Exhibit No.:	
Issue(s):	Weather Normalization; Block Weather Normalization; Solar Adjustment; Rider EDI Adjustment; Growth Adjustment
Witness:	Nicholas Bowden, Ph.D.
Type of Exhibit:	Surrebuttal and True-Up Direct Testimony
Sponsoring Party:	Union Electric Company
File No.:	ER-2022-0337
Date Testimony Prepared:	March 13, 2023

MISSOURI PUBLIC SERVICE COMMISSION

FILE NO. ER-2022-0337

SURREBUTTAL AND TRUE-UP DIRECT TESTIMONY

OF

NICHOLAS BOWDEN, Ph.D.

ON

BEHALF OF

UNION ELECTRIC COMPANY

d/b/a Ameren Missouri

St. Louis, Missouri
March, 2023

P

TABLE OF CONTENTS

SURREBUTTAL AND TRUE-UP DIRECT TESTIMONY

OF

NICHOLAS BOWDEN, Ph.D.

FILE NO. ER-2022-0337

Q. Please state your name and business address.

A. Nicholas Bowden, Union Electric Company d/b/a Ameren Missouri ("Ameren Missouri" or "Company"), One Ameren Plaza, 1901 Chouteau Avenue, St. Louis, Missouri 63103.

Q. Are you the same Nicholas Bowden that filed direct and rebuttal testimony in this proceeding?

A. Yes, I am.

I. PURPOSE OF TESTIMONY

Q. What is the purpose of your surrebuttal and true-up direct testimony in this proceeding?

A. The purpose of my surrebuttal and true-up direct testimony is twofold. First, I provide the updated billing units and normalized revenue through the true-up period. Next, I respond to Staff rebuttal testimony related to the following issues.

1. Weather Normalization (Staff witness Hari K. Poudel, Ph.D.)
2. Block Weather Normalization (Staff witness Michael Stahlman)
3. Solar Adjustment (Staff witness J Luebbert)
4. Rider EDI Adjustment (Staff witness Nancy L. Harris)
5. Growth Adjustment (Staff witness Kim Cox)

II. UPDATED BILLING UNITS THROUGH THE TRUE-UP PERIOD

Q. What is the true-up date for this case?

A. The true-up date is December 31, 2022.

Q. Please provide the billing units and normalized revenue through the true-up date.

A. The normalized test year billing units through the true-up date are detailed in Schedule NSB-S1. The Company's normalized revenue through the true-up date in this case is $2,718,494,163. The Company's updated test year revenue, total revenue adjustments, and normalized revenue are summarized by customer class in Table 1.

Table 1. Normalized Revenue By Class

Customer Class	Actual Revenues (in Dollars)	Total Adjustments (in Dollars)	Normalized Revenue (in Dollars)
1M	1,319,758,387	53,738,192	1,373,496,579
2M	289,713,400	13,953,736	303,667,136
3M	533,311,616	25,077,541	558,389,158
4M	228,373,105	5,951,554	234,324,659
11M	194,139,273	12,537,441	206,676,714
Lighting	39,051,060	2,807,294	41,858,354
MSD	77,165	4,398	81,564
*Total	2,604,424,006	114,070,157	2,718,494,163
Total may differ from sum of rows due to rounding.			

Q. What adjustments are the Company making to normalize billing units through true-up?

A. The Company is making the same five types of adjustments to normalize billing units and revenues as I described in direct testimony. The Company is also making the same three types of adjustments that do not impact billing units but do impact revenue as I described in my direct testimony. The five billing unit adjustments are as follows:

1 A weather normalization adjustment;

2. A days adjustment;

3. An energy efficiency adjustment;

4. A customer-owned solar adjustment; and

5. A growth adjustment.

The three direct revenue adjustments are as follows:

1. A rate annualization adjustment;

2. An economic development incentive adjustment; and

3. A Community Solar adjustment.

The revenue value of each billing unit adjustment is shown in Table 2 by customer class.

Table 2. Billing Unit Revenue Adjustments

Customer Class	Weather Adjustment (in Dollars)	Days Adjustment (in Dollars)	Energy Efficiency Adjustment (in Dollars)	Solar Adjustment (in Dollars)	Growth Adjustment (in Dollars)
1M	-28,892,005	27,889	-9,762,526	-1,669,460	2,132,518
2M	-3,878,688	-152,270	-2,461,915	-175,764	1,344,277
3M	-2,841,078	-599,362	-6,504,380	-113,258	145,344
4M	-1,363,444	-2,103,623	-1,194,945	-20,456	-3,799,103
11M	-860,880	-132,504	-95,935	-3,674	1,723,319
Lighting	0	0	0	0	581,530
MSD	0	0	0	0	0
*Total	-37,836,095	-2,959,871	-20,019,700	-1,982,612	2,127,884
***Total may differ from sum of rows due to rounding.**					

The value of each direct revenue adjustment is shown below in Table 3 by customer class.

Table 3. Non-Billing Unit Revenue Adjustments

Customer Class	Rate Annualization Adjustment (in Dollars)	Economic Development Adjustment (in Dollars)	Community Solar Adjustment (in Dollars)
1M	91,455,106	0	446,671
2M	19,268,755	0	9,341
3M	35,472,689	-482,414	0
4M	14,613,115	-179,990	0
11M	11,968,713	-61,598	0
Lighting	2,225,764	0	0
MSD	4,398	0	0
*Total	175,008,541	-724,002	456,013
***Total may differ from sum of rows due to rounding.**			

The above-values were used by Company witness Mitchell Lansford in arriving at the Company's revenue deficiency (i.e., the annual increase in revenues sought for approval in this case) as of the true-up date in this case.

III. STAFF'S WEATHER NORMALIZATION

Q. Did Staff offer rebuttal testimony related to weather normalization?

A. Yes.

Q. Did Staff offer any criticism of the Company's weather normalization process in that rebuttal?

A. No.

Q. What information did Staff offer in rebuttal testimony related to weather normalization?

A. Staff characterizes and motivates its own regression model specification and highlights the most important difference between the regression specification it chose and the regression specification that the Company chose.

Q. Did Staff accurately characterize the regression specification that it uses?

A. No. Staff witness Hari K. Poudel states that "Staff used the Auto Regressive Moving Average (ARMA) model in the regression analyses."[1] Staff did not use an ARMA model. An ARMA model **only** includes lags of the dependent variable, i.e. electricity usage, and lags of the error term. Staff's regression specification, just like the Company's, is centered around modeling the relationship between an exogenous (truly independent) variable, the weather, and electricity usage. An ARMA model of electricity usage could be specified, but by definition, an ARMA model could not include an exogenous variable such as the weather. What Staff did was include a first order autoregressive or AR1 term alongside the binary controls and exogenous weather variables. The AR1 term is synonymous with a one period lag of the dependent variable discussed in my rebuttal testimony.

Q. Why do you feel it is important to point out what might sound like a subtle technical point?

A. ARMA models are a well-defined and widely used class of time series models with distinct technical characteristics. Staff did not need to identify the class of model it used, but they tried to do just that, and failed. Staff's failure to know what model they are not using raises concerns about its understanding of the technical implications of the model that it is actually using. It is the technical implications of the lagged dependent variable or AR1 which create a problem with Staff's weather normalization procedure. Furthermore, Staff makes statements about the benefits of ARMA models that support the notion that Staff is motivated by the wrong objective. I will expand on competing objectives in regression analysis a little farther below.

