

*Exhibit No.:*  
*Issue(s):* *Weather*  
*Normalization*  
*Witness:* *Michael L. Stahlman*  
*Sponsoring Party:* *MoPSC Staff*  
*Type of Exhibit:* *Direct Testimony*  
*Case No.:* *GR-2021-0320*  
*Date Testimony Prepared:* *January 24, 2022*

**MISSOURI PUBLIC SERVICE COMMISSION**

**INDUSTRY ANALYSIS DIVISION**

**TARIFF/RATE DESIGN DEPARTMENT**

**DIRECT TESTIMONY**

**OF**

**MICHAEL L. STAHLMAN**

**THE EMPIRE DISTRICT GAS COMPANY,  
d/b/a Liberty**

**CASE NO. GR-2021-0320**

*Jefferson City, Missouri*  
*January 2022*



1 However, the Conception weather station is less reliable in providing daily information.  
2 Therefore, Staff recommends using the KCI weather station to weather normalize all of  
3 Empire's service territories.

4 Q. Why was normal weather developed for this rate cases?

5 A. Natural gas usage and revenue vary from year to year based on weather  
6 conditions. The temperature pattern in the test year is the primary determinant for  
7 weather-sensitive<sup>1</sup> customers' gas usage and Empire's revenue in the test year. Each  
8 year's weather is unique, so rates for weather-sensitive customer classes must be based on  
9 test year usage and revenue adjusted to a level commensurate with "normal" weather  
10 conditions, rather than actual test year usages and revenue.

11 Q. Where did Staff obtain its weather data?

12 A. Staff obtained weather data from the Midwest Regional Climate Center  
13 ("MRCC").<sup>2</sup> The KCI weather data was used for actual and normal weather variables. This  
14 weather station was selected based on the availability and reliability of the weather data as well  
15 as their approximate location to Empire's customer base. The weather data sets consist of actual  
16 daily maximum temperature ("T<sub>max</sub>") and daily minimum temperature ("T<sub>min</sub>") observations.  
17 Staff used these daily temperatures to develop a set of normal mean daily temperature  
18 ("MDT")<sup>3</sup> values. Natural gas sales are predominantly influenced by "ambient air  
19 temperature,"<sup>4</sup> so MDT and the derivative measure, heating degree days ("HDD"),<sup>5</sup> are the

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<sup>1</sup> Residential and the Small Commercial classes, excluding the Small Commercial Firm Service Large and transportation classes, are considered weather sensitive. This is further discussed by Staff in the Direct Testimony of Joel McNutt.

<sup>2</sup> <https://mrcc.purdue.edu/>.

<sup>3</sup> By National Climatic Data Center convention, MDT is average of daily maximum temperature (Tmax) and daily minimum temperature (Tmin) e.g.  $MDT = (T_{max} + T_{min}) / 2$ .

<sup>4</sup> Ambient air temperature is the outside temperature of the surrounding air without taking into account the humidity or wind in the air.

<sup>5</sup> Where  $MDT < 65^{\circ}F$ ,  $HDD = 65 - MDT$ ; otherwise,  $HDD = 0$ .

1 measures of weather used in adjusting test year natural gas sales. HDDs were originally  
2 developed as a weather measure that could be used to determine the relationship between  
3 temperature and gas usage. HDDs are calculated as the difference between 65°F and when MDT  
4 is below 65°F, and are equal to zero when MDT is above 65°F.

5 Q. What is a climate normal?

6 A. According to the National Oceanic and Atmospheric Administration (“NOAA”),  
7 a climate “normal” is defined as the arithmetic mean of a climatological element computed over  
8 three consecutive decades.<sup>6</sup> In developing climate normal temperatures, the NOAA focuses on  
9 the monthly maximum and minimum temperature time series to produce the serially-complete  
10 monthly temperature (“SCMT”) data series.<sup>7</sup>

11 Staff utilized the SCMT published in July 2011 by the National Climatic Data  
12 Center (“NCDC”) of NOAA. To Staff’s knowledge, NOAA is the only entity that provides  
13 reasonably reliable weather data for 30-year historical period and test year period for the  
14 Kansas City region. For the purposes of normalizing the test year gas usage and revenues,  
15 Staff used the adjusted  $T_{\max}$  and  $T_{\min}$  daily temperature series for the 30-year period of  
16 January 1, 1990, through December 31, 2019, at KCI. The series are consistent with  
17 NOAA’s SCMT during the most recent NOAA 30-year normal period ending 2010.

