COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

ELECTRONIC JOINT APPLICATION OF LOUISVILLE GAS AND ELECTRIC COMPANY AND KENTUCKY UTILITIES COMPANY FOR CERTIFICATES OF PUBLIC CONVENIENCE AND NECESSITY FOR FULL DEPLOYMENT OF ADVANCED METERING SYSTEMS	)))))))	**CASE NO. 2018-00005**

RESPONSE OF
LOUISVILLE GAS AND ELECTRIC COMPANY
AND
KENTUCKY UTILITIES COMPANY
TO THE ATTORNEY GENERAL'S
SUPPLEMENTAL DATA REQUEST FOR INFORMATION
DATED APRIL 27, 2018

FILED: MAY 11, 2018

VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

The undersigned, **David E. Huff**, being duly sworn, deposes and says that he is Director of Customer Energy Efficiency & Emerging Technologies for LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and that the answers contained therein are true and correct to the best of his information, knowledge and belief.

David Huff
David E. Huff

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 11th day of May 2018.

Susan M Hug (SEAL)
Notary Public

My Commission Expires:

SUSAN M. HUG
NOTARY PUBLIC
ID # 581907
COMMISSION EXPIRES 6/26/2021
STATE AT LARGE - KENTUCKY

VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

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

____
John P. Malloy

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 11th day of May 2018.

Susan M Hug (SEAL)
Notary Public

My Commission Expires:

SUSAN M. HUG
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VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

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

Rick E. Lovekamp
Rick E. Lovekamp

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 10th day of May 2018.

Susan M. Hug (SEAL)
Notary Public

My Commission Expires:

SUSAN M. HUG
NOTARY PUBLIC
ID # 581907
COMMISSION EXPIRES 6/26/2021
STATE AT LARGE - KENTUCKY

Louisville Gas and Electric Company and Kentucky Utilities Company
Response to the Attorney General's Supplemental Data Request for Information
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Question No. 1

Witness: David E. Huff

Q-1. Reference the Malloy testimony regarding the Companies' five years of experience with AMS (page 11).

a. Describe the meters and related infrastructure devices deployed in the 2012 deployment of 1,500 advanced meters in downtown Louisville, including counts of each type of meter or infrastructure device deployed.

b. For each type of meter or infrastructure device deployed, how many have been replaced, for whatever reason, since the initial deployment?

c. Reference the Malloy testimony, page 10. Did those meters have an estimated 20-year life as those proposed in this matter?

i. Explain the Companies' current outlook on the original life of the deployed meters, whether they will meet or exceed their expected life, and how that impacts the expected life for those it proposes to deploy in the future.

A-1.

a. The collectors, routers, and meters are the same as described in Exhibit JPM-1 Appendices, Appendix A-3. The counts as of November 20, 2017 are shown below.

Device Type	Count
Meters (Residential and Commercial Endpoints)	1,583
RF Router	3
L+G C6500 Collector	2
L+G C7500 Collector	0
M120 RF Gas Module	0
M220 RF Gas Module	0
GPR-PT C&I Pressure and Temperature Monitoring Module	0

b. In total, 127 electric meters have been exchanged since the initial deployment. Three of the meters removed were retired from service permanently due to physical damage.

All others were reprocessed as a result of service installation change or removal requests through Companies' regular business process. The Companies would note that these removal requests are not "opt-outs," but rather normal operations, e.g., actual change or rewire in electric service delivered, service removals or transfers due to demolition or new construction, or accounts moving to a different rate.

As it pertains to the RF network infrastructure equipment deployed, one collector was exchanged through an IT troubleshooting exercise involving the meter head-end application servers. The Companies later determined the collector was functioning properly, and it is currently available as a spare. None of the three installed routers have been exchanged since the initial deployment.

c. Yes.
   i. The meters and associated equipment installed are the same as the equipment being proposed for the full AMS deployment. The Companies continue to expect a service life of 20 years for the equipment installed in the Downtown Network and as part of the AMS Customer Service Offering because that equipment continues to perform as expected. Therefore, the Companies believe a 20-year service life is reasonable to assume for the full AMS deployment.

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Question No. 2

Witness: John P. Malloy

Q-2. Describe any experience the Companies' parent, PPL Corporation, and/or any of its other affiliates have had with AMS.

A-2. PPL was one of the first investor-owned utilities in North America to deploy an Automated Metering Infrastructure ("AMI"). PPL deployed its initial AMI solution from 2002-2004 using a Power Line Carrier ("PLC") technology. In accordance with a 2008 Pennsylvania state law requiring all utilities with over 100,000 customers to deploy smart meters,[1] in September 2015 the Pennsylvania Public Utility Commission approved PPL's plan to replace approximately 1.2 million meters (with meters comparable to those the Companies propose to deploy) at an estimated cost of $449.3 million.[2]

PPL has recently described their experience in their 2017 Smart Meter Implementation Annual Progress Report as being "on target with planned functionality schedule, meter installs, and projected cost."[3] They go on to state "PPL Electric is following the approved Smart Meter Implementation Plan without any material modifications. The number of RF meters installed to date, along with the scope, schedule and cost of the program, is in direct alignment with the approved plan."[4]

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[1] 66 Pa. C.S.A. Sec. 2807(f).
[2] http://www.puc.pa.gov/pcdocs/1380515.docx.
[3] PPL Electric Utilities 2017 Annual Progress Report Smart Meter Implementation Plan. Pennsylvania Public Utility Commission Docket Number M-2014-2430781 http://www.puc.pa.gov/pcdocs/1533883.pdf (accessed May 7, 2018) Page 3.
[4] Id. at page 12.

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Question No. 3

Witness: John P. Malloy

Q-3. Reference the Malloy testimony regarding non-technical loss recovery benefits from AMS. Mr. Malloy reports the Companies collected $163,552 in tampering fees billed in 2017 through November. What was the amount of tampering fees collected in December, 2017?

A-3. The amount of tampering fees collected in December 2017 was $19,734.

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Question No. 4

Witness: John P. Malloy

Q-4. Reference the "AMS Cost-Benefit Summary (2018-2040)", Malloy testimony page 15.

a. Provide the Companies' estimates of non-technical loss recovery benefits from AMS by year from 2018-2040 which results in the benefit net present value of $196.8 million projected in the Companies' AMS Business Case.

b. Provide the revenue projections by customer class (or rate class) by year on which the Companies' estimates of non-technical loss recovery benefits were based.

c. The Attorney General understands that the non-technical loss recovery benefits from AMS by year from 2018-2040 were calculated by: total revenues x 2% theft x 60% detection rate x 60% collection rate. If this is not the case, please explain.

A-4.

a. See the response to PSC 1-24a.

b. See the attachment to the response to AG 1-24b.

c. See the response to PSC 1-24a. The non-technical loss recovery benefits were calculated by: total electric revenues of applicable rate classes x 99.2% of customers that do not opt out x 2% non-technical line losses x 60% detection x 60% collection.

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Question No. 5

Witness: John P. Malloy

Q-5. Reference the "AMS Cost-Benefit Summary (2018-2040)", Malloy testimony page 15. Recalculate the Net Present Value column of this table using all projected Nominal Values in the current business case using a 15-year and 18-year benefit period rather than a 23-year benefit period. Retain all current assumptions (such as discount rate) in your response as were used to develop the original figures in the Summary on Malloy testimony page 15.

A-5.