[1] File No. ER-2022-0337, Hari K. Poudel, Ph.D. Rebuttal Testimony, at p. 2, ll. 8 - 9.

Q. Did Staff highlight the most important difference between its weather model and the weather model used by the Company?

A. Yes. Staff highlighted the fact that it included a lag of the dependent variable or AR1 term in its model of the relationship between weather and electricity usage, and the Company did not.

Q. Why is this difference important?

A. The difference is important because it is the inclusion of the lagged dependent variable which causes the bias in Staff's estimate of the effect of weather on usage, and an unbiased estimate of the effect of weather on usage is the thing we need to weather normalize usage.

Q. Does Staff provide any evidence to suggest the problem you outline in rebuttal does not exist?

A. No.

Q. Does Staff provide any evidence to suggest that the problem you outline in rebuttal does exist?

A. Yes. Specifically, Staff witness Poudel states "[t]here is some correlation between energy consumed in the past and the energy used in the future along with the impact of the weather."[2] Staff correctly notes that there is a *correlation* between energy usage yesterday and energy usage today. Staff, however, does not assert there is a *causal* relationship between energy usage yesterday and energy usage today. Staff does not assert a causal relationship because there is no plausible explanation for a causal relationship between usage yesterday and usage today. There is, however, a very plausible explanation for the correlation between usage yesterday and

[2] *Id.*, p. 2, ll. 14-16. In terms of Staff's regression specification, past equals yesterday and future equals today or past equals today and future equals tomorrow.

usage today. Electricity usage observed on any one day is caused by the weather on that day. Since weather is correlated from one day to the next, so is electricity usage.[3]

Q. How is the distinction between correlation and causation evidence that the problem you outline in rebuttal does exist?

A. Achen proves mathematically the conditions under which the inclusion of a lagged dependent variable will result in a biased estimate of the effect of truly exogenous independent variable.[4] In our context, the lagged dependent variable is yesterday's usage, and the truly exogenous variable is today's weather. The second and third conditions are necessary, and the first makes the math easier and the results clearer. The first condition is also true in our context, so we include it here. The three conditions are as follows:

1. The lagged dependent variable (yesterday's usage) doesn't have a casual effect.
2. The exogenous variable (weather) follows an autoregressive process.
3. The error term follows an autoregressive process.

We can determine if a variable is autoregressive by estimating the following model:

$$x_t = \rho x_{t-1} + \varepsilon_t$$

And testing to see if $\rho > 0$. We first conduct this test using the weather variable used by Staff in its weather normalization models. The estimate of ρ is 0.9965 and the t-statistic is 400. This is clear evidence that the exogenous variable, weather, follows an autoregressive process.[5] The error term by its nature unobservable, so we do the standard next best thing. We use the

[3] The correlation between yesterday's and today's temperature for the period Staff uses to estimate its model is 0.94877.
[4] Achen, C. H. (2000, July). Why lagged dependent variables can suppress the explanatory power of other independent variables. In annual meeting of the political methodology section of the American political science association, UCLA, (Vol. 20, No. 22, pp. 7-2000).
[5] The results of the model result in the failure to reject the hypothesis that $\rho = 1$ at the 95% confidence level. Having $\rho = 1$ is basically saying that the weather is unpredictable day to day.

estimates of the error term or residuals taken from the true model. Since there is no plausible reason to believe the lag of the dependent variable has a causal relationship with itself in the next period, we exclude the lag from the model. Again, we use Staff's data and regression model, excluding the lagged dependent variable, and estimate the error term. Then we use those error terms to estimate the autoregressive model above. Then estimate of ρ is 0.4087 and the t-statistic is 13. This is clear evidence that the error term follows an autoregressive process.[6]

It should be clear at this point that Staff's inclusion of the lag of electricity usage in a model intended to identify the causal relationship between weather and usage is problematic. In fact, it causes Staff's estimate of the relationship to be invalid. This causes Staff's weather normalization procedure to be invalid.

Q. Does Staff offer any evidence to suggest it is pursuing the wrong objective when specifying their weather model?

A. Yes, there are several similar comments which illustrate Staff is pursuing the wrong objective. First, Staff witness Poudel states "ARMA is one of the models that [sic] used in the electricity price forecasting."[7] It is true that ARMA and its more general relatives have been used in the scientific literature to forecast *electricity prices*, but that fact is not relevant to a discussion of *weather normalization*. Weather normalization has nothing to do with electricity prices or the kind of out-of-sample forecasting ARMA models are used for in that context.[8] Staff witness Poudel further illustrates Staff is pursuing the wrong objective in saying "Staff used the AR1 that helps in

[6] Achen's proofs provide another piece of information which helps us to understand that the problem identified here is true. Achen's proofs show that the parameter estimate on lagged usage converges to the autocorrelation parameter from the error model as the autocorrelation parameter from the exogenous variable model converges to 1. The parameter estimate on the lagged usage variable in Staff's model is 0.438 and the standard error of the estimate is 0.028, which means that the parameter estimate on the lagged usage variable is not statistically different from estimate of the autocorrelation parameter from the error model, 0.4087.

[7] File No. ER-2022-0337, Hari K. Poudel, Ph.D. Rebuttal Testimony, at p. 2, ll. 8 - 9

[8] Bowden, N., & Payne, J. E.. Short term forecasting of electricity prices for MISO hubs: Evidence from ARIMA-EGARCH models. Energy Economics, 2008, Vol. 30, Issue 6, 3186-3197.

improving the estimation of the future energy consumption."[9] Staff has now moved to the relevant context, energy consumption or usage, but remains erroneously fixated on the idea of forecasting future consumption. Staff witness Poudel reiterates: "[i]n order to reflect the relationship between the past and the future energy consumption behavior of customers, Staff's analysis kept the AR1 term in the [sic] in the energy forecast modeling." There are a couple of things which Staff could be confused about here, and we can unpack its confusion a little, but it is perfectly clear that nothing Staff offers relates to the validity of its model. ARMA models are useful for forecasting the future (out-of-sample) for one reason. In time periods, beyond the sample, the values of other variables which explain the dependent variable will be unknown. ARMA models only use values of the dependent variable from the past, so this trouble can be avoided by using them. However, weather normalization has nothing to do with forecasting out-of-sample.

Q. Assume Staff is not concerned with forecasting out-of-sample, but rather with predicting usage within the sample. Does this resolve the issue?

A. No. Staff should not be concerned with predicting usage in the sample. Staff should be concerned with identifying the causal impact of weather.

