MISSOURI PUBLIC SERVICE COMMISSION

INDUSTRY ANALYSIS DIVISION

TARIFF/RATE DESIGN DEPARTMENT

SURREBUTTAL TESTIMONY

OF

MICHAEL L. STAHLMAN

UNION ELECTRIC COMPANY,
d/b/a Ameren Missouri

CASE NO. ER-2024-0319

Jefferson City, Missouri
February 14, 2025

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Q.	Please state your name and business address.

A.	My name is Michael L. Stahlman, and my business address is Missouri Public Service Commission, P.O. Box 360, Jefferson City, Missouri, 65102.

Q.	By whom are you employed and in what capacity?

A.	I am employed by the Missouri Public Service Commission ("Commission") as a Regulatory Economist for the Tariff/Rate Design Department, in the Industry Analysis Division.

Q.	Are you the same Michael Stahlman that filed direct and rebuttal testimony in this case?

A.	Yes

Q.	What is the purpose of your testimony?

A.	I will address Dr. Bowden's rebuttal testimony on weather normalization and the block adjustments.

Q.	Please summarize your testimony.

A.	First, I discuss some corrections and changes to my direct filed workpapers. Then I respond to Dr. Bowden's critiques of Staff's block usage estimation models. Finally, I

1   respond to Dr. Bowden's critique of the AR(1) model[1] and demonstrate that due to his exclusion

2   of lagged variables, his own weather normalization coefficients are biased.

3   **CORRECTIONS AND CHANGES**

4   Q.   First, did you reach out to Dr. Bowden early in the case as he discusses on pages

5   32 and 33 of his rebuttal testimony?

6   A.   Yes. I realized that I was applying an existing normalization method differently

7   and chose to provide this information early in the case to try and avoid a lengthy discussion on

8   statistical analysis and econometrics before the Commission. I informed him I would be

9   available to discuss this model and any issues he identified in its application.

10   Q.   Did Dr. Bowden ever ask questions or identify issues with your modelling prior

11 to rebuttal testimony?

12   A.   No.

13   Q.   Did you make any changes to your workpapers as a result of

14 Dr. Bowden's testimony?

15   A.   Yes. First, I was surprised when his testimony stated that I had "results where

16 block 1 and block 2 usage move in opposite directions."[2] Either by neglecting to save or losing

17 the work to several Excel crashes, the workpaper used in Staff's direct case was an early version

18 which still contained these errors. This workpaper was updated and distributed to the parties

19 prior to filling this surrebuttal. While this may not necessarily negate all of Dr. Bowden's

20 critiques, it does resolve the issues about illogical results.

21   Q.   What is the impact of correcting this workpaper?

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[1] The AR(1) model is a type of autoregressive model that uses the prior value in predicting a current value.
[2] Rebuttal Testimony of Nicholas Bowden, p. 5, l. 16.

1   A.   I provided the corrected results to Staff witness Kim Cox who stated Staff's

2   revenue calculations reduced by approximately $2.5 million. This is larger than Dr. Bowden's

3   estimated impact of $1.25 million.[3]

4   Q.   Did you make other corrections?

5   A.   Yes. Staff reviewed the section entitled, "Staff Removes Residuals before

6   Calculating Normalization Factors". Staff agreed with the example shown and updated all its

7   normalization workpapers to correct this issue. Note, these corrections were made after

8   distributing the corrected block workpapers above, and these changes will also impact the

9   values in those workpapers. While making these corrections, I also noticed some data entry

10   errors in the Industrial Small Primary Service workpaper and corrected those.

11   Finally, while Staff disagrees with some of Dr. Bowden's logic, Staff finds that he

12   provided sufficient evidence that the weather normalization of the Small General Services

13   ("SGS") Legacy Time-of-Day customers should be evaluated separately from the other SGS

14   class customers. However, Staff does not have the hourly or daily usage data for this customer

15   class. As a result, Staff applied the general SGS weather normalization factor to customers in

16   that rate schedule as Dr. Bowden suggested.

17   Q.   Do you have any recommendations based on the changes made so far?

18   A.   Yes. The Commission should order Ameren Missouri to provide three years of

19   hourly usage for all rate schedules in a customer class that has time-of-use rates in future

20   rate cases.

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[3] Rebuttal Testimony of Nicholas Bowden, p. 16, l. 6.