18 There may be circumstances under which inconsistencies and biases in the 30-year time  
19 series of daily temperature observations occur, (e.g. such as the relocation, replacement, or  
20 recalibration of the weather instruments). Changes in observation procedures or in an  
21 instrument’s environment may also occur during the 30-year period. NOAA accounted for

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<sup>6</sup> Retrieved on October 17, 2013, <https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals>.

<sup>7</sup> Retrieved on October 17, 2013, <http://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/source-datasets/>. The SCMT, computed by the NOAA, includes adjustments to make the time series of daily temperatures homogeneous.

1 documented and undocumented anomalies in calculating its SCMT.<sup>8</sup> The meteorological and  
2 statistical procedures used in the NOAA's homogenization for removing documented and  
3 undocumented anomalies from the  $T_{\max}$  and  $T_{\min}$  monthly temperature series is explained in a  
4 peer-reviewed publication.<sup>9</sup>

5         Subsequent to determining the homogenized monthly temperature time series described  
6 above, NOAA also calculates monthly normal temperature variables based on a 30-year normal  
7 period, e.g. maximum, minimum, average temperatures, and HDD values. These monthly  
8 normals are not directly usable for Staff's purposes because the NOAA daily normal  
9 temperatures and HDD values are derived by statistically "fitting" smooth curves through these  
10 monthly values.<sup>10</sup> As a result, the NOAA daily normal HDD values reflect smooth transitions  
11 between seasons and do not directly relate to the 30-year time series of MDT as used by Staff.  
12 However, in order for Staff to develop adjustments to normal HDD for gas usage, Staff must  
13 calculate a set of normal daily HDD values that reflect the actual daily and seasonal variability.

14         Q.     How did Staff calculate daily normal weather?

15         A.     Staff used a ranking method to calculate normal weather estimates of daily  
16 normal temperature values, ranging from the temperature that is "normally" the hottest to the  
17 temperature that is "normally" the coldest, thus estimating "normal extremes." Staff ranked  
18 MDTs for each month of the 30-year history from hottest to coldest and then calculated the  
19 normal daily temperature values by averaging the ranked MDTs for each rank, irrespective of  
20 the calendar date. The ranking process results in the normal extreme being the average of the

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<sup>8</sup> Arguez, A., I. Durre, S. Applequist, R. S. Vose, M. F. Squires, X. Yin, R. R. Heim, Jr., and T. W. Owen, 2012: NOAA's 1981-2010 U.S. Climate Normals: An Overview. *Bulletin of the American Meteorological Society*, 93, 1687-1697.

<sup>9</sup> Menne, M.J., and C.N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, 22, 1700-1717.

<sup>10</sup> A more detailed description is discussed in Won, S. J., Wang, X. H., & Warren, H. E. (2016). Climate normals and weather normalization for utility regulation. *Energy Economics*, 54, 405-416.

1 most extreme temperatures in each month of the 30-year normals period. The second most  
2 extreme temperature is based on the average of the second most extreme day of each month, and  
3 so forth. Staff's calculation of daily normal temperatures is not the same as NOAA's calculation  
4 of smoothed daily normal temperatures because Staff calculated its normal daily temperatures  
5 based on the rankings of the actual temperatures of the test year, and the test year temperatures  
6 do not follow smooth patterns from day to day. More details of Staff's ranked average method  
7 for normal weather are explained in a peer-reviewed publication.<sup>11</sup> Using these normal daily  
8 temperatures, Staff calculated normal HDD for each day of the test year. This information was  
9 made available to Staff witness Joel McNutt to calculate the weather normalization adjustments.

10 Q. Did Staff look at other weather stations?

11 A. Yes. Based on this company's prior general rate case, Case No. GR-2009-0434,  
12 Staff also reviewed the weather station at Conception, Missouri. Unlike KCI, Conception is not  
13 designated by NOAA as a First-Order Weather Station. First-order weather stations are usually  
14 located at regional or municipal airports, where professional observers continuously monitor  
15 the weather instruments. The NOAA-certified instruments at KCI - record daily maximum and  
16 minimum temperatures, with hourly observations of precipitation, temperature, dew point,  
17 wind, and other weather elements.