Q. Does Staff argue that the lagged dependent variable or AR1 term helps to identify the causal impact of weather?

A. No. Staff does not draw any distinction between causal identification and in-sample prediction.

Q. Why is that a problem?

A. In-sample prediction can be improved by including variables which do not have a causal interpretation. However, the inclusion of those variables can corrupt the identification of

[9] File No. ER-2022-0337, Hari K. Poudel, Ph.D. Rebuttal Testimony, at p. 2, ll. 13 – 14.

causal effects associated with other variables that do have a causal interpretation. This is what Staff appears to be doing. Staff appears to include the AR1, because it believes it should be forecasting/predicting electricity usage when in fact, it should not be. Staff does not appear to understand that the same statistical methods can be used to do different things. Specifically, regression analysis can be used for prediction or for causal inference. The two need not be complimentary, and indeed in this case, they are not. Staff's pursuit of predictive power of its electricity usage forecast model corrupts Staff's ability to identify the causal impact of weather. The true causal impact of weather is the thing we care about, because it is the one and only thing we need to know in order to weather normalize usage. Staff's model does not identify the causal impact of weather, and this fact causes its weather normalization procedure to be invalid. I therefore recommend the Commission use the Company's weather normalization results in establishing billing units in this case.

IV. STAFF'S BLOCK NORMALIZATION

Q. Does Staff offer any criticism of the Company's block normalization process in rebuttal?

A. Yes. Staff witness Michael Stahlman claims that the Company's model is inefficient, not consistent with theory or the data, and is unreliable.

Q. What does Staff claim is the most significant evidence that the Company's model is unreliable?

A. Staff witness Stahlman claims that the Company's use of additional logical constraints in its block normalization procedure is the most significant evidence that the procedure is unreliable.[10]

[10] File No. ER-2022-0337, Michael Stahlman Rebuttal Testimony p. 1-2, February 15, 2023.

Q. Are the additional logical constraints evidence that the Company's procedure is unreliable?

A. No. In fact, Staff's failure to include similar constraints is evidence that its procedure is unreasonable.

In my direct testimony, I outline how the additional logical constraints improve the performance of the Company's weather normalization procedures.[11] Those constraints are valuable because of **one fact** about the weather normalization procedure used by the Company: while the Company produces one regression model for total kWh and another regression model for the proportion of Block 1 kWh, **those models are estimated independent of each other**. Therefore, it is possible for the two models to produce results that are inconsistent. The constraints prevent the results prescribed by the Block 1 regression model from dictating outcomes that would be inconsistent with the results of the total kWh model results. This is outlined using specific numerical examples from the test-year in my direct testimony.

While Staff's characterization of the impact of the Company's use of the constraints is incomplete and inaccurate at times, we will ignore that for now, because one other fact clearly discredits Staff's criticism and Staff's model. Staff acknowledges that the Company's "solution," the use of the additional constraints, is "better than using inappropriate regression adjustments."[12]

Q. How does this acknowledgement discredit Staff's criticisms and Staff's model?

A. The **one fact** stated above related to the Company's procedure applies equally to Staff's weather normalization procedures. The regression Staff estimates to model the relationship

[11] File No. ER-2022-0337, Nicholas Bowden Direct Testimony, p. 14 -17, August 1, 2022.
[12] File No. ER-2022-0337, Michael Stahlman Rebuttal Testimony, p. 2. This section is extracted from a larger quotation. "Q. Does the 'additional logical constraint' include an alternative method of weather-normalizing the blocks in the affected months? A. No. Dr. Bowden's solution is to leave the block unadjusted. This solution, while better than using an inappropriate regression adjustment, questions the whole reason for weather normalizing the block usage; if not necessary here, why bother with the other months?"

between total kWh and weather is completely independent of the regression Staff estimates to model the weather normalized proportion of kWh in Block 1. Thus, it is also possible for Staff's two models to produce results that are inconsistent in the exact same way that the Company's models could have been inconsistent had the Company not included the logical constraint. In fact, Staff's models do produce inconsistent or "inappropriate regression results." Despite acknowledging the that the Company's "solution" is "better than using inappropriate regression results," Staff chooses to use inappropriate regression results. Staff's choice to use inappropriate regression results despite the existence of a known solution makes Staff's Block normalization process unreasonable.

Q. Please provide any examples of Staff choosing to use inappropriate regression results to normalize Block 1 kWh in the face of a known solution.

A. There are numerous examples. For the sake of brevity, I will only enumerate the instances associated with normalization process applied to customers on the Residential Anytime Users rate. For three of the 12 months included in Staff's updated test year analysis, Staff chooses not to use its regression results, but for reasons unrelated to the issue discussed above.[13] We will ignore those three months and turn to the remaining nine months where the regression results are used to apportion the weather normalized kWh to blocks. In five of the remaining nine months, Staff's regression results are inappropriate, but Staff uses them anyway. Those months are November 2021, February 2022, March 2022, April 2022, and May 2022. We will use February 2022 to illustrate why the regression results Staff uses are inappropriate in all those months.

The relevant empirical evidence related to February 2022 is provided in Table 4. The Table provides the observed test year kWh, the observed Block 1 proportion, Staff's total weather

[13] In those three months Staff replaces the regression results for the Block 1 proportion with 100%. Staff offers no explanation, but there is certainly no reasonable one.

normalization factor, Staff's Block 1 normalized proportion, and the results of Staff's weather normalization procedure. Table 4 shows that Staff's total kWh normalization and Block 1 normalization produce incompatible results. Staff ignores the incompatibility of the results and instead makes billing unit adjustments that are inappropriate and unreasonable.

Weather related usage in February is driven by electric space heating loads. Staff's February total weather normalization factor is 0.97536. A total weather normalization factor less than 1 in February indicates that lower than normal temperatures caused higher than normal usage. When Staff's February total weather normalization factor of 0.97536 is multiplied by actual February usage, the result is lower normalized usage. This is logical.

Now, what are the implications for the number of Block 1 kWh, the number of Block 2 kWh, and the proportion of the number of total kWh in Block 1 and Block 2? If total usage decreases because normal temperature is greater than test year actual temperature, then we would expect to see decreases in both Block 1 usage and Block 2 usage. That is exactly what the logical constraint employed by the Company in its process ensures occurs in the Company's weather normalization process. If the average per customer usage was greater than the Block 1 limit of 750, which it was, then we would expect to see a greater reduction in Block 2 kWh than the reduction in Block 1 kWh. If the reduction in Block 2 kWh is greater than reduction in Block 1 kWh, then the Block 1 proportion of the total would increase. It is not necessary for the number of Block 1 kWh to increase in order for the Block 1 proportion to increase, and there is no reason to believe the number of Block 1 kWh will increase.

The Block 1 proportion observed in the test year was 42.4%. Staff's regression estimate prescribes an increase in the Block 1 proportion as logic outlined above would suggest. Is the size of the prescribed increase appropriate given the change prescribed by the total weather normalization? The short answer is no. Staff's regression prescribes that the Block 1 proportion increase from 42.4% to 45.8%. The increase, which Staff implements, is too large, because it requires an increase in Block 1 kWh in order to allow a decrease in Block 2 kWh large enough to reach the prescribed proportion given the adjustment prescribed by total kWh weather normalization. This is a clear example of how the independent nature of the two regression models can produce inconsistent or incompatible results. There is no reasonable explanation that supports increasing Block 1 kWh in a month that was colder than normal, which requires a weather adjustment to decrease total kWh for the period. Despite this fact, Staff does just that. Specifically, Staff increases Block 1 kWh usage by 28 million so that Staff can decrease Block 2 kWh by 58 million kWh, given that the total change must equal the 30 million kWh decrease prescribed by the total weather normalization.

