resource availability to the DMS and energy trading operators.

Task 12.1 – Design, Implement & Test DER Management System
Task 12.2 – Design, Implement & Test DR Management System
Task 12.3 – Commission DER/DR Management Subsystems
Task 12.4 – Smart DER/DR Implementation Report

8.C.5) Phase 5 Commissioning & Operation

Task 13.0 - Integrated System Operational Test & Demonstration

In this task, the integrated operation of all SmartGrid demonstration project, grid operations and distributed resources will be demonstrated and tested.

Task 13.1 – Develop Integrated System Operation Test Plan
Task 13.2 – Conduct Integrated System Operational Test in Accordance with the Test Plan
Task 13.3 – Perform a Field Demonstration of the Integrated SmartGrid and DR/DER Functionality.
Task 13.4 – Integrated System Testing & Field Demonstration Report

Decision Point 4 – Operational Readiness Review (go/no-go decision point): Approval to proceed with Daily Operation & Data Collection (Task 14 & 15)

Task 14.0 - Operate Integrated Solution

Upon approval to proceed, KCP&L will commence the daily operation of the SmartGrid demonstration system for the 24 month data collection period.

Task 14.1 – Operate System According to Program Plan & Procedures
Task 14.2 – Document any Grid Operational Issues and Resolutions

Task 14.3 – Document any DER Operational Issues and Resolutions
Task 14.4 – Produce an Operations Issues and Resolutions Report

Task 15.0 – Program Data Collection

In this task, 24 months of performance and consumption data will be collected, compiled and analyzed for the project area. This data will be compared against the baseline data to measure the impact on grid performance, system efficiencies, and end-use consumption patterns achieved by the demonstrated technologies. KCP&L will submit this data to the SmartGrid Information Clearinghouse (SGIC) in the form, format, and frequency required.

Task 15.1 – Collect Program Performance & Consumption Data
Task 15.2 – Compile & Manage Program Data
Task 15.3 – Analysis of Program Data
Task 15.4 – Deliver Program Data to SGIC
Task 15.5 – Data Collection Summary Report

8.D. Deliverables

The following deliverables will be submitted to the DOE for this proposed project. Each deliverable is associated with its corresponding task number outlined in the ―Tasks to be Performed” above:

Table 1: DOE Deliverables

No.	Task	Corresponding Deliverable
1	1.1	Baseline Project Management Plan
2	3.5	SmartMeter Implementation Report
3	4.2	Semi-Annual Project Meetings
4	4.3	Semi-Annual Project Management Plan Updates
5	4.4	DOE Peer and Reasonableness Reviews
6	4.9	Final Project Technical Report
7	4.10	Final Project Reporting
8	5.6	Project Integration Architecture & Design Document
9	6.5	Public Outreach and Education Implementation Report
10	7.4	Baseline Data Collection Report
11	8.6	SmartSubstation Implementation Report
12	9.6	SmartGrid ADA Implementation Report
13	10.7	SmartEnd-Use Implementation Report
14	11.6	SmartGeneration Report
15	12.4	Smart DER/DR Implementation Report
16	13.4	Integrated System Testing & Field Demonstration Report
17	14.3	Operations Issues and Resolutions Report
18	15.4	Data Collection Summary Report

8.E. Reporting, Briefings and Technical Presentations

The KCP&L Project Management Office (PMO), will act as the lead and working with the key project teams and partners, shall prepare detailed briefings for presentation to the DOE. In fact, one of the key tasks of the PMO, as laid out in Task 5.0 and further elaborated below includes:

8.E.1) Project Management and Project Briefings:

- Task 5.1 Maintain Project Management Plan - The PMP will be updated internally on a monthly basis to reflect ongoing project status and changes in project schedule, resources, and tasks.

- Task 5.2 Semi-Annual Project Review Meetings - The KCP&L project team representatives will meet semiannually with the NETL Project Officer and staff at the Project Officer's facility in located in Pittsburgh, PA; Morgantown, WV; or Washington, or at an alternative site as designated by the Project Officer to explain the plans, progress and results of the project to date. One of the semi-annual meetings will be scheduled 30 days before completion of each Budget Period and a final briefing will be presented at least 30 days prior to expiration of the award.
- Task 5.3 Semi-Annual PMP Updates - Within 15 days of the semi-annual project review meeting, the KCP&L project team will issue a Semi-Annual PMP Update that incorporates suggestions and changes agreed to during the project review meeting.
- Task 5.4 DOE Peer Reviews & Reasonableness Review -The KCP&L project team will work openly with the Project Officer and staff to facilitate periodic DOE Peer Reviews and a DOE Reasonableness Review during the first Budget Period.

8.E.2) Project Administration and Reporting

- Task 5.5 Project Administration – This task will involve general administration of the total project including budget management, invoicing, and other administrative activities.
- Task 5.6 Periodic Reporting - Periodic reports and other deliverables will be provided in accordance with the Federal Assistance Reporting Checklist.
- Task 5.7 Topical Reporting - Topical reports and other deliverables listed previously in Section D will be submitted in draft form for review and comment. Final topical reports incorporating DOE comments will be submitted.
- Task 5.10 Final Reporting - Final project reports will be provided in accordance with the Federal Assistance Reporting Checklist.

8.E.3) Technical Presentations

Task 5.8 – Technical Presentations - KCP&L project representatives will present project results at up to five (5) appropriate technical conferences or meetings as directed by the DOE Project Officer.

TITLE OF WORK TO BE PERFORMED

KANSAS CITY GREEN IMPACT ZONE –
SMARTSUBSTATION & SMARTGRID DEMONSTRATION

PROGRAM AREA OF INTEREST

SMARTGRID REGIONAL DEMONSTRATIONS
TRANSMISSION AND DISTRIBUTION (T&D) INFRASTRUCTURE

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TITLE OF WORK TO BE PERFORMED

KANSAS CITY GREEN IMPACT ZONE –
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PROGRAM AREA OF INTEREST

SMARTGRID REGIONAL DEMONSTRATIONS
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Equipment Appendix

We do not anticipate using any existing DOE or other Federal equipment for this project. The following table provides a listing of significant KCP&L equipment and electrical grid facilities that will be used to conduct the Demonstration Project.

Available Equipment	Equipment Use
KCP&L Corporate LAN & Fiber WAN	Network Communication & Field Data Backhaul
DataRaker Meter Data Analysis SW license	Project meter data analysis
Midtown Substation – all 12kv equipment	Platform for SmartSubstation deployment and demonstration
Distribution Grid - all 12kv poles, wires and equipment in demonstration area	Platform for SmartDistribution deployment and demonstration