15-year AMS Cost-Benefit Summary (2018-2032)

$M		Nominal Values		Net Present Values
(Costs)				
Total Project Costs (Capital)		(320.0)		(357.1)
Total Project Costs (O&M)		(29.8)		(26.0)
Total Project Costs	**$**	**(349.8)**	**$**	**(383.1)**
Total Recurring Costs (Capital)		(26.2)		(15.8)
Total Recurring Costs (O&M)		(54.1)		(30.3)
Total Recurring Costs	**$**	**(80.3)**	**$**	**(46.1)**
Total Lifecycle Costs	**$**	**(430.1)**	**$**	**(429.2)**
Benefits				
Operational Savings		237.8		147.8
ePortal Benefit		89.0		54.4
Recovery of Non-Technical Losses		228.1		140.6
Total Lifecycle Benefits	**$**	**554.9**	**$**	**342.8**
Net Benefits vs (Costs)	**$**	**124.8**	**$**	**(86.4)**

Discount Rate: 6.32%

18-year AMS Cost-Benefit Summary (2018-2035)

$M	Nominal Values	Net Present Values
(Costs)		
Total Project Costs (Capital)	(320.0)	(357.1)
Total Project Costs (O&M)	(29.8)	(26.0)
Total Project Costs	**$ (349.8)**	**$ (383.1)**
Total Recurring Costs (Capital)	(29.2)	(17.2)
Total Recurring Costs (O&M)	(73.3)	(37.5)
Total Recurring Costs	**$ (102.5)**	**$ (54.7)**
Total Lifecycle Costs	**$ (452.3)**	**$ (437.8)**
Benefits		
Operational Savings	304.3	172.8
ePortal Benefit	113.6	63.6
Recovery of Non-Technical Losses	290.2	163.9
Total Lifecycle Benefits	**$ 708.1**	**$ 400.3**
Net Benefits vs (Costs)	**$ 255.8**	**$ (37.5)**

Discount Rate: 6.32%

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Question No. 6

Witness: Rick E. Lovekamp

Q-6. Reference witness Lovekamp's response to AG-DR-1-07, in which the witness states "If the Companies achieve any AMS operational savings shown in the AMS Business Case, those savings will be implicit in the Companies' future test years and rates."

a. The witnesses' use of the word "if" in his response indicates that operational savings from AMS may not be achieved, or may not be achieved to the extent anticipated by the Companies in their AMS business case. Explain why the AMS CPCN should be approved, and the Companies' cost recovery and profits virtually assured, given that customer savings and a favorable AMS business case for customers are not assured.

b. Explain how customers will receive operating benefits, in the form of reduced rates, between the time the AMS business case indicates the first benefits will be delivered (2018 per business case page 44) and the time of the Companies' next rate case, the filing of which is dictated by the Companies.

c. Explain how the Companies will ensure that AMS-related operational savings "implicit in the Companies' future test years and rates" will be at least as large or larger than the Companies indicate in the business case.

d. If AMS operational savings (if any) are "implicit," identify how they can be objectively identified and verified.

A-6.

a. First, the Companies believe their application and supporting testimony and exhibits demonstrate that full deployment of AMS will be cost-effective and prudent based on reasonable assumptions about future conditions. The Companies attempted to make conservative assumptions regarding benefits and included a level of contingency regarding costs precisely because the future cannot be known with certainty. If the Commission agrees that the Companies' analysis and assumptions are reasonable and determines the project is in the public interest, it would be appropriate for the Commission to approve cost recovery for prudent project expenditures, including the cost of capital, through rates.

Second, the Companies dispute the assertion that their "cost recovery and profits [are] virtually assured." The Companies are assured only of an opportunity to obtain cost recovery and earn a reasonable rate of return on prudently deployed capital through rates approved as fair, just, and reasonable by the Commission. It is not "virtually assured" that the Companies will earn their approved return; indeed, they routinely do not. Weather, changes in economic conditions, and competition from competing technologies, including non-utility renewable energy resources and energy efficiency, are just a few of the factors that affect their ability to earn a Commission-approved rate of return.

b. The cited benefits consist almost entirely of avoided capital costs, which customers will effectively receive through base rates beginning with the Companies' next changes in base rates. Based on the current procedural schedule and anticipated time for approval in this proceeding, the Companies currently expect that the benefits shown on the AMS Business Case page cited in the request will begin in 2019. The Companies have publicly stated their intent to file their next base-rate applications no later than September 28, 2018, with a forecasted test year of May 1, 2019, through April 30, 2020, and with new rates anticipated to take effect on May 1, 2019.[5]

c. The Companies have taken a conservative approach to estimating AMS-related operational savings, and will endeavor to achieve the greatest level of operational savings they reasonably can from full AMS deployment. The Companies believe the Commission's standard ratemaking processes are sufficient to ensure that all AMS-related operational savings will be appropriately accounted for in base rates.

d. Some categories of AMS-related operational savings should be possible to identify with a reasonable degree of confidence, e.g., reduced meter-reading expense and avoided meter capital. Other categories, such as avoided outage management costs, would be somewhat more speculative, but could still be estimated after the fact by making certain assumptions about the costs the Companies would have incurred without AMS to address the outages that actually occurred in a given time period.

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[5] *In the Matter of: Kentucky Industrial Utility Customers, Inc. v. Kentucky Utilities Company and Louisville Gas and Electric* Company, Case No. 2018-00034, Direct Testimony of Kent W. Blake at 7 (Jan. 29, 2018) ("LG&E and KU expect to file for a change in their base rates no later than September 28, 2018 …. Base rates are expected to be reset effective May 1, 2019 based on a forecasted test year of May 1, 2019 to April 30, 2020."); Case No. 2018-00034, Direct Testimony of Kent W. Blake at 3 and 7 (Apr. 6, 2018) ("[T]he TCJA Surcredit rates were based on the benefits of the TCJA from January 1, 2018, the effective date of the TCJA, through and including April 30, 2019, the day prior to the next expected change in the Companies' base rates following a rate case the Companies expect to file in September 2018. … The Companies plan to file a base rate case by the end of September 2018").

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Question No. 7

Witness: David E. Huff

Q-7. Reference witness Huff's response to AG-DR-1-09, in which the witness states the AMS Offering was promoted to all customers in each rate class referenced in the data request. Provide the count of customers by rate class as of December 31, 2017:

a. RS

b. RTOD-E

c. GS

A-7. Customer counts by rate class as of December 31, 2017 are below.[6]

a. RS – 796,085

b. RTOD-E – 86

c. GS – 128,083

[6] Customer counts exclude the Companies' Virginia and Tennessee jurisdictional customers.

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Question No. 8

Witness: John P. Malloy

Q-8. Reference the Companies' proposal to offer the MyMeter e-Portal to all AMS customers in the event the Companies' AMS CPCN is approved.

a. Describe the promotional efforts the Companies will undertake to make customers aware of the MyMeter e-Portal capability should the AMS CPCN be approved.

b. Describe the promotional efforts the Companies will make specifically toward low-income customers in this regard.

A-8.

a. The Companies will use a multi-channel approach to create awareness of AMS and facilitate energy literacy across all customer groups. See Exhibit JPM-1, Appendix A-4 for illustrative examples of the promotional efforts used in the AMS Opt-In Program. The Companies will use customer surveys to measure awareness and energy literacy. MyMeter portal statistics will be used to measure customer engagement. The survey results will be used to continually adjust the campaign to ensure success.

b. Low-income customers will be covered in the overall education campaign. They will also receive additional assistance from low-income agencies, which will be able to access their clients' MyMeter information via the Companies' low-income portal.

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Question No. 9

Witness: David E. Huff

Q-9. Refer to witness Huff's response to AG-DR-1-14. Describe the units (kWh? MWh? Percentage change in usage? Etc.) associated with figures 7.2073 and 1.0084 in the "Estimate" column.

A-9. The units in the "Estimate" column are in kWh.

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Question No. 10

Witness: David E. Huff

Q-10. Refer to the TetraTech analysis of active My Meter users, provided as Appendix A-10. Table 1 indicates that 4.5% (116/2569) of the treatment group were removed from the analysis as "outliers", while 13.3% (57/428) of the contrast group were removed from the analysis as "outliers".

a. Provide the definitions used to eliminate "outliers" from the treatment group.

b. Provide the definitions used to eliminate "outliers" from the contrast group.

c. Provide the pre- and post-consumption values for each of the 116 outliers removed from the treatment group.

d. Provide the pre- and post-consumption values for each of the 57 outliers removed from the contrast group.