Table 4

Staff February 2022	Observed	Weather Normalization	Normalized	Change
Total Winter kWh	1,222,568,268	0.97536	1,192,445,270	-30,122,998
Block 1	518,229,729	0.458	546,463,340	28,233,611
Block 2	704,338,539		645,981,929	-58,356,610
Percent Block 1	0.424		0.458	

Q. Can you use the example above to illustrate how the additional logical constraints used by the Company provides improved performance and protect against the type of unreasonable adjustments that Staff adopts?

A. Yes. We can make one simplifying assumption to illustrate how the additional logical constraints modify the regression results and protect against the unreasonable types of adjustment made by Staff. This assumption is not necessary, it simply makes the illustration easier to follow.[14] Assume all customers are average. Table 5 provides the February 2022 customer count and the average customer kWh usage. Now apply Staff's total weather normalization to the average customer, 0.97536*1,442.74 = 1,407.19. This illustrates how the average customer's usage changes as a result of the weather normalization of total kWh. Given all the customers are average, there is no need to estimate the effect of the proportion, we can observe the effect on the proportion directly by applying the total equally to each of the equal average customers.

Table 5

Staff February 2022	Observed	Normalized	Change
Customers	847,393	847,393	0
Average Usage	1,442.74	1,407.19	-35.54

Each customer's usage decreases by 1,442.74 – 1,407.19 = 35.54 kWh. If we take each customer's decrease and multiply it by the total number of customers, then we see we have achieved the total decrease of 847,393 * 35.54 = 30,116,347.22 kWh.[15] Furthermore, all of the decrease happened above the Block 1 threshold, i.e. there is a 30 million kWh decrease in Block 2 kWh and 0 decrease in Block 1 kWh. There is no rational way for us generate more decreases in Block 2 kWh while respecting the total kWh decrease. We certainly cannot pretend that each one of these customers has more Block 1 kWh, so we can subtract more Block 2 kWh, but that is exactly the kind of thing Staff's adjustments imply you can do.

Now to be clear, this is not how the constraint is implemented, but it does provide a rational way for us to view the outcome of the constraint. The constraint operates by forcing both Block 1 and Block 2 to move in the same direction as the total kWh normalization, or at least not move in

[14] When we say necessary here, we mean that the same result can occur even if the assumption was not true.
[15] Here the product is short approximately 6,000 kWh, but that is simply the result of rounding the usages to 2 decimals. If we rounded to five decimals, then we would be within 1 kWh of the total.

the opposite direction. In the cases where the Block 1 proportion regression dictates Block 1 or Block 2 move in the opposite direction, the constraint stops the movement at 0. The result is a modification, not a nullification, of the Block 1 proportion regression result. That fact is illustrated in Table 6.

Table 6

Staff February 2022	Observed	Normalized	Modified
Total Winter kWh	1,222,568,268	1,192,445,270	1,192,445,270
Block 1	518,229,729	546,463,340	518,229,729
Block 2	704,338,539	645,981,929	674,215,541
Percent Block 1	0.424	0.458	0.435

The Modified column of Table 6 show the results that would occur if the Company's additional logical constraint were applied to Staff's procedure. The additional logical constraint prevents the illogical increase in the number of Block 1 kWh Staff chooses to make in its adjustment procedure, when we know total usage is decreasing as a result of the overall weather adjustment for that month. However, the additional logical constraint does not negate the outcome suggested by the regression model, but rather modifies it. Staff's regression model suggests the Block 1 proportion should increase from 0.424 to 0.458, but this can't be achieved by rational means, so the additional logic constraint modifies the increase from 0.458 to 0.435.

Q. Does Staff accurately describe the effect of the additional logical constraints?

A. No. Staff conflates adjustments to Block 1 kWh with adjustments to the proportion of total kWh in Block 1 and inaccurately portrays the relationship between the regression analysis and the outcome. Specifically, Staff witness Stahlman states the following: [16]

> Q. Does the 'additional logical constraint' include an alternative method of weather-normalizing the blocks in the affected months?

[16] File No. ER-2022-0337, Michael Stahlman Rebuttal Testimony, p. 2, ll. 4 - 8.

A. No. Dr. Bowden's solution is to leave the block unadjusted. This solution, while better than using an inappropriate regression adjustment, questions the whole reason for weather normalizing the block usage; if not necessary here, why bother with the other months?

First, the question is misguided and conflates the number of Block 1 kWh with the proportion of total kWh in Block 1. It asks if the additional logical constraint includes an alternative method for normalizing the blocks. Point one: The question conflates the two things, the number of Block 1 kWh and the proportion of the total kWh in Block 1, by vaguely referring to the 'blocks'. The Company's regression model, just like Staff's, uses the proportion of the total kWh in Block 1 as the dependent variable, not the number of kWh in Block 1. Point two: The question presupposes that the additional logical constraint is or should offer an alternative to the regression, when in fact it is a complimentary addition to the regression model, not a substitute for it. The fact that there is an important difference between the number of kWh in Block 1 and proportion of total kWh in Block 1 is outlined in detail above. Also, the fact that the additional logical constraint modifies rather than replaces the regression results is outlined in detail above.

Second, if we remove the conflation and ignore the misguidance, then Staff's answer is still wrong. The answer is yes, the additional logical constraints result in a different value of the normalized Block 1 proportion, i.e. it adjusts the proportion of total kWh in Block 1. It is true, that the constraint can hold the number of Block 1 (or Block 2) kWh constant, but this is not the same thing as not adjusting the Block 1 proportion.

Q. What do you think about Staff's criticism of the Company's use of month specific regressions?

A. There are a couple of problems. First, Staff incorrectly identifies the data used in the regressions. This is troubling since the data is the same that is used throughout the entirety of both the Company's and Staff's billing unit and normalized revenue analysis. Staff says that the usage data is provided by revenue month, which is false. I clearly explain in my direct testimony that the data is provided by primary month. The two, revenue and primary, are two different definitions of time that can be used to aggregate the Company's usage data. Calendar month data, on the other hand, doesn't exist because we have billing cycles that spread metering and billing operations more or less uniformly across time. The seasonal proration of primary month bills, which was discussed at great length in our last case, renders billing units which are effectively based on the calendar.

Regardless, Staff identifies a supposed problem - that weather is defined by calendar month and usage is defined by primary month, which actually represents usage spread across two calendar months. Staff is incorrect about this though. For example, primary month February usage will reflect some calendar month January and some calendar month February usage in it, varying between customers based on when each customer billed in that period has their meter read according to the Company's twenty-one billing cycles. Staff then assumes that the Company's February regression analysis looks at the relationship between some January usage and some February usage and weather that occurred strictly in the calendar month of February. However, the weather variable that the Company actually uses for the regression analysis is not based on weather that occurred strictly within the calendar month of February. To calculate the weather variable used in the regression, the Company looks at its twenty-one billing cycles that occur within the primary month and accumulates weather data for each billing cycle that matches the dates that customers billed in that cycle use energy for purposes of determining their bill and averages the observed weather across those billing cycles. This practice ensures an accurate match between the weather data and the usage data included in the regression analysis. Therefore, Staff's criticism is misplaced, simply because Staff does not understand the nature of the weather variable the Company used in its analysis. Staff's point should be rejected.