BLOCK ESTIMATIONS

1

2   Q.   Throughout the first portion of his rebuttal testimony, Dr. Bowden insists that

3 the appropriate model is to compare block usage with weather and not normal

4 usage-per-customer.[4] Does weather determine block usage?

5   A.   No, not directly. Per Ameren Missouri's tariff, a customer's overall use

6 determines the blocks. If a customer uses less than 750 kWh in a winter month (with no summer

7 days), then all of that customer's usage is in the first block, regardless of the outdoor

8 temperature. Temperature only impacts this relationship in the sense that colder temperatures

9 in winter correlate to higher usages, thus increasing the likelihood that a customer uses more

10 than 750 kWh.

11   Q.   Why did you qualify the previous answer with "with no summer days"?

12   A.   It is my understanding that Ameren Missouri prorates that block based on the

13 number of days in the winter season.[5] Therefore, if a customer's bill covers 32 days and three

14 of those days are in the winter season, Block 1 becomes usage less than approximately 70 kWh[6]

15 and Block 2 becomes usage above that. It is also my understanding that the usage is prorated

16 between summer and winter, so that if that same customer used 1000 kWh in that period,

17 approximately 94 kWh[7] would be deemed to have occurred in winter. This makes the blocks

18 for months with both summer and winter usage outliers when compared to months with only

19 winter usage and it becomes almost arbitrary to apply a block percentage.

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[4] E.g., Dr. Bowden's rebuttal testimony on p. 7 l. 19 though p. 8 l. 9.
[5] Per Ameren Missouri's General Rules and Regulations, V. Billing Practices, A. Monthly Billing Periods, "Beginning in calendar year 2021, summer rates will be applicable for service rendered from June 1st through September 30th. Where a bill includes any portion of both Summer and Winter periods the rate application will be prorated." (MO PSC Schedule 6, 3rd Revised Sheet No 130.)
[6] 70 kWh Winter Block 1 Cutoff $\cong$ (3 winter days ÷ 32 total days in cycle) × 750 kWh Block 1 Cutoff
[7] 94 kWh Winter Block 1 Usage $\cong$ (3 winter days ÷ 32 total days in cycle) × 1000 kWh Total Usage

1   Q.   One of Dr. Bowden's major critiques was that your method resulted in illogical

2   results. Did Dr. Bowden's primary method have illogical results?

3   A.   As discussed in my rebuttal, yes. However, when the results were illogical, he

4   left the block percentages unadjusted.

5   Q.   Dr. Bowden also states, "Staff does not appear to have a theoretical reason for

6   estimating a power function."[8] Is there a reason that the relationship would not be

7   strictly linear?

8   A.   Yes. Block 1 is naturally going to be a percentage of total usage bounded by a

9   value greater than 0% and less than or equal to 100%. A strict linear relationship could result

10   in illogical results, such as Block 1 being greater than 100% or less than 0%.

11   Q.   Did Staff's workpaper only have a sample size of eight (8)?[9]

12   A.   No. It's clearer in the updated workpaper, but even in the original workpaper

13   the residential class used a sample size of 18, and not eight (8).

14   Q.   Do you agree that Figure 10 of Dr. Bowden's rebuttal supports a finding that

15   single and three phase customers should be combined?

16   A.   No. It shows that there are large differences between the two classes, such as

17   approximately 5% in February 2024. As discussed in my direct and rebuttal testimonies, this

18   analysis is very sensitive to weather. Even the difference of 1% can be the difference between

19   logical and illogical results.

20   Q.   Could there be other issues with using the 17 years of weather and block usage

21   as he discusses on page 7 of his rebuttal?

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[8] Rebuttal Testimony of Nicholas Bowden, p. 23, ll. 6-7.
[9] Rebuttal Testimony of Nicholas Bowden, p. 8, ll. 16-17.

1   A.   Yes. First, it's unclear how Dr. Bowden aligned the calendar month weather

2 data with the revenue month, which covers a range of approximately two months. Also,

3 Dr. Bowden's analysis assumes that the essential relationship between weather and usage, due

4 to items such as the installation of heat pumps or other energy efficiency devices, did not

5 significantly impact the block usage over that time.

6 **WEATHER NORMALIZATION**

7   Q.   Dr. Bowden spends a large amount of time discussing Staff's weather

8 normalization models compared to his own. Do you agree with his discussion?