A-10. Please see the attached document provided by Tetra Tech, which helps clarify the steps it took in its analysis and corrects data previously provided in Table 1 of on Exhibit JPM-1, Appendix A-10, page 5 of 10. The Companies would note that this corrected table does not change the impact findings of the Tetra Tech analysis.

a.-b. In summary, both the treatment and the contrast group removed customers for the following reasons, applied sequentially:

	Accounts Screened	
Screening Definition	**Treatment**	**Contrast**
Accounts screened out due to extremely low consumption (pre and/or post treatment): Tetra Tech defined this as having any single month with less than 100 kWh in consumption	202	10
Accounts screened out due to extreme change in average monthly consumption pre and post by more than 30%.	285	47
Model screening – model cannot accurately predict these cases' consumption due to high variance of consumption in either the pre- or post- datasets.	701	0
Outliers: Accounts representing the top and bottom one percent of modelled savings are removed.	28	14
Total	1,216	71

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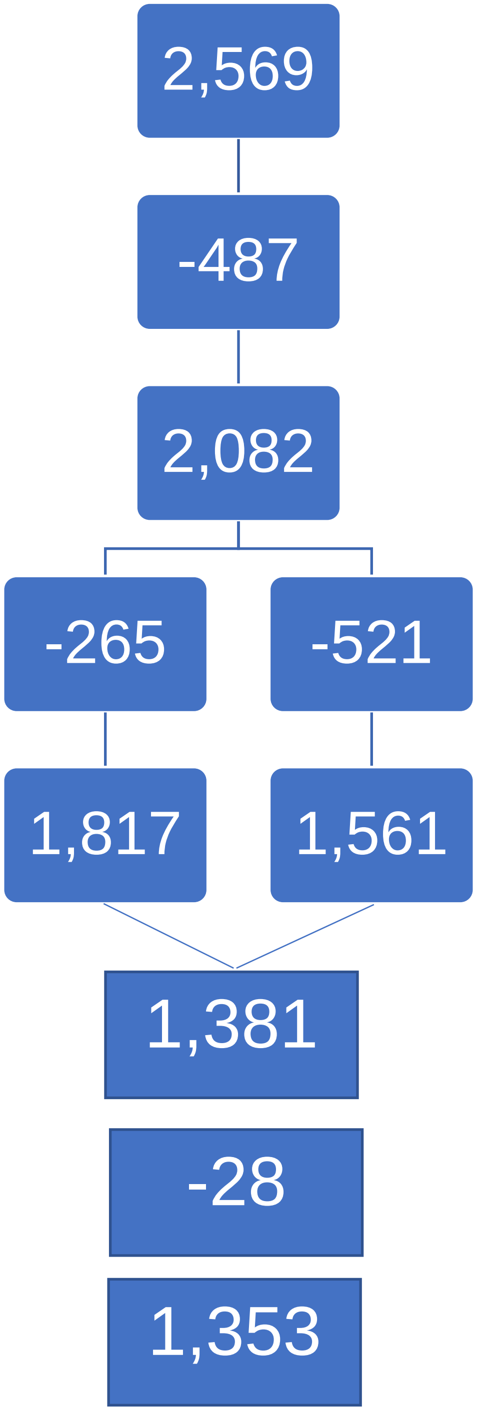
c. The requested information for the 28 treatment-group outliers is below.

ID	annual_kWh_pre	annual_kWh_post	Δ kWh
1	35,008	26,361	8,647
2	56,049	47,539	8,510
3	15,656	19,986	(4,330)
4	23,830	31,723	(7,893)
5	17,403	22,960	(5,557)
6	33,671	23,301	10,370
7	50,046	41,776	8,270
8	27,688	32,058	(4,370)
9	28,069	20,036	8,033
10	31,884	24,226	7,658
11	25,105	29,944	(4,839)
12	34,354	24,880	9,474
13	24,561	16,860	7,700
14	20,083	25,613	(5,529)
15	19,923	10,918	9,005
16	18,902	23,181	(4,279)
17	23,727	15,980	7,746
18	(747,554)	22,470	(770,024)
19	1,284,165	21,037	1,263,127
20	(378,432)	12,272	(390,704)
21	26,143	16,122	10,021
22	24,746	30,469	(5,723)
23	18,224	9,945	8,280
24	29,018	34,200	(5,182)
25	12,445	17,181	(4,736)
26	(6,125)	7,432	(13,558)
27	9,329	20,948	(11,619)
28	42,105	15,579	26,527

d. The requested information for the 14 contrast-group outliers is below.

ID	annual_kWh_pre	annual_kWh_post	Δ kWh
1	24,193	14,030	10,164
2	24,638	13,162	11,476
3	33,855	18,522	15,333
4	30,738	19,413	11,325
5	27,165	33,102	(5,937)
6	14,206	30,000	(15,794)
7	19,103	26,729	(7,626)
8	10,606	27,148	(16,541)
9	20,454	12,550	7,904
10	47,615	38,904	8,711
11	27,654	37,279	(9,624)
12	21,786	27,979	(6,193)
13	27,911	16,067	11,844
14	29,091	17,087	12,004



>Treatment Group with 12 months post opt-in data and at least 12 months total

Accounts Screened (N=487)

- Accounts screened out due to extremely low consumption (pre and/or post treatment): Tetra Tech defined this as having any single month pre/post with less than 100 kWh in consumption (N=202)
- Accounts screened out due to extreme change in consumption: (average monthly consumption post / average monthly consumption pre) less than 0.7 or greater than 1.3 (N=285)

Iterative PRISM Modeling (N=2,082)

- Modelling to find best-fit temperature; two sets of output created (pre and post), each containing 2,082 records

Accounts Screened (N=265 and N=521)

- Coefficient of variation (std. dev./mean) calculated for each account in both files. Accounts with coefficient of variation (CV) > 0.4 removed due to high variability

Remaining Accounts (N=1,817 in pre dataset; N=1,561 in post dataset)

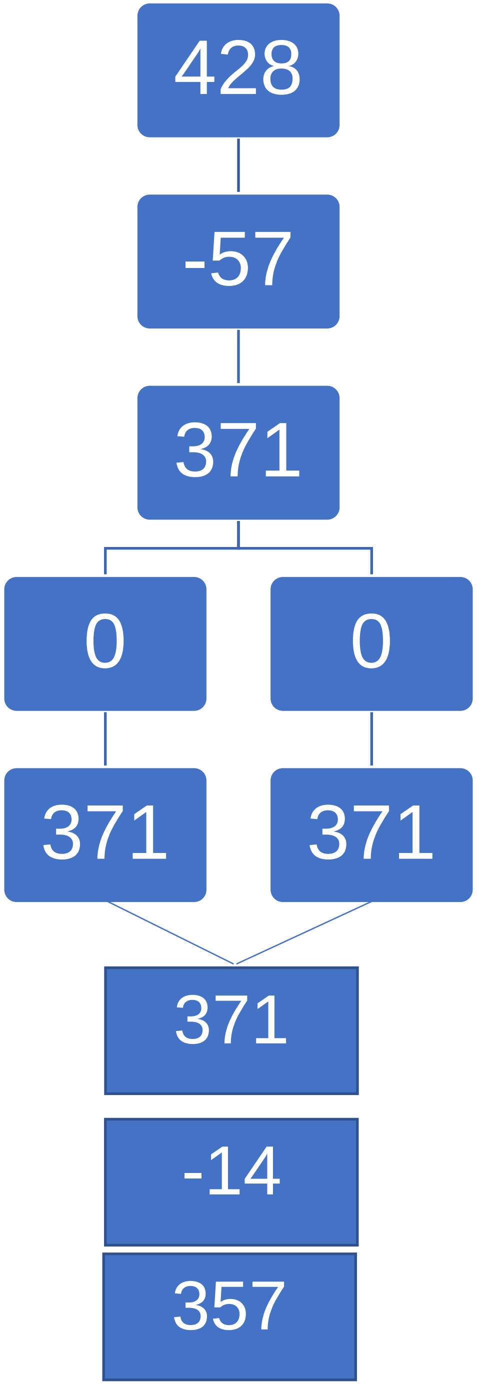
>Merge files, retain records with CV<0.4 in both pre and post dataset.

Accounts Screened (N=28)

- Accounts representing the top and bottom one percent of modelled savings are removed

Final Number (N=1,353)

- 1,381 – 28 = 1,353 records, (Table 3).



>Contrast Group with up to 4 months post opt-in data and at least 28 months total

Accounts Screened (N=57)

- Accounts screened out due to extremely low consumption (pre and/or post treatment): we defined this as having any single month pre/post with less than 100 kWh in consumption (N=10)
- Accounts screened out due to extreme change in consumption: (average monthly consumption post / average monthly consumption pre) less than 0.7 or greater than 1.3 (N=47)

Iterative PRISM Modeling (N=371)

- Modelling to find best-fit temperature; two sets of output created (pre and post), each containing 371 records

Accounts Screened (N=0 and N=0)

- CV (std. dev./mean) calculated for each account in both files. Accounts with CV > 0.4 removed due to high variability

Remaining Accounts (N=371 in pre dataset; N=371 in post dataset)

>Merge files, retain records with CV<0.4 in both pre and post dataset.