Q. How do you respond to Staff's characterization of the relationship between weather and Block 1 usage as indirect?

A. It does not make sense. Staff witness Stahlman says the relationship between heating degree days and Block 1 usage is indirect because more heating degree days means more usage, and larger customers tend to have more usage in the second block than the first.[17] The first part is true, the regressions and experience tell us that more heating degree days causes more usage. The second part is not necessarily true and doesn't logically tie the first part to Staff's conclusion. The second part is that larger customers tend to use more usage in the second block than the first. The more kWh a customer uses the more usage they have in the second block, but only after they pass the 750 kWh threshold. Passing the threshold doesn't mean the number of Block 2 kWh is greater than Block 1 kWh. And what does this have to do with the relationship between heating degree days and Block 1 usage? If anything, the corrected version of the second part explains how the effect of heating degree days on total usage **directly** leads to changes in the proportion of Block 1 kWh.

Nonetheless, Staff continues and states that analyzing the average usage is a more direct way of determining Block 1 usage. This statement has no clear meaning and certainly isn't supported by any evidence, empirical or theoretical. The truth is this: each customers' usage is directly affected by weather. The proportion of usage in Block 1 and the average usage are both

[17] File No. ER-2022-0337, Michael Stahlman Rebuttal Testimony, p. 4 and ll. 4-9, February 15, 2023.

characteristics of the mathematical distribution of customer usage.[18] In that way, both the proportion in Block 1 and the average are directly caused by weather. There is no similar interpretation of the average usage causing the proportion in Block 1. They are both characteristics of the mathematical distribution of usage which is driven by weather.

V. SOLAR ADJUSTMENT

Q. Did Staff witness J Luebbert submit rebuttal testimony related to the Company's Solar Adjustment?

A. Yes.

Q. Did Staff accurately describe the general mechanics of the Company's Solar Adjustment?

A. Yes. Staff witness Luebbert accurately describes the general mathematical mechanics of the Company's Solar Adjustment. The Company's Solar Adjustment is an example of a billing unit annualization adjustment with the same mechanics as the Company's MEEIA Adjustment.

Q. Did Staff disagree with the mechanics of the Company's Solar Adjustment?

A. No.

Q. Did Staff disagree with the Company's Solar Adjustment?

A. Yes.

Q. Why does Staff disagree with the Solar Adjustment?

[18] Mathematical distribution here refers to the mathematical object often represented graphically using a histogram. In this instance, the number of kWh billed in a specific month is on the horizontal axis and number of customers billed the specific number is on the vertical axis. This histogram would tell you the highest and lowest kWh used by a customer in that month, and how much customers used any number of kWh in that month. The location of the average would depend on the shape of that histogram and could be represented graphically as a point or vertical line located at the calculated average usage.

A. Staff witness Luebbert questions the accuracy of the Company's estimation of kWh generated by behind-the-meter solar installations by criticizing the Company's data source, the National Renewable Energy Laboratory's ("NREL") PVWatts. Staff's primary evidence that PVWatts is unreliable is the legal disclaimers included on the PVWatts website. A reasonable person would not conclude that a legal disclaimer intended to prevent frivolous lawsuits is evidence that the estimates offered by PVWatts are unreliable. In fact, PVWatts is a widely recognized source of reliable estimates of solar generation output in the United States.[19] In fact, the reliability of PVWatts has been recognized by the Commission itself as the only alternative to direct metering for the determination Solar Renewable Energy Credits accruing to the electric utilities from behind-the-meter solar generation.[20]

Q. Does Staff criticize the Company's applications of the PVWatts data?

A. Staff criticizes the fact that the Company applies a single kWh generation estimate from PVWatts to all behind-the-meter solar installations. This is true – the Company uses the annual kWh generation estimate produced by PVWatts for the location of Ameren Headquarters, 1901 Chouteau Avenue, St. Louis, Missouri. Staff characterizes it as an assumption that all solar installations happen at this address. This is a fair way to characterize the assumption, but it doesn't make the assumption invalid. Staff's criticism is without merit for at least two reasons.

First, the Company and Staff both use an equivalent assumption for weather normalization. Both Staff and the Company use temperature data from a single location, the National Weather Service station at Lambert International Airport in St. Louis. Similar to Staff's characterization of

---

[19] PVWatts relies on the data from the National Solar Radiation Database (NSRDB). The NSRDB data is derived from the Physical Solar Model. The Physical Solar Model combines known and measurable facts like the temperature of the sun, the distance between the sun and any location on the Earth at every point in time, and NASA GOES satellite measurements of clouds to calculate the amount of solar radiation (in kW) that hits the Earth at any location at any time of the year during a typical meteorological year.
[20] 20 CSR 4240-20.100(4)(K).

solar installations, our shared weather models assume all customers HVAC systems are installed at Lambert Airport, but of course they are not.

Second, solar radiation doesn't vary much across the Company's service territory on monthly or annual timescales, which is what is important for estimating the solar adjustment. PVWatts estimates 1384 kWh annually per kW installed. Latitude matters more than longitude in terms of solar irradiance, so Cape Girardeau is a good example of a distant population center in the Company's service territory. PVWatts estimates 1400 kWh annually per kW installed. The difference between the estimates is only 1.156%.

Q. Are there any other billing unit annualization adjustments based on known and measurable investments in behind-the-meter energy technologies which rely on estimates of kWh to determine the adjustment?

A. Yes. The MEEIA adjustment is based on the known number of energy efficiency investments and estimates of their kWh savings. This is true whether those savings are deemed or evaluated. They are always estimates.

Q. Does Staff witness Luebbert make any arguments which may confuse relevant facts?

A. Yes. The rate proceeding starts with the Company's filing of a direct case. That direct case is based on a test year. In this case, that test year was April 2021 to March 2022. Approximately five months later Staff files its direct case, but that case is based on a different test year, sometimes referred to as the updated test year. In that filing, the test year was July 2021 to June 2022. Ultimately, the Company updates its direct filing to conform to Staff's test year. In terms of billing units, the early months of the Company's direct test year are removed and replaced with the later months of the Staff's updated test year. In this case, the billing units for April 2021 through June 2021 are completely removed in every meaningful way from the calculation of test year normalized revenue and billing units used to calculate rates. In the same way, the kW of solar installed in April 2021 through June 2021 are removed from the calculation of the Solar Adjustment in every meaningful way.

Specifically, Staff witness Luebbert states the following:

> Q. What level of solar generation has been added behind the meter during the test year?
>
> A. **____________________** were added in the test year. However, the billing determinants reflected in Staff's direct case fully reflect the energy output from the solar arrays installed prior to July, 2021, which accounts for more than 23% of the total solar capacity installed during the test year.[21]

The **_______________** is the solar capacity installed in April 2021 to March 2022 and 2,931.09 kW or 23.59% of that capacity was installed in April, May, and June of 2021. Staff's direct case establishes a new test year (the update period) and that test year excludes billing units in these three months from the calculation of normalized revenues and rates. Furthermore, this referenced capacity is excluded from the solar adjustment used in the updated test year. Staff's assertion is an irrelevant and confusing tautology at best and is potentially misleading. This statement should be utterly disregarded.

Q. Did Staff compare the level of solar investment made in the test year in File No. ER-2014-0258 when Staff made a solar adjustment to the level of solar investment made in this case?