9   A.   No. Much of Dr. Bowden's discussion is confusing and contradictory. It's

10 unclear that he has spent the time to properly develop the underlying theoretical model.

11 For instance, he states, "We are trying to weather normalize today's total kWh usage, and there

12 is a difference between predicting today's usage and weather normalizing today's usage."[10]

13 But the dependent variable, the "y" of the model $y_t = \beta_0 + \beta_1 x_t + u_t$, is that day's usage.

14   For clarity to the Commission, I will focus on the issue by focusing only on the

15 residential energy models and approach this section of testimony thus:

16   (1) First, I will show that there is strong evidence of the need for an AR(1) model, both

17   theoretically and statistically;

18   (2) Next, I will show that ignoring AR(1) can result in biased estimators, and can

19   invalidate the model;

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[10] Rebuttal Testimony of Nicholas Bowden, p. 46, ll. 12-14.

1   (3) I will show that Dr. Bowden's model is not strictly exogenous,[11] and even if we

2   assumed strict exogeneity, statistical analysis still shows the need for an

3   AR(1) model;

4   (4) Finally, I will demonstrate that Dr. Bowden's coefficients are biased.

5 I will focus on the residential class, but this discussion would be applicable to other classes.

6   <u>Need for AR(1) Model</u>

7   Q.   Dr. Bowden says, "There is no reason to believe that yesterday's total kWh

8 causes today's total kWh." Do you agree?

9   A.   Absolutely not. Both Staff and Ameren Missouri use a weighted two day mean

10 daily temperature in the regression models in part because of the relationship between the prior

11 day usage and today's usage. The correlation between prior usage and current usage has been

12 well documented in energy economics. An American Council for an Energy-Efficient

13 Economy ("ACEEE") study stated, "[i]t is well accepted that most household energy use is

14 habitual rather than a series of conscious decisions."[12] As an example, it can be fairly routine

15 for a person to make a pot of coffee every morning, or to turn on the television at a particular

16 time of day, and also to have a set bedtime by which lights are turned off. This, and other

17 routines and habits, mean that prior day usage can be an excellent predictor of a current usage.

18   Q.   Is there a statistical test that can be performed to show the need to use an

19 AR(1) model?

20   A.   Yes. As discussed in Dr. Hamilton's textbook *Time Series Analysis*, the test to

21 determine if an AR(1) model is needed can be performed by the following regression:

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[11] Strictly exogenous in the context of a time series regression means the error term is unrelated to any instance of the variable X; past, present, and future.
[12] Lutzenhiser, L., Moezzi, M., Hungerford, D., & Friedmann, R. (2010). "Sticky Points in Modeling Household Energy Consumption." ACEEE Summer Study on Energy Efficiency Buildings. p. 7-173

1    $Y_t = c + \theta Y_{(t-1)} + e_t.$[13] If θ is close to zero, that means that the errors are essentially white

2   noise and an AR(1) model is not necessary. If θ is close to one, then the AR(1) model is needed.

3   Staff performed this test and, for residential energy, found θ to be significant at

4   approximately .897, with a 95% confidence interval of approximately 0.878 to 0.917. Thus, an

5   AR(1) model is both justified in theory, as discussed above, and by statistical analysis.

6   Q.   Dr. Bowden states, "Yesterday's total kWh is a good predictor of today's total

7   kWh because yesterday's total kWh is highly correlated with today's weather, which is the real

8   cause of today's total kWh."[14] Do you agree?

9   A.   No. While I agree that yesterday's total kWh is a good predictor of today's total

10   kWh, this is because much of energy use tends to be habitual or routine. Further, Dr. Bowden

11   does not adequately support the claim that yesterday's total kWh is highly correlated with

12   today's weather, nor is it supported by logic. It would be akin to saying weather forecasters

13   should review their energy usage to make tomorrow's forecast. In reality, it seems that

14   Dr. Bowden is aware, or should be aware, that there is a need for an AR(1) model.

15   <u>Ignoring AR(1) can Result in Biased Estimators</u>

16   Q.   Dr. Bowden states, "Autocorrelation does not make the estimate of the

17   relationship between weather and today's total usage inaccurate."[15] Do you agree?