Accounts Screened (N=14)

- Accounts representing the top and bottom one percent of modelled savings are removed

Final Number (N=357)

- 371 – 14 = 357 records, (Table 3).

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Question No. 11

Witness: David E. Huff

Q-11. The Companies' response to AG-DR-1-17c is not responsive. Provide the statistical outputs of the difference of differences regression results without the HDD and CDD adjustment as requested. "Statistical Outputs" means, for each variable, the Estimate, Standard Error, t value, t test, and significance of the regression results as the Companies provided in the response to AG-DR-1-14.

A-11. See below for variable definitions that make up the model followed by the requested statistical outputs.

Model: $ADC_{it} = \alpha_i + \beta post_{it} + \epsilon_{it}$

Where

ADC_{it} = average daily consumption for customer i at time t
α_i = customer-specific intercept controlling for customer-specific differences in usage correlated over time
$post_{it}$ = customer-specific post-period indicator, equal to one following start of treatment

The model was run separately for households in treatment and households in contrast group.

Treatment Group (N=1,353 Accts)

The GLM Procedure

Dependent Variable: adc

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	37580.99	37580.99	50.44	<.0001
Error	42035	31315733.75	744.99		
Corrected Total	42036	31353314.74			

R-Square	Coeff Var	Root MSE	adc Mean
0.001199	66.12076	27.29454	41.27983

Source	DF	Type I SS	Mean Square	F Value	Pr > F
post	1	37580.98740	37580.98740	50.44	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
post	1	37580.98740	37580.98740	50.44	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
Intercept	42.40162086	0.20656353	205.27	<.0001	41.99675211	42.80648960
post	-1.91872792	0.27015006	-7.10	<.0001	-2.44822756	-1.38922828

Contrast Group (N=357 Accts)

The GLM Procedure

Dependent Variable: adc

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	330.099	330.099	0.48	0.4890
Error	10637	7335206.164	689.594		
Corrected Total	10638	7335536.264			

R-Square	Coeff Var	Root MSE	adc Mean
0.000045	60.81705	26.26011	43.17887

Source	DF	Type I SS	Mean Square	F Value	Pr > F
post	1	330.0992318	330.0992318	0.48	0.4890

Source	DF	Type III SS	Mean Square	F Value	Pr > F
post	1	330.0992318	330.0992318	0.48	0.4890

Parameter	Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
Intercept	43.36302711	0.36832952	117.73	<.0001	42.64103236	44.08502186
post	-0.35263993	0.50968965	-0.69	0.4890	-1.35172697	0.64644711

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Question No. 12

Witness: John P. Malloy

Q-12. Refer to witness Malloy's response to AG-DR-1-20, in which witness Malloy provides a schedule indicating that the revenue requirement (including carrying costs) of $320 million in project capital balloons to $515 million to be collected from customers. The same schedule indicates that the revenue requirement (including carrying costs) of $43.8 million in recurring capital balloons to $63 million to be collected from customers.

a. Provide all documentation, calculations, estimates, assumptions, workpapers, etc. which translates $320 million in nominal project capital into a net present value of $357.1 million.

b. Provide all documentation, calculations, estimates, assumptions, workpapers, etc. which translates $515 million in nominal project capital revenue requirement into a net present value of $342.5 million.

c. Is the discount rate used to calculate the NPV in (a) above the same as the discount rate used to calculate the NPV in (b)? If not, please recalculate the NPV of (b) using the same discount rate used to calculate (a), and provide both discount rates.

d. Provide all documentation, calculations, estimates, assumptions, workpapers, etc. which translates $43.8 million in nominal recurring capital into a net present value of $22.3 million.

e. Provide all documentation, calculations, estimates, assumptions, workpapers, etc. which translates $63 million in nominal recurring capital revenue requirement into a net present value of $20.9 million.

f. Is the discount rate used to calculate the NPV in (d) the same as the discount rate used to calculate the NPV in (e)? If not, please recalculate the NPV of (e) using the same discount rate used to calculate (d), and provide both discount rates.

g. If carrying costs were included in the cost estimates supplied by the Companies in the AMS Business Case, explain why carrying costs were not listed as one of the costs considered in the "robust and extensive analysis efforts" to develop detailed cost estimates as described in Malloy testimony page 14.

A-12.

a. See attachments being provided in Excel format.

b. See attachments being provided in Excel format.

c. No, the discount rate used in (a), which is 6.32%, is not the same as the rate used in (b), which is 6.58% and was updated as a result of the Tax Cuts and Jobs Act as stated in the response to AG 1-20c. The NPVRR resulting from calculating (b) with a discount rate of 6.32% is $347.5 million.

d. See attachments being provided in Excel format.

e. See attachments being provided in Excel format.

f. No, the discount rate used in (d), which is 6.32%, is not the same as the rate used in (e), which is 6.58% and was updated as a result of the Tax Cuts and Jobs Act as stated in the response to AG 1-20c. The NPVRR resulting from calculating (e) with a discount rate of 6.32% is $21.7 million.

g. The list of items on page 14 of Malloy testimony are project-specific costs and considerations that require extensive evaluation and were used as inputs to the calculation to determine carrying costs and the resulting revenue requirement of the AMS project. Because cost of capital and other carrying costs do matter from the perspective of the customer, those costs were included in the calculation of NPVRR to ensure that the project resulted in a net benefit to the customer.

The attachments are being provided in separate files in Excel format.

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Question No. 13

Witness: John P. Malloy

Q-13. The AMS Cost-Benefit Summary indicates $108.8 million in nominal, recurring O&M costs from 2018-2040 (Malloy testimony page 15). Per AMS Business Case page 40, these costs range from about $5 million annually in 2023 to about $7 million annually by 2040. For a typical year during this period, provide a list of the O&M departments included in the recurring O&M figure as well as the annual dollar amounts for each department and a brief description of the reasons for the associated O&M increases for each department.

A-13. O&M costs for the year 2025, a typical year, are listed in the table below by business area. Labor costs are escalated at an annual rate of 3% for cost of living increase assumptions and all other costs are escalated at an annual rate of 2.2% to account for inflation.

Recurring O&M Costs ($000s)	2025
Network Infrastructure	**$ 462.3**
Labor	$ 156.6
Other O&M	$ 305.7
IT Systems	**$ 2,614.4**
Labor	$ 131.1
Software Maintenance Fees	$ 1,564.1
Hardware Maintenance Fees	$ 919.2
Meter Operating Center	**$ 1,562.7**
Labor	$ 1,537.7
Other O&M	$ 25.0
AMS Engineering	**$ 416.0**
Labor	$ 416.0
Total O&M Costs	**$ 5,055.4**

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Question No. 14

Witness: John P. Malloy

Q-14. The Companies' Excel worksheet response to AG-DR-1-21 included the impact of operating savings which are not assured, and if achieved, for which the Companies provide no plans to deliver to customers in the form of lower rates until some future rate case of unspecified timing is prosecuted.

a. Recalculate and provide the Companies' Excel worksheet response to AG-DR-1-21 with no (zero dollars) anticipated operating expense reductions.

b. Indicate whether the bill impact calculations provided by the Companies in the updated response to AG-DR-1-21 (without anticipated operating expense reductions) are:

i. Cumulative year-over-year (each year's figure is simply added to baseline to obtain that year's bill impact).

ii. Independent year-by-year (each year's figure must be added to previous years' figures to obtain a given year's bill impact).

iii. Alternatively, present the estimated average monthly bill by year including the impact of both the capital revenue requirement and O&M but not the anticipated operating expense reduction (rather than presenting the incremental impact by year).