A. Yes.

[21] ER-2022-0337, J Luebbert Rebuttal Testimony, p. 4, ll. 21 – 24 thru p. 5., ll. 1 – 2.

P

Q. Did the Company compare the levels of solar investment made in the test year in File No. ER-2014-0258 when Staff made a solar adjustment to the level of solar investment made in this case?

A. Yes. I made this comparison in my rebuttal testimony.

Q. How did those comparisons compare?

A. Staff concluded that the levels were not similar, while I conclude they were.

Q. Why did the two comparisons yield different conclusions?

A. Staff compared the level of kW installed in each case and I compared both the level of kW installed and the impact those kW would have on revenues. Staff compared the approximately **__________** installed in this case to the approximately **__________** installed in the last case and concluded that those levels are not similar. I compare the nearly $900,000 impact those nearly **__________** would have to the nearly $1,000,000 impact those **__________** would have and concluded they were similar because they are only about 11% apart (whereas the installed kW are about 280% apart). The kW and the kWh they imply have an impact on billing units, but the entire process of normalizing billing units is predicated on the calculation of revenues. Therefore, the revenue impact is of greater importance than the billing unit impact alone.

Q. Should similarity to the one case where Staff proposed an adjustment be the deciding factor?

A. No. Staff can say that **__________** is not similar to **__________**, but one could also say that **__________** is still large. Furthermore, the **__________** was known and measurable and the impact was significant at the time of the Company's direct testimony. We discussed the changing nature of the test year above and now we have additional information about the updated test year and true up. The level of capacity added between July 2021 and December 2022, the updated test year through true-up, is **__________** and the estimated impact on revenues is negative $1,982,612.

Q. Did Staff define any conditions under which Staff would be comfortable making a solar adjustment?

A. Yes, Staff defined two conditions under which Staff might allow measured behind-the-meter kWh generated by solar installations to be used to make billing unit adjustments. In order to understand Staff's recommendations, it is helpful to categorize kWh generated behind-the-meter into three categories. Staff's recommendation relates to two of those categories. Assume we are talking about a customer with an interval meter, i.e., a meter which measures and stores measurements at some regular time interval, e.g., each hour. In each interval, the meter measures and stores kWh consumed minus kWh generated. Below are the three categories:

1. Energy consumed is greater than energy generated in the interval. The meter measures and stores a positive number. Energy generation could be greater than zero but is less than energy consumed. If generation is greater than zero, then billing units are lower in the interval than they would be absent the generation, but the Company cannot see actual consumption or generation, just the positive difference. Therefore, the Company has no information about the reduction in billing units which result from the generation in that interval.

2. Energy consumed is less than energy generated. The meter measures and stores a negative number. Energy consumption could be greater than zero but is less than energy generated. If consumption is greater than zero billing units are lower in the interval than they would be absent the generation, but the Company cannot see actual consumption or generation, just the negative difference. Therefore, the Company has incomplete information about the reduction in billing units which result from the generation in that interval.

3. The sum of 1 and 2 for all the intervals in a billing cycle is negative. This means generation was greater than consumption over a billing cycle. The negative from the sum does not roll over to the next billing cycle. Rather the customer gets paid a net-metering (avoided fuel cost) rate for the remaining net negative kWh.

This is implied in 3, but the negative meter reads (excess generation) from 2 are used to reduce (net) the positive kWh in 1 in the billing process. This is where the name 'net metering' comes from. Category 3 outlines one possible outcome of net metering. The other possible outcome is that the sum of 1 and 2 is positive, but that condition is not relevant to Staff's positions, so we omit its explicit inclusion in the list of categories.

Q. What is the first condition under which Staff would consider allowing behind-the-meter generation to be used to adjust billing units?

A. Staff would consider allowing the net negative kWh described in 3 above to be used to adjust kWh.[22]

Q. Do you agree with Staff's first consideration?

A. No. These kWh never actually reduce billing units. They are excluded from netting billing units by the tariff. That is why they are paid the avoided cost rate. They reduce the Company's need to generate, but those kWh flow out through that customer's meter and in through another customer's meter, where they are metered and billed. It is just that the Company did not need to generate those kWh and therefore avoids the cost of generating each one. The idea behind the adjustment is to quantify the kWh that will reduce billing units either behind-the-meter or

[22] File No. ER-2022-0337, J Luebbert Rebuttal Testimony p.6 ll. 3-10, February 15, 2023.

through the net metering policy. These are the kWh that don't do either. In fact, we said earlier that Staff generally characterized the mechanics of the adjustment correctly. However, Staff did omit one small piece of the equation. Staff is correct to say we know this quantity of kWh and we use this quantity to reduce the solar annualization adjustment because this quantity, although generated behind the meter, does not actually reduce billing units.[23] This is contrary to the entire process of establishing billing units and is therefore unreasonable.

Q. What is the second condition under which Staff would consider allowing behind-the-meter generation to be used to adjust billing units?

A. Staff recommends that the Company process and retain the negative quantities associated with 2 above and use those quantities to construct an adjustment.

Q. Do you agree with Staff second condition for establishing a solar adjustment?

A. I agree that those kWh are one of three parts of the total kWh which reduce billing units. The other two parts are the non-zero kWh of consumption netting behind-the-meter in 2 and the portion of consumption netted behind-the-meter by any non-zero generation in 1. It is not clear how that one portion of the behind the meter generation could be used to accomplish the goal of the adjustment. The goal is to determine billing units which reflect known and measurable additions of generation capacity behind-the-meter so that the Company can calculate rates allowing it to cover its cost of operation. The Company knows there will be less billing units because of these additions. The Company may not know them precisely, but it can estimate them reliably. It is unclear how much of the total billing unit reductions which result from known behind-the-meter generators will fall into category 2. Given the same level of consumption and generation this number will vary just based on the timing of that generation and consumption.

[23] File No. ER-2022-0337, Nicholas Bowden Direct Testimony, p. 20 ll. 16-23, p. 21 ll. 1-2, August 1, 2022.

Actual reductions in billing units will not. It is as if Staff is not concerned with accurately calculating billing units, which is supposedly its express concern.

VI. RIDER EDI ADJUSTMENT

Q. Do you have any further response to Staff's Rider EDI adjustment than what you included in your rebuttal testimony?

A. No, I agree with Staff's position in rebuttal.

VII. GROWTH ADJUSTMENT

Q. Does Staff witness Kim Cox critique the Company's Growth Adjustment?

A. Yes, Staff observes that the Company uses a customer count forecast to perform a Growth Adjustment in its direct filing of billing units and normalized revenue. Staff asserts that a customer count forecast should not be used to adjust billing units.

Q. Why does the Company use a customer count forecast to perform a Growth Adjustment in its direct filing?

A. The Company uses a customer count forecast to perform a Growth Adjustment to better reflect expected billing units at the point in time which the Company expects the test year true up to take place.

Q. Did the Company use a customer count forecast to perform its Growth Adjustment at the time of true-up?

A. No. The Company uses actual customer counts from the true-up date to perform its Growth Adjustment.

VIII. RIDER C

Q. Would Staff witness Sarah L.K. Lange's recommended change to Rider C require billing unit adjustments?

A. Yes. Rider C involves scaling metered kW and kWh to determine billable kW and kWh. Staff recommends a change in that scaling factor, which would have a known and measurable effect on Rider C customers' billing units. Those billing units would need to be adjusted if Staff's proposal is adopted.