18   A.   No. A more accurate statement would be, as put forth by Dr. Dennis Halcoussis,

19   "Autocorrelation *by itself* leaves the coefficient estimate unbiased." (emphasis added)[16]

20   Dr. Halcoussis continues, "[A]utocorrelation often occurs because an independent variable is

21   missing from the model. A relevant independent variable that is missing from the model can

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[13] Hamilton, James D., *Time Series Analysis*, 1994. pp. 53-56.
[14] Rebuttal Testimony of Nicholas Bowden, p. 46, l. 22 – p. 74 l. 1.
[15] Rebuttal Testimony of Nicholas Bowden, p. 53 ll. 4-5.
[16] Halcoussis, Dennis, *Understanding Econometrics*, 2005. p. 141

1 bias the coefficient estimates of the remaining variables, even without autocorrelation."[17] To be

2 fair to Dr. Bowden, I think he would agree given his discussion on strict exogeneity.[18]

3   Q.   Does Dr. Halcoussis discuss the dangers of leaving autocorrelation untreated?

4   A.   Yes. He states:

5   Left untreated, autocorrelation is dangerous for the researcher. Anyone
6   examining the work can easily criticize it, pointing out that coefficients
7   that seem to be significant may be insignificant, since the t-statistics are
8   higher than their true values. The F-statistic, R^2, and adjusted R^2 may
9   not be accurate either. These symptoms can be fatal for any model,
10   making the results at best unclear and at worst meaningless.[19]

11 In short, "[w]hen the autocorrelation comes from a missing independent variable, the estimates

12 will be biased."[20]

13   <u>Strict Exogeneity</u>

14   Q.   Dr. Bowden, summarizing Dr. Jeffrey M. Wooldridge, states, "Strict exogeneity

15 is the 'crucial assumption' for unbiased or accurate estimates in time series regression

16 analysis."[21] Would you agree that if Dr. Bowden's model held strict exogeneity, the

17 coefficients would be unbiased?

18   A.   Yes.

19   Q.   Is Dr. Bowden's model strictly exogenous?

20   A.   No. I hesitate to get deep into the weeds of this statistical analysis, but it is

21 important given Dr. Bowden's rebuttal. A relevant paragraph on page 350 of Dr. Wooldrige's

22 *Introductory Econometrics* reads thus:

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[17] Ibid
[18] For example, Rebuttal Testimony of Nicholas Bowden, p. 53 ll. 2-4.
[19] Halcoussis, Dennis, *Understanding Econometrics*, 2005. p. 141
[20] Halcoussis, Dennis, *Understanding Econometrics*, 2005. p. 141
[21] Rebuttal Testimony of Nicholas Bowden, p. 51, ll. 9–10.

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> In the simple static regression model $y_t = \beta_0 + \beta_1 z_t + u_t$ [strict exogeneity] requires not only that u_t and z_t are uncorrelated, but that u_t is also uncorrelated with past and future values of z. This has two implications. **First z can have no lagged effect on y**. If z does have a lagged effect on y, then we should estimate a distributed lag model. A more subtle point is that strict exogeneity excludes the possibility that changes in the error term today can cause future changes in z. ***This effectively rules out feedback from y on future values of z***. [Emphasis added]

10 First, recall that both Ameren Missouri and Staff use a two-day weighted mean daily

11 temperature. This means that yesterday's weather does have a lagged effect on today's usage

12 violating the first implication. Further, recall that Dr. Bowden's own testimony states,

13 "Yesterday's total kWh is a good predictor of today's total kWh because yesterday's total kWh

14 is highly correlated with today's weather."[22] This is saying that the future value of weather

15 (variable z) has feedback on today's usage (kWh); the y of the equation violates the second

16 implication. Therefore strict exogeneity does not hold even under his own analysis.

17 Additionally, on page 416 of Dr. Wooldrige's *Introductory Econometrics*, he states a

18 model where the regressors are strictly exogenous "rules out models with lagged dependent

19 variables." Because both Staff and Ameren use a two-day weighted mean daily temperature,

20 there is, in a sense, a lag in that dependent variable (i.e. yesterday's temperature impacts today's

21 energy consumption).

22 Q. For arguments' sake, assume that the model is strictly exogenous. Is there a test

23 that can be performed to see if the AR(1) model is justified?