A-14. The Companies disagree with the premise of this question. AMS-related savings and costs will be reflected in future rate proceedings, the first of which the Companies have publicly and repeatedly stated they will file no later than September 28, 2018.[7] In addition, it is not reasonable to assume zero operating expense reductions resulting from full AMS deployment with respect to the categories of operating expenses the Companies have

[7] *In the Matter of: Kentucky Industrial Utility Customers, Inc. v. Kentucky Utilities Company and Louisville Gas and Electric* Company, Case No. 2018-00034, Direct Testimony of Kent W. Blake at 7 (Jan. 29, 2018) ("LG&E and KU expect to file for a change in their base rates no later than September 28, 2018 …. Base rates are expected to be reset effective May 1, 2019 based on a forecasted test year of May 1, 2019 to April 30, 2020."); Case No. 2018-00034, Direct Testimony of Kent W. Blake at 3 and 7 (Apr. 6, 2018) ("[T]he TCJA Surcredit rates were based on the benefits of the TCJA from January 1, 2018, the effective date of the TCJA, through and including April 30, 2019, the day prior to the next expected change in the Companies' base rates following a rate case the Companies expect to file in September 2018. … The Companies plan to file a base rate case by the end of September 2018").

identified as creating savings in this proceeding, e.g., meter-reading expense. Notwithstanding these concerns, the Companies are providing the requested information.

a. See attachment being provided in Excel format. Note that savings resulting from ePortal and non-technical losses are not considered operational savings but are included in the recalculation.

b. These bill impact calculations are cumulative year-over-year variances compared to a baseline year.

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

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Question No. 15

Witness: John P. Malloy

Q-15. Refer to witness Malloy's response to AG-DR-1-22, which states that today, non-technical losses are billed through a tampering charge or a customer account adjustment.

a. In 2017, what was the count of instances in which tampering charges were billed, and what was the size of the average charge in dollars?

b. In 2017, what was the count of instances in which a customer's account was adjusted for unbilled amounts, and what was the size of the average adjustment in dollars?

c. Describe how the unbilled amounts are estimated for account adjustments. If tampering charges vary, describe how tampering charges are determined.

A-15.

a. In 2017 there were 4,065 tampering charges billed.[8] The average charge billed was $77.23.

b. In 2017, the Companies had 5,250 instances when a customer's account was adjusted for unbilled amounts. The average size of the adjustment was $172.92.

c. Adjustments are estimated per regulation (KAR 807 5:006 Section 11). When available, estimates are based on the customer's previous two years' usage history at the premise for the same months that are being adjusted. Additionally, if a new meter is installed, usage on the new meter and the impact of weather conditions are taken into account. If no premise history is available for this customer, then usage is based on usage on the new meter. In some cases other options to estimate usage may include a review of another similar class of customer in the vicinity. Usage at a customer's previous premise is used if no other options are available.

[8] The number of tampering charges billed differs from the number of confirmed tampering incidents reported in response to AG 1-23(a) because in some cases there is not an active account to bill related to the tampering.

The Companies determine the amount of the tampering charges based on the Unauthorized Reconnect Charge provisions of the Companies' electric tariffs.[9]

[9] Louisville Gas and Electric Company, P.S.C. Electric No. 11, Original Sheet No. 45.1; Kentucky Utilities Company P.S.C. No. 18, Original Sheet No. 45.1.

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Question No. 16

Witness: Rick E. Lovekamp

Q-16. The response to AG-DR-1-28c states "the Companies recommend against being required to offer Peak Time Rebates or any other rate structure or feature as a condition of approving full AMS deployment." Explain why the Companies would recommend against offering a Peak Time Rebate if the AMS CPCN is approved.

A-16. The Companies did not state they would recommend against offering a Peak Time Rebate if the Commission approved the AMS CPCN; rather, as the question quotes accurately, the Companies stated they "recommend against being required to offer Peak Time Rebates or any other rate structure or feature *as a condition* of approving full AMS deployment." (Emphasis added.) The Companies cannot know in advance which new rates and rate structures will be most appropriate to propose until AMS is deployed and the Companies have been able to collect and analyze a meaningful amount of data. Therefore, it would be premature at best, and possibly counterproductive, to require the Companies to implement a Peak Time Rebate as a condition of approving full AMS deployment.

Until the Companies are able to collect and analyze data from the full AMS deployment sufficient to permit them to make well-informed new rate-structure proposals, the Companies believe their three current different residential rates of RS, RTOD-E, and RTOD-D offer customers options that reflect the Companies' cost of service and may allow participating customers to reduce their bills.

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Question No. 17

Witness: John P. Malloy

Q-17. Refer to the Companies' response to AG-DR-1-32, in which the Companies estimate approximately $160,000 in annual crew time and mileage reductions resulting from more rapid outage detection through AMS upon full deployment (2023). This appears to be enough to support a reduction of 1-2 headcount among troublemen and linemen. Please confirm the Companies will reduce headcount among troublemen and linemen by 1-2 upon full AMS deployment if approved due to AMS's rapid outage detection capabilities.

A-17. The Companies do not plan to reduce lineman or troubleman headcount. The cited savings result from reduced overtime and mileage, not reduced headcount.

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Question No. 18

Witness: John P. Malloy

Q-18. Refer to the Companies response to AG-DR-1-33, in which the Companies estimate about $272,000 in annual crew time and mileage reductions resulting from fewer "Ok On Arrival" calls through AMS upon full deployment (2023). This appears to be enough to support a reduction of about 2-3 headcount among troublemen and linemen. Please confirm the Companies will reduce headcount among troublemen and linemen by 2-3 upon full AMS deployment if approved due to AMS's remote "meter status check" capabilities.

A-18. The Companies do not plan to reduce lineman or troubleman headcount. The cited savings result from reduced overtime and mileage, not reduced headcount.

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Question No. 19

Witness: John P. Malloy

Q-19. Refer to the Companies' AMS Business Case, which indicates significant reductions in the cost to remotely disconnect and reconnect service (Business Case page 40). Currently, the Companies charge $28 to reconnect service. Provide the reduced reconnection fee the Companies will charge for customers with AMS meters if the CPCN is approved.

a. Refer to Duke Response to AG-DR-2-40 in Case No. 2017-00321, in which Duke Energy of Kentucky certified that its reconnection fee would be $3.45. If the Companies' reduced disconnect and reconnect service cost is not as low as Duke's, provide a complete explanation as to why that is the case.

A-19. The Companies have not requested to change any rates or charges in this proceeding, and therefore have not calculated the charge to reconnect service when AMS is fully deployed. The Companies have stated their intent to file their next base-rate applications no later than September 28, 2018.[10]

a. See above.

[10] *In the Matter of: Kentucky Industrial Utility Customers, Inc. v. Kentucky Utilities Company and Louisville Gas and Electric* Company, Case No. 2018-00034, Direct Testimony of Kent W. Blake at 7 (Jan. 29, 2018) ("LG&E and KU expect to file for a change in their base rates no later than September 28, 2018 …. Base rates are expected to be reset effective May 1, 2019 based on a forecasted test year of May 1, 2019 to April 30, 2020."); Case No. 2018-00034, Direct Testimony of Kent W. Blake at 3 and 7 (Apr. 6, 2018) ("[T]he TCJA Surcredit rates were based on the benefits of the TCJA from January 1, 2018, the effective date of the TCJA, through and including April 30, 2019, the day prior to the next expected change in the Companies' base rates following a rate case the Companies expect to file in September 2018. … The Companies plan to file a base rate case by the end of September 2018").

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Question No. 20

Witness: David E. Huff

Q-20. One potential benefit of an AMS deployment is avoiding costs through coincident peak demand reduction rates such as Peak Time Rebate.

a. What avoided capacity cost (in $) per MW did the Companies assume in their most recent demand-side management program filing which included an avoided capacity cost assumption? Provide each component individually:

i. Avoided generation capacity cost per MW

ii. Avoided transmission capacity cost per MW

iii. Avoided distribution capacity cost per MW

b. Provide all documentation, calculations, assumptions, workpapers, etc. used to justify the avoided capacity cost dollar estimate per MW from (a) above.

c. What do the Companies estimate as the average kW per residential customer at coincident peak?

d. What is the Companies' current peak generation capacity, in MW, from all sources (owned generation capacity plus purchased generation capacity)?

e. Provide the annual coincident system peak forecast from the Companies' most recent Integrated Resource Plan.