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.

Residential - Anytime Users	Billing Units	Current Rates	Current Revenue
Customer Charge			
Total Bills	7,656,624	9.00	68,909,616
Low Income Charge	7,656,624	0.14	1,071,927
Energy Charge			
Summer kWh	2,816,115,417	0.1296	364,968,558
Winter kWh			
First 750 kWh	3,038,626,921	0.0881	267,703,032
Over 750 kWh	2,408,038,028	0.0591	142,315,047
Total Anytime Users kWh	8,262,780,366		
Total Anytime Users Revenue			844,968,181

Residential - Anytime TOD	Billing Units	Current Rates	Current Revenue
Customer Charge			
Total Bills	384	9.00	3,456
Low Income Charge	384	0.14	54
			0
Energy Charge			0
Summer kWh			0
Off Peak	231,429	0.0786	18,190
On Peak	43,842	0.3346	14,670
Winter kWh			0
First 750 kWh	272,503	0.0881	24,008
Over 750 kWh	195,529	0.0591	11,556
Total kWh	743,304		
Total Anytime TOD Revenue			71,933

Residential - Evening Morning Savers			
	Billing Units	**Current Rates**	**Current Revenue**
Customer Charge			
Total Bills	5,333,904	9.00	48,005,136
Low Income Charge	5,333,904	0.14	746,747
Energy Charge			
Summer kWh	1,887,454,825	0.1263	238,385,544
Summer Peak kWh	1,157,843,675	0.005	5,789,218
Winter kWh			
First 750 kWh	1,736,041,513	0.0867	150,514,799
Over 750 kWh	1,357,290,055	0.0578	78,451,365
Winter Peak kWh	1,624,212,263	0.0025	4,060,531
Total kWh	4,980,786,393		
Total Anytime TOD Revenue			525,953,340

Residential - Overnight Savers			
	Billing Units	**Current Rates**	**Current Revenue**
Customer Charge			
Total Bills	9,276	9.00	83,484
Low Income Charge	9,276	0.14	1,299
Energy Charge			
Summer kWh			
Off Peak	1,096,369	0.0608	66,659
On Peak	2,232,484	0.1525	340,454
Winter kWh			
Off Peak	1,831,824	0.0524	95,988
On Peak	3,503,639	0.0858	300,612
First 750 kWh	194,099	0.0881	17,100
Over 750 kWh	142,761	0.0591	8,437
Total kWh	9,001,175		
Total R-TOU2 Revenue			914,033

Residential - Smart Savers			
	Billing Units	**Current Rates**	**Current Revenue**
Customer Charge			
Total Bills	6,012	9.00	54,108
Low Income Charge	6,012	0.14	842
Energy Charge			
Summer kWh			
Off Peak	653,851	0.0637	41,650
Intermediate Peak	1,150,888	0.1008	116,010
On Peak	314,644	0.3359	105,689
Winter kWh			
Off Peak	989,239	0.0526	52,034
Intermediate Peak	1,735,923	0.0645	111,967
On Peak	337,183	0.1798	60,625
First 750 kWh	283,008	0.0881	24,933
Over 750 kWh	211,644	0.0591	12,508
Total kWh	5,676,380		
Total R-SmartSavers Revenue			580,366

Residential - Ultimate Savers			
	Billing Units	**Current Rates**	**Current Revenue**
Customer Charge			
Total Bills	5,736	9.00	51,624
Low Income Charge	5,736	0.14	803
Energy Charge			
Summer kWh			
Off Peak	1,836,979	0.0479	87,991
On Peak	255,625	0.2831	72,367
Winter kWh			
Off Peak	3,338,504	0.0423	141,219
On Peak	414,334	0.1539	63,766
Demand Charge			
Summer Demand	10,456	7.71	80,617
Winter Demand	20,021	3.18	63,668
Total kWh	5,845,443		
Total kW	30,477		
Total R-SmartSavers Revenue			562,055

Community Solar Revenue	446,671
Total Residential Revenue	1,373,496,579

Small General Service Class	Billing Units	Current Rates	Current Revenue
Customer Charge			
One-phase	1,151,879	11.33	13,050,789
Three-phase	466,994	21.68	10,124,432
Limited Unmetered Service	85,843	6.01	515,919
TOD Bills			
One-phase	18,155	21.72	394,323
Three-phase	1,907	42.42	80,877
Low Income Charge	1,724,778	0.18	310,460
Total Bills	1,724,778		
Energy Charge			
Summer kWh	1,061,022,584	0.1135	120,426,063
Off Peak	26,896,276	0.0688	1,850,464
On Peak	15,403,254	0.1687	2,598,529
Winter kWh			
Base	1,472,287,916	0.0848	124,850,015
Seasonal	472,118,529	0.0488	23,039,384
Off Peak	56,611,937	0.0507	2,870,225
On Peak	30,919,851	0.1111	3,435,195
kWh Lighting Rate	2,267,734	0.0490	111,119
Total kWh	3,137,528,082		
Total Revenue			303,657,795

Community Solar Revenue	9,341
Total SGS Revenue	303,667,136

Large General Service	Billing Units	Current Rates	Current Revenue
Customer Charge			
Standard Bills	128,484	102.8	13,208,155
TOD Bills	608	21.08	12,817
Low Income Charge	128,484	2.06	264,677
Demand Charge (kW)			
Summer	8,031,915	5.87	47,147,340
Winter	14,900,672	2.18	32,483,465
Energy Charge			
Summer kWh			
First 150HU	1,026,499,016	0.1054	108,192,996
Next 200HU	1,115,800,142	0.0793	88,482,951
Over 350HU	462,230,770	0.0534	24,683,123
Off Peak	12,587,739	-0.0065	-81,820
On Peak	6,884,129	0.0114	78,479
Winter kWh			
Base Energy Charge			
First 150HU	1,681,248,695	0.0662	111,298,664
Next 200HU	1,779,474,298	0.0492	87,550,135
Over 350HU	735,910,323	0.0387	28,479,729
Seasonal Energy	441,180,846	0.0387	17,073,699
Off Peak	25,976,550	-0.0019	-49,355
On Peak	13,290,357	0.0035	46,516
Total kWh	7,301,082,866		
Total EDI Discount			-482,414
Total Revenue			558,389,158

Small Primary Service			
	Billing Units	Current Rates	Current Revenue
Customer Charge			
Standard Bills	7,992	352.19	2,814,702
TOD Bills	227	21.08	4,785
Low Income Charge	7,992	2.06	16,464
Demand Charge (kW)			
Summer	2,862,027	5.06	14,481,854
Winter	5,123,628	1.84	9,427,476
Energy Charge			
Summer kWh			
First 150HU	405,194,411	0.1023	41,451,388
Next 200HU	487,952,498	0.0769	37,523,547
Over 350HU	365,057,224	0.0517	18,873,458
Off Peak	29,396,903	-0.0048	-141,105
On Peak	14,259,129	0.0084	119,777
Winter kWh			
Base Energy Charge			
First 150HU	662,456,477	0.0644	42,662,197
Next 200HU	800,570,993	0.0479	38,347,351
Over 350HU	600,743,914	0.0374	22,467,822
Seasonal Energy	187,850,110	0.0374	7,025,594
Off Peak	49,881,072	-0.0018	-89,786
On Peak	25,669,977	0.0031	79,577
Reactive Power (kvar)	1,266,631	0.38	481,320
Rider B 34.5/69 kV Discount	832,926	-1.24	-1,032,828
Rider B 138 kV Discount	6,085	-1.47	-8,944
Total kWh	3,629,032,707		
Total EDI Discount			-179,990
Total Revenue			234,324,659