24 A. Yes. Dr. Wooldridge discusses and provides this test starting on page 416 of his

25 *Introductory Econometrics* textbook. It is similar to the test for AR(1) discussed above, but is

26 ran on the residuals of a model against the lagged residuals. Staff ran this test on Dr. Bowden's

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[22] Rebuttal Testimony of Nicholas Bowden, p. 46, ll. 22–23.

1   residential energy model and found the coefficient to be significant at approximately .501, with

2   a 95% confidence interval of approximately 0.541 to 0.461. Thus, an AR(1) model is also

3   justified by this statistical analysis.

4   Q.   What about Dr. Bowden's analysis on pages 51 and 52?

5   A.   This does not appear to be proper analysis to evaluate strict exogeneity as it does

6   not include any analysis of the residuals with respect to time.

7   Dr. Bowden's Coefficients are Biased

8   Q.   Given all of the above, did you perform analysis to see if Dr. Bowden's weather

9   coefficients are biased?

10   A.   Yes. For the residential energy model, I compared Dr. Bowden's weather

11   coefficients in his direct model with the same coefficients in a model where the only change

12   was to include an AR(1). As seen in Figure 1, the result showed large changes in

13   the coefficients.

14   **Figure 1. Changes in Weather Coefficients in Dr. Bowden's Direct-Filed**

15   **Residential Energy Model and the Same Model with AR(1) Included**

16

	Direct Filed Coefficients	AR(1) Model Coefficents	Change (%)
ResSplines.AvgT	-2341363.7	-1989614.0	15.0%
ResSplines.XColdAvgT	1464492.9	1145969.0	21.7%
ResSplines.CoolAvgT	296411.0	257112.9	13.3%
ResSplines.MILDAvgT	567718.5	632023.2	-11.3%
ResSplines.WarmAvgT	889108.6	750791.9	15.6%
ResSplines.HotAvgT	655279.5	713818.4	-8.9%
ResSplines.ShoulderWarm	-424471.1	-476039.0	-12.1%

17

1   The variable ResSplines.AvgT even moved outside the original's 95% confidence interval,[23]

2   and the overall model statistics improved with the inclusion of AR(1).

3   Q.   In rebuttal testimony, you stated, "The difference in time periods, test year and

4   update period, can make it difficult to compare the weather normalization, but for the months

5   that overlapped, the adjustment factors seemed to be similar. Staff does not have large concerns

6   with the method used in those areas, at this time, with the exception of the TOU noted above."[24]

7   Has your opinion changed?

8   A.   Yes. In addition to Dr. Bowden's rebuttal testimony, Ameren Missouri provided

9   Staff some results of update workpapers in response to Staff Data Request 0694. Those

10   workpapers, combined with Dr. Bowden's rebuttal testimony, show that Staff and Ameren

11   Missouri were farther apart than what I originally thought.[25]

12   Q.   Please summarize your testimony.

13   A.   Staff has made corrections to its weather normalization and block usage

14   estimation based on some of Dr. Bowden's critiques. For the reasons above, Staff continues to

15   recommend that the Commission use Staff's weather normalization and block usage estimates,

16   as corrected. Staff further recommends that the Commission should order Ameren Missouri to

17   provide three years of hourly usage for all rate schedules in a customer class that has time-of-use

18   rates in future rate cases.

19   Q.   Does this conclude your surrebuttal testimony?

20   A.   Yes.

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[23] MetrixND does not provide a 95% confidence interval, but I calculated the approximate values by adding/subtracting 1.96 times the coefficient's standard error to the coefficient value.
[24] Rebuttal Testimony of Michael L. Stahlman, p.2, ll. 20-23.
[25] Staff witness Kim Cox estimated the difference due to weather and day adjustments, based on Ameren Missouri's response to Staff Data Request 0694 which included Dr. Bowden's adjustments at the update period and after my own corrections above ($3.6 million), to be approximately $7.8 million.

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	)	Case No. ER-2024-0319
Its Revenues for Electric Service	)	

AFFIDAVIT OF MICHAEL L. STAHLMAN

STATE OF MISSOURI	)	
	)	ss.
COUNTY OF COLE	)	

COMES NOW MICHAEL L. STAHLMAN and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing *Surrebuttal / True-Up Direct Testimony of Michael L. Stahlman*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

_____
MICHAEL L. STAHLMAN

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this ___4th___ day of February 2025.

_____
Notary Public