A-20. a. The Companies used $0 per kW-year in their demand-side management program filing currently pending before the Commission, Case No. 2017-00441.

i. $0 / kW-year

ii. $0 / kW-year

iii. $0 / kW-year

b. See generally the Companies' application and supporting testimony and exhibits in Case No. 2017-00441.[11] More specifically, see, e.g., Exhibit GSL-1 at 173 and 181; Exhibit GSL-3 at 11, 38, and 58; Direct Testimony of David E. Huff at 12-13 and 17; and the Companies' response to AG 2-6(d).

c. Based on the forecasted residential load profiles provided in the Companies' last base rate case, the estimated average demand per residential customer during the Companies' coincident peak is approximately 3.4 kW for LG&E residential customers and 3.1 kW for KU residential customers.

d. The Companies' net summer generation capacity is 8,161 MW.

e. See the table below that was filed with the Commission as part of the 2017 Annual Resource Assessment.

	2018	**2019**	**2020**	**2021**	**2022**
Peak Load	7,047	6,761	6,749	6,725	6,725
DSM at Peak Hour	-374	-343	-327	-323	-320
Net Load	6,673	6,418	6,422	6,402	6,405
Existing Capability	7,841	7,570	7,570	7,571	7,571
Bluegrass Capacity Purchase and Tolling Agreement	165	0	0	0	0
OVEC Purchase	152	152	152	152	152
CSR/Interrupt	138	138	138	138	138
Total Supply	8,296	7,860	7,860	7,861	7,861

[11] Available at https://www.psc.state.ky.us/PSC_WebNet/ViewCaseFilings.aspx?case=2017-00441.

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Question No. 21

Witness: John P. Malloy

Q-21. Reference the response to CAC-DR-1-5. Does LG&E have this information available for its customers?

a. Have the Companies considered conducting a survey of its customers to obtain this information?

b. Have one or both of the Companies ever conducted any such surveys as set forth in subpart a. to this question? If so, please provide results. If not, why not?

A-21. No. Information for Kentucky residents who are also customers of LG&E or KU, classified as low income, and have internet access is not publicly available or collected by the Company.

a. No.

b. No. The Companies have elected to use information publicly available from the U.S. Census Bureau, which provides a reasonable estimation for the LG&E and KU service areas. See the response to CAC 1-3.

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Question No. 22

Witness: John P. Malloy

Q-22. Reference the business case, p. 18. Are the Companies aware of any other outdoor products having a 20-year battery life? If so, please provide descriptions of such products.

A-22. The Companies currently utilize automated meter reading (AMR) for over 29,000 gas meters that feature a one-way encoder receiver transmitter (ERT) radio to enable short distance meter reading. These existing ERT radios have been found to achieve a 20-year battery life by Itron. See attached.

100G Single-Battery ERT® Modules: Achieving a 20-Year Battery Life

Fixed Network AMI Solutions

Satish D. Bhakto, Ph.D
Hardware Engineering Advisor

Jonathan Mueller
Itron R&D Engineering Manager

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INTRODUCTION

For natural gas and combination utilities deploying automated meter reading (AMR) or advanced metering infrastructure (AMI) technology, battery longevity and frequency of required battery change-outs in radio frequency (RF)-based endpoints can make a dramatic difference in the cost of system deployment and operation.

Given these variables, the difference between having to do multiple battery change-outs over a 20-year product life is nothing short of dramatic. Add in the customer inconvenience and the implications of a battery change-out become clear. After all, the purpose of AMR and AMI is to eliminate the need to visit the meter.

This white paper is meant to address the battery life of Itron's 100G, 100G DL and 100G DLN, and 100G DLS ERT® modules. It will provide a high-level technical overview of battery life determination for the module predecessor, the 100G Gas ERT. It serves to provide technical insight in determining allowable current levels for 20-year operation and variances between the first release of the 100G which contained two cells, and the subsequent release of the 100G DL, 100G DLN, and 100G DLS which contain one cell. It will speak to several major and minor design improvements in the 100G DL, 100G DLN, and 100G DLS that make a one-cell solution realizable while maintaining a 20-year battery life.

Itron will be implementing a 100G series battery field monitoring program. Customers can use data presented in this white paper along with future field data to manage their AMR and AMI systems more cost-effectively, and time the change-outs of their modules.

ABOUT 100G DL, 100G DLN, AND 100G DLS ERT MODULES

The 100G DL, 100G DLN, and 100G DLS automatically store 40 days of hourly data on the hour. Mathematically that is 960 intervals (40 days x 24 hours/day), with the oldest interval dropping off as a new interval is collected. As with the 100G, the 100G DL, 100G DLN, and 100G DLS are equipped with programmable output power and can be optimized for handheld, mobile or fixed network reading all without the need for a license from the Federal Communications Commission.

Used in conjunction with mobile reading, the 100G DL, 100G DLN, and 100G DLS module provides functionality very near that of a fixed network. The module enables move in and move out functionality to minimize off cycle reads reducing the cost of special reads and/or truck rolls. The daily data can be used to settle customer service and billing disputes. For monthly gas balancing, the module allows utilities to assess penalties for transportation customers and meet the accountability requirements set forth by Sarbanes Oxley. The hourly data can also be used to facilitate load studies and projections. When the 100G DL, 100G DLN, or 100GDLN is read by Itron's new Fixed Network AMI solution, benefits such as remote disconnect, time synchronized interval data, and time-based billing can now also be realized.

The 100G DL, 100G DLN, and 100G DLS build upon the field-proven design of the 40G, 40GB and 100G Gas ERT modules to deliver an industry leading 99.999 percent read accuracy rate. Like the 100G module, the 100G DL module offers up to 250 milliwatts of output power, the 100G DLN and 100G DLS offer up to 500 milliwatts and can operate in a bubble-up mode. Regardless of data collection solution, the module offers a 20-year battery life to ensure low cost of ownership.

DETERMINING ALLOWABLE CURRENT LEVELS FOR 20-YEAR BATTERY LIFE

Itron uses a $Li\text{-}SOCl_2$ (lithium thionyl chloride) battery in 100G DL, 100G DLN, and 100G DLS ERT modules. An important characteristic of this battery is the flat voltage profile. The battery life is a function of the current seen by the battery. For this type of chemistry, self-discharge of the battery is also critical in determining its life.

Itron uses a twofold approach to determine battery life. The first being theoretical/lab experimental data and the second being field data.

The theoretical approach is based on models to simulate the failure mechanism. In a typical battery, the various failure mechanisms are as follows:

- Exhaustion of battery capacity, relative self-discharge and voltage drop due to the operating conditions
- Integrity of the mechanical can (i.e. battery packaging)

Battery life models based on battery chemistry are developed to simulate the above failure mechanisms. Itron also conducts accelerated lab tests to simulate the above failure modes. These experiments include discharge under various conditions as well as micro-calorimetry to determine the pertinent model parameters.