Large Primary Service			
	Billing Units	Current Rates	Current Revenue
Customer Charge			
Standard Bills	756	352.19	266,256
TOD	60	21.08	1,265
Low Income Charge	756	220.99	167,068
Demand Charge (kW)			
Summer	2,373,150	21.00	49,836,153
Winter	4,223,011	9.34	39,442,923
Energy Charge			
Summer kWh			
Energy	1,294,256,040	0.0357	46,204,941
Off Peak	84,694,869	-0.0035	-296,432
On Peak	42,546,301	0.0064	272,296
Winter kWh			
Energy	2,261,625,981	0.0326	73,729,007
Off Peak	152,366,069	-0.0018	-274,259
On Peak	74,777,529	0.0029	216,855
Reactive Power (kvar)	285,420	0.38	108,459
Rider B 34.5/69 kV Discount	1,589,995	-1.24	-1,971,593
Rider B 138 kV Discount	656,209	-1.47	-964,627
Total kWh	3,555,882,021		
Total EDI Discount			-61,598
Total Revenue			206,676,714

Company Owned Lighting 5M			
	Billing Units	**Current Rates**	**Current Revenue**
100000 MH Direct	361	74.26	321,694
11000 MV Open Btm	75	10.56	9,504
140000 HPS Direct	4	74.88	3,594
20000 MV Direct	191	22.83	52,326
20000 MV Enclosed	1,702	17.39	355,173
25500 HPS Direct	2,242	23.75	638,970
25500 HPS Enclosed	4,450	18.29	976,686
27500 HP Enclosed	207	18.29	45,432
3300 MV Open Btm	1,054	10.54	133,310
3300 MV Post Top	73	23.39	20,490
34000 MH Direct	606	22.87	166,311
34200 HPS Direct	4	23.75	1,140
36000 MH Direct	2,045	22.87	561,230
47000 HPS Direct	85	37.58	38,332
50000 HPS Direct	2,152	37.58	970,466
50000 HPS Enclosed	1,122	33.04	444,851
54000 MV Direct	13	33.89	5,287
54000 MV Enclosed	46	29.35	16,201
5800 HPS Open Btm	46	10.89	6,011
6800 MV Enclosed	3,298	12.7	502,615
6800 MV Open Btm	5,581	11.09	742,719
6800 MV Post Top	6,547	24.3	1,909,105
9500 HPS Enclosed	4,486	13.23	712,197
9500 HPS Open Btm	12,003	11.62	1,673,698
9500 HPS Post Top	34,071	24.84	10,155,884
LED 100 W EQ Bracket	78,268	10.68	10,030,827
LED 250 W EQ Bracket	11,854	17.24	2,452,356
LED 400 W EQ Bracket	1,967	31.67	747,539
LED Direct-Large	526	71.72	452,697
LED Direct-Medium	3,499	35.98	1,510,728
LED Direct-Small	2,905	22.44	782,258
LED Post Top - All	14,060	23.71	4,000,351
Municipal Discount		-0.0392	-1,583,470
Total Revenue			38,856,513

Customer Owned Lighting 6M			
	Billing Units	**Current Rates**	**Current Revenue**
100W LED Energy Only	45	1.66	896
11000 MV Energy Only	24	4.67	1,345
11000 MV Enrg&Maint	26	7.1	2,215
12900 MH Enrg&Maint	53	7.06	4,490
162W LED Energy Only	8	2.6892	258
180W LED Energy Only	9	2.988	323
196W LED Energy Only	28	3.2536	1,093
20000 MV Energy Only	88	7.21	7,614
20000 MV Enrg&Maint	38	9.33	4,254
25500 HPS Enrg&Maint	425	7	35,700
25500 HPS Enrgy Only	26	4.87	1,519
25W LED Energy Only	2	0.415	10
26W LED Energy Only	29	0.4316	150
27W LED Energy Only	10	0.4482	54
3300 MV Enrg&Maint	3	4.08	147
3300 MV Enrgy Only	84	2.02	2,036
36W LED Energy Only	43	0.5976	308
40W LED Energy Only	25	0.664	199
44W LED Energy Only	1	0.7304	9
45W LED Energy Only	47	0.747	421
50000 HPS Enrg&Maint	65	10.04	7,831
50000 HPS Enrgy Only	1	7.65	92
54000 MV Energy Only	11	17.17	2,266
54000 MV Enrg&Maint	4	19.8	950
54W LED Energy Only	33	0.8964	355
5500 MH Enrg&Maint	169	5.96	12,087
57W LED Energy Only	7	0.9462	79
60W LED Energy Only	4	0.996	48
6800 MV Enrg&Maint	1,445	5.25	91,035
6800 MV Enrgy Only	121	3.28	4,763
6M Ltd LED 100 W EQ	9,467	3.07	348,764
6M Ltd LED 250 W EQ	106	3.98	5,063
6M Ltd LED 400 W EQ	8	7.03	675
70W LED Energy Only	13	1.162	181
72W LED Energy Only	19	1.1952	273
75W LED Energy Only	182	1.245	2,719
80W LED Energy Only	249	1.328	3,968
85W LED Energy Only	50	1.411	847
9500 HPS Enrg&Maint	8,526	4.08	417,433
9500 HPS Enrgy Only	116	1.9	2,645
Fixture Revenue			965,117
Municipal Discount		-0.0392	-37,790
Total Revenue			927,326

Customer Owned Lighting 6M Metered			
	Billing Units	**Current Rates**	**Current Revenue**
Bills	20,051	7.75	155,395
Energy	42,066,286	0.049	2,061,248
Billed Revenue			2,216,643
Municipal Discount		-0.0641	-142,129
Total Revenue			2,074,515

Total Lighting Revenue	41,858,354

MSD Horsepower Service			
	Billing Units	**Current Rates**	**Current Revenue**
	36,900	0.1842	81,564

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Adjust Its Revenues for Electric Service.	)))	Case No. ER-2022-0337

AFFIDAVIT OF NICHOLAS BOWDEN, Ph.D.

STATE OF MISSOURI)
) ss
CITY OF ST. LOUIS)

Nicholas Bowden, Ph.D., being first duly sworn states:

My name is Nicholas Bowden, Ph.D., and on my oath declare that I am of sound mind and lawful age; that I have prepared the foregoing *Surrebuttal and True-Up Direct Testimony*; and further, under the penalty of perjury, that the same is true and correct to the best of my knowledge and belief.

/s/ Nicholas Bowden, Ph.D.
Nicholas Bowden, Ph.D.

Sworn to me this 13th day of March, 2023.