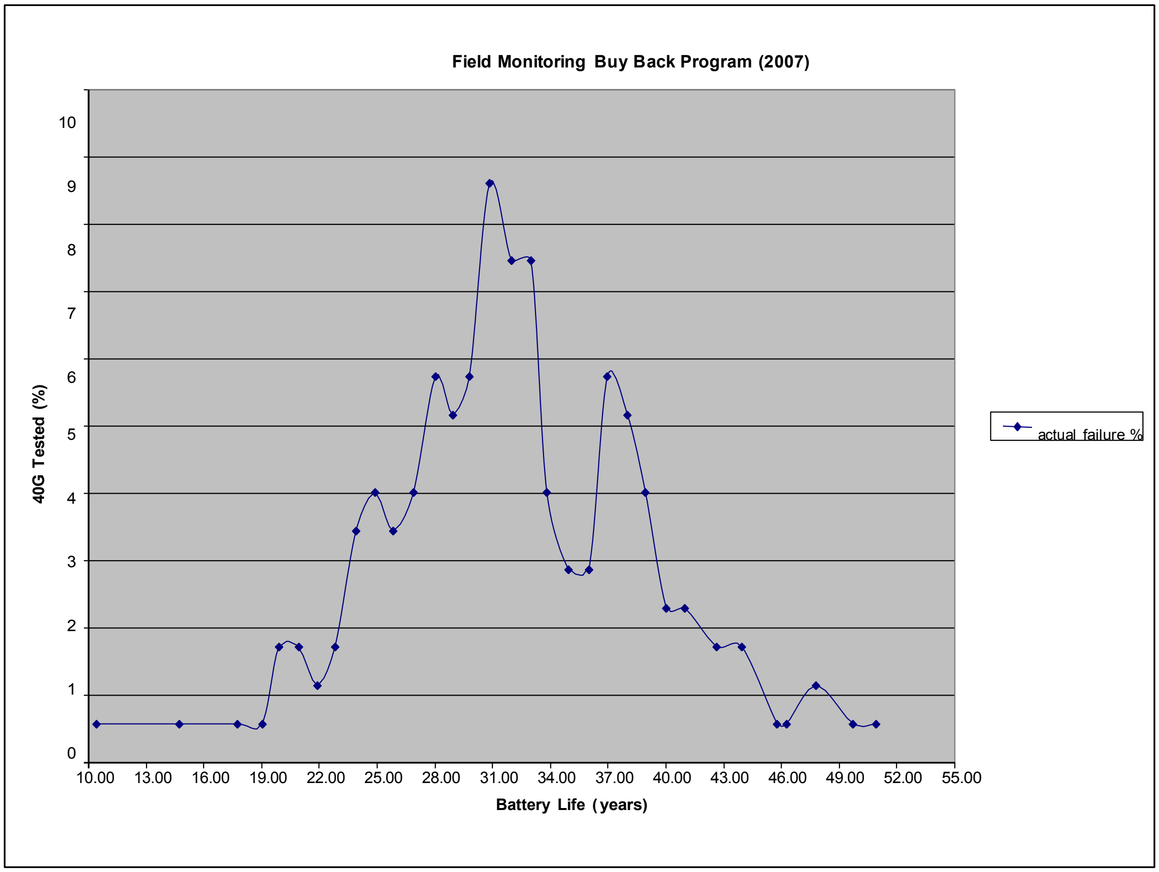
The second phase of this approach is to test the model with field data. Field research has proven to be a primary factor in revising estimates of average battery life for Itron. Rising above its competitors, Itron initiated a Battery Field Monitoring Program in 1997—over fifteen years ago. To date the program is specific to Itron's existing 40 Series Gas ERT module. To carry out testing, functional modules from four to six utilities that have been in the field for more than five years, are returned to Itron each year. Various tests are conducted in-house on the batteries including determination of the remaining battery capacities. This is all done to provide customers with as accurate information as possible in determining overall battery life.

The Battery Field Monitoring Program enables Itron to further check, verify and refine its battery life prediction model against "real-world" data. Itron customers can then use this data to manage their system cost-effectively and time the change-outs of their applicable ERT modules.

Based on the above modeling/lab tests approach and field data we have developed battery life equations as a function of the average current seen by the battery. The model takes into account such variables as product type, battery type, location and climate, and the type of data collection technology used.

As an example, the 2007-2008 field data from six utilities and 174 modules is shown in the Field Monitoring Buy Back Program (2007) chart on the following page.

The mean life is equal to 32.03 years (standard deviation = 10.69 years). Itron has similar curves from previous battery field monitoring programs for 2.75 Ah capacity batteries.



The initial less than 1% failures prior to year 15 are due to circuit problems in earlier 40G modules. This problem was resolved in post-July 1999 modules. Due to circuit substrate changes, this problem is nonexistent in 100G DL, 100G DLN, and 100G DLS ERT modules.

The battery used in modules from the field data above has a capacity of 2.75Ah, whereas the battery used in 100G DL, 100G DLN, and 100G DLS modules has a higher capacity of 3.65Ah. As shown in the calculations in the next paragraphs, for a 40 Series gas module, even with a 3.65 Ah battery, the model life estimation is equal to 26.04 years. The above field data with a lower capacity battery (2.75 Ah) show a mean life equal to 32.03 yrs. This data show Itron's model is overwhelmingly conservative.

BATTERY LIFE CALCULATIONS FOR 100G DL, 100G DLN, 100G DLS AND 100G ERT MODULES

The current used by the 100G DL, 100G DLN, and 100G DLS was designed and validated through a series of tests. Self-discharge has been accounted for in the calculations by using micro-calorimetry and field data.

CALCULATION OF BATTERY LIFE FOR 100G DL, 100G DLN, AND 100G DLS ERT MODULES

Failure mechanism (a) viz. capacity, self-discharge and voltage drop

Average current consumed by the circuit during standby as well as transmit =14.86 µA.

Self-discharge of battery (based on the tests mentioned above) = 7.31 µA

Average battery capacity = 3.65 Ah (single cell)

$$\text{Average life* } = \frac{3{,}65\ \text{Ah} \times 10^6}{(14.86+7.31) \times 0.9} / 8760 = 20.86 \text{ years}$$

Failure mechanism (b) viz. integrity of the mechanical can

Based on accelerated tests done on the product (including the battery), battery life is at least 20 years.

(* Based on field data from 40 Series gas modules using the same battery chemistry, this estimation is conservative by at least 10%, which accounts for 0.9 in the above equation)

CALCULATION OF BATTERY LIFE FOR 100G ERT MODULES

Failure mechanism (a) viz. capacity, self-discharge and voltage drop

Average current consumed by the circuit during standby as well as transmit = 30 µA.

Self-discharge of the 2 pack battery (based on the tests mentioned above) = 14.62 µA

Average battery capacity = 7.3 Ah (2 pack)

$$\text{Average life* } = \frac{7.3\ \text{Ah} \times 10^6}{(30+14.62) \times 0.9} / 8760 = 20.75 \text{ years}$$

Failure mechanism (b) viz. Integrity of the mechanical can

Based on accelerated tests done on the product (including the battery), life is at least 20 years.

(* Based on field data from 40 Series gas modules using the same battery chemistry, this estimation is conservative by at least 10%, which accounts for 0.9 in the above equation)

As an example of the comparison of the model and field data, estimations for 40G and the latest field data are listed here:

Calculation of battery life for 40 Series Gas ERTs used in Wake Up Mode

Failure mechanism (a) viz. capacity, self-discharge and voltage drop

Average current consumed by the circuit during standby as well as wake up (once a month) =10 μA.

Self-discharge of battery (based on the tests mentioned above) = μA Average battery capacity (at present) = 3.65 Ah

Average life = (3.65 Ah X 10^6) / 8760 = 26.04 years

(10+6)

Failure mechanism (b) viz. Integrity of the mechanical can = 20 years

Based on accelerated tests done on the product (including the battery) life is at least 20 years.

Field Data for 40 Series Gas ERTs (2007-2008 Field Monitoring Program)

Sample Size: 174 ERTs

6 Utilities

2.75 Ah battery

Mean = 32.03 years

Standard deviation = 10.69 years

(Note the model predictions for 40G wake up units are for 3.65Ah battery and the field data are for 2.75Ah battery.) These data show that the model is quite conservative also for 2.75Ah battery in the field.

EFFICIENCY GAINS THAT ALLOW 20-YEAR BATTERY LIFE WITH ONE CELL

Getting 20 years of life out of a battery requires that the electrical circuit draw very low levels of electrical current. This means the circuitry does as little as possible as efficiently as possible between essential functions and sleep.

As with most new products, the period between new releases acts as time to refine and perfect the product. Itron took the time between the release of the initial 100G module and the release of the 100G DL and thereafter the releases of the 100G DLN and 100G DLS modules as an opportunity to optimize battery performance.

In the 100G ERT module, the circuits operate in current-consuming-modes too long and draw excess average current for a one-cell, 20-year solution. Consuming a higher average current required the initial 100G module to have a two-cell battery pack to maintain a 20-year battery life. Additionally, its radio frequency integrated circuit (RFIC) limitations forced tradeoffs that kept the design from achieving a single-cell battery existence. These limitations were to the point that there was no benefit in optimizing small details for improved efficiency since a one- cell design was not possible.

With a more efficient RFIC, as is used with the 100G DL, 100G DLN and 100G DLS, fewer tradeoffs were required and near single-battery performance was readily obtained. With a few additional small improvements, current consumption was reduced by slightly more than a factor of two and, as a result, a one-cell solution was realizable. In actuality, the battery-life is improved over that of the initial 100G ERT module. This is of ultimate benefit to customers as designing a more efficient product allows Itron to be more price competitive. There are three major design improvements and several small improvements in the 100G DL, 100G DLN, and 100G DLS that reduce average current. They follow in order of significance.

Limited isolation in the RFIC between On/Off Keying (OOK) modulation circuits and the internal power amplifier

Due to this internal coupling, the RFIC used in the original 100G ERT is not able to modulate the transmitted message. Instead, the power amp (PA), external to the RFIC, is modulated. As a result, the RFIC is active throughout the transmitted message which approximately doubles transmit current. In mobile mode (+10 dBm) this requires the PA to be active for transmit operation. The reason the RFIC cannot be modulated in the original 100G ERT is because the internal coupling causes pulling of the “on” bits, resulting in a spectrum that is not sufficiently clean. With 100G DL, 100G DLN, and 100GDLS, the RFIC (same for both series) performs the modulation and the device is off during the “off” bits of the transmitted message. In addition, the PA is not active when the endpoint is operated in mobile mode.

Time allotment for settling of the RFIC

The RFIC used in the 100G ERT module requires more time than that used in the 100G DL, 100G DLN, and 100G DLS ERT modules to prepare for transmit or receive functions. There is more delay required:

- from the point that the device is powered until it is reading for commands.
- for the crystal oscillator of the RFIC to stabilize
- for the phase-locked loop of the RFIC to settle on frequency.

All this means that the RFIC for the original 100G ERT module is powered longer, consuming more electrical current from the battery.

Receive current

The 100G ERT module consumes more current in receive mode.

Fixed Network Messages

The 100G DL supports “advanced” fixed network messages; specifically the network interval message (NIM) and the network consumption message (NCM). These messages contain more information that the standard 96-bit consumption message (SCM) and are intended for fixed network support. While the SCM is 96 bits, the fixed network messages are approximately 200 and 375 bits for the NCM and the NIM respectively. The fixed network messages transmit at the high power setting (+24 dBm or 250 mW). The occurrence of these messages is low enough that these longer messages at high power do not reduce battery life below the 20-year mark. Since the NIM and NCM messages bubble up less frequently, average current remains less than that of the average current of a 100G DL in mobile mode (+10 dBm every 15 seconds). A typical scenario may be a NCM transmission every 2 minutes with a +10 dBM SCM transmission one minute after, or a NIM transmission every 5 minutes with a +10 dBM SCM transmission each minute on the four minutes in between. Even at these rates the 100G DL will consume less average current than a unit programmed to mobile mode.

The 100G DLN and 100G DLS were further enhanced with a higher power higher data rate fixed network FM transmission that enabled the addition of a 500 mW fixed network mode that operates with the same duty cycle as the 100G DL for fixed network mode.

SUMMARY

At a time when utilities continually search for innovative ways to drive out costs, the 100G DL and specifically the latest models—the 100G DLN and 100G DLS—ERT modules provide a sensible pathway from handhelds to mobile to fixed network. The module brings value to customers with its increased output power—mobile AMR users can collect RF reads from a greater distance.

The 100G DL, 100G DLN, and 100G DLS ERT modules use Li-$SOCl_2$ technology for their power source/battery. These modules will operate for 20 years on a single 'A' cell (3.65Ah), while the 100G ERT module required two cells for a 20-year battery life. Many efficiency gains were made to accomplish this, most notably changing the RFIC. The technology inherent to the 100G DLN and 100G DLS ERT modules bring with them added messaging for fixed network support. When these messages are used, the endpoint will maintain a 20-year battery life.

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Louisville Gas and Electric Company and Kentucky Utilities Company
Response to the Attorney General's Supplemental Data Request for Information
Dated April 27, 2018

Case No. 2018-00005

Question No. 23

Witness: John P. Malloy

Q-23. Have the companies investigated the potential for synergies and cost savings, given that their affiliate PPL Electric Distribution in Pennsylvania is currently deploying its own AMS network? Provide a discussion.

A-23. Yes. The Companies have routinely discussed PPL's experience with smart meters through telephone conference calls, in-person meetings, and exchange of information. The Companies and PPL have shared best practices and lessons learned from PPL's deployment, and will continue to do so. Beyond those items, the Companies' discussions with PPL have not uncovered any potential synergies or savings to date due to the significant geographic separation and different service-territory characteristics of the Companies' and PPL's respective service territories, among other issues. The Companies will continue to discuss these issues with PPL as their respective deployments and network operations go forward, and will seek to implement any synergies and cost savings as the Companies identify them.

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Question No. 24

Witness: Rick E. Lovekamp

Q-24. Reference the response to AG–DR-1-25. Are the Companies willing in their next base rate case to identify, quantify, and document both the precise quantifications and alleged savings the proposed AMS program would bring, and to identify precisely where those entries or adjustments could be located in the Applications? If the Companies are not willing to do so, why not?

A-24. Yes, the Companies are willing to identify in their next base-rate applications how they have accounted for anticipated AMS-related operational savings. Note that operational savings do not include non-technical-loss benefits or ePortal benefits.

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Case No. 2018-00005

Question No. 25

Witness: Rick E. Lovekamp

Q-25. Are the Companies requesting cost recovery in this matter?

a. If not, do the Companies believe the costs to customers, and the recovery of those costs, are at issue in this matter and should be addressed?

A-25. No, the Companies are not requesting cost recovery in this proceeding.

a. What should be addressed in this proceeding is prescribed by KRS 278.020(1), namely whether the public convenience and necessity require the proposed full deployment of AMS. The relevant Commission regulation, 807 KAR 5:001 Sec. 15(2), clarifies that how a utility plans to finance a facility's construction and the facility's ongoing annual cost of operation are items a utility must submit as part of its application for a certificate of public convenience and necessity. In the Commission's final order in its most recent smart-grid administrative case, the Commission listed several issues it had considered regarding smart-meter-related certificates of public convenience and necessity ("CPCNs"); cost recovery was not among them: "[W]hen addressing requests for CPCNs for AMR and AMI meters, the Commission has noted its concern regarding a number of meter related issues such as cost, compatibility with current system equipment and software, and unplanned obsolescence.[12] Therefore, the cost of the proposed full deployment of AMS is certainly at issue in this proceeding and should be addressed, as should the anticipated benefits of the deployment so the Commission can determine whether the deployment is likely to serve the public convenience and necessity. But cost recovery is not at issue in this proceeding, and is not required to be addressed; it will be addressed in the Companies' future base-rate cases if the Commission grants the requested certificate.

[12] *In the Matter of: Consideration of the Implementation of Smart Grid and Smart Meter Technologies,* Case No. 2012-00428, Order at (Apr. 13, 2016).

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Case No. 2018-00005

Question No. 26

Witness: John P. Malloy

Q-26. If the Commission should approve the CPCN in whole or in part, will the meters the Companies intend to install comply with IEEE Standard 1547 (revised)?[13]

a. It is the Attorney General's understanding that this standard is currently undergoing revisions, including but not limited to: (i) the interoperability/communications requirements for Distributed Energy Resources; (ii) bulk systems; and (iii) the provision of a standardized non-proprietary communication interface. Provide a discussion of the extent to which the AMS meters and related infrastructure, including software and firmware, can be upgraded in order to meet the anticipated revisions to this standard.

A-26. The Companies' understanding of IEEE Standard 1547 (revised) is that it is not a metering standard but a standard regarding the communications and interoperability of Distributed Energy Resources (DER). As such, the meters the Companies intend to install only would need to comply with IEEE Standard 1547 (revised) to the extent the meters, along with the related AMS infrastructure, enable communications for DERs. With this understanding the AMS meters and related communications infrastructure the Companies intend to install will comply with IEEE Standard 1547 (revised) in its current form as the Companies understand it. Note that the standard is not a mandatory standard and has not been finalized.

a. Generally speaking, the AMS meters and related infrastructure are capable of remote, over the air upgrades. To the extent the anticipated revisions are understood, the AMS communications network is believed to comply with IEEE Standard 1547 (revised) as currently proposed and would not require software or firmware upgrades. Once the standard is finalized, further analysis may be needed to understand how to meet revisions of this standard and whether over the air upgrades are needed.

[13] The Electric Power Research Institute has a publicly-accessible fact sheet regarding IEEE 1547, accessible at the following website: https://www.epri.com/#/pages/product/000000003002011346/