18 Q. Did Staff use this weather station in its final weather normalization analysis?

19 A. No. Several factors influenced Staff's determination to not use the Conception  
20 weather station for the weather normalization adjustment this case. First, NOAA has updated  
21 its climate normals twice since the weather at Conception was last used. Staff has not yet

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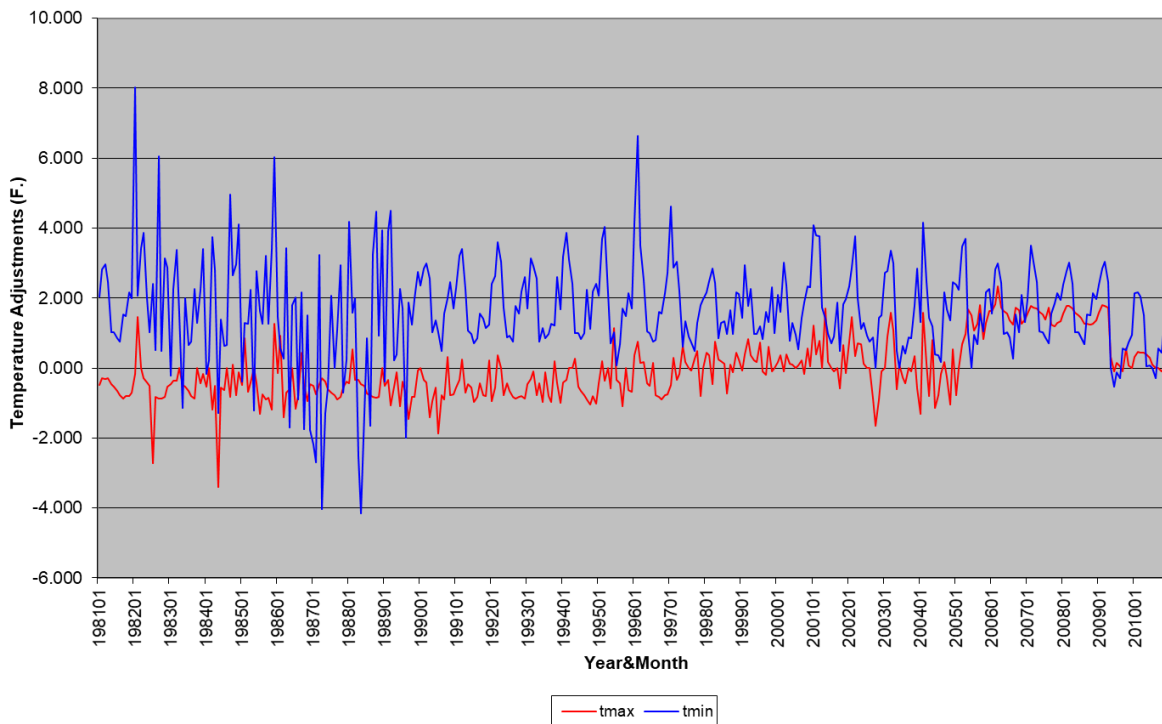
<sup>11</sup> Won, S. J., Wang, X. H., & Warren, H. E. (2016). Climate normals and weather normalization for utility regulation. *Energy Economics*, 54, 405-416.

1 incorporated new climate normal adjustments for the most current ten-year period, but Staff  
2 reviewed the adjustments made for the prior ten-year period and found the adjustments to be  
3 unreasonable.

4 The adjustments are not a product of NOAA, but were calculated by Staff by comparing  
5 the average monthly high and low temperatures NOAA publishes for a weather station to the  
6 monthly average high and low temperatures calculated from the unadjusted daily data provided  
7 through MRCC. The difference between the two averages was the proposed monthly  
8 adjustment for a weather station daily high and low temperatures. As seen in Figure 1 below,  
9 the resulting temperature adjustments were neither small nor consistent from month to month:

10 Figure 1

**Conception, MO Monthly Temperature Adjustments**



11

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Michael L. Stahlman

1 Staff would expect that a change in instrumentation or location would result in a step adjustment  
2 that was relatively consistent over a certain time period. However, the changes above do not  
3 correlate to any know change in equipment or equipment location and change from one month  
4 to the next by several degrees. Because of the erratic nature of these adjustments, Staff  
5 disregarded the adjustments and developed a temperature series based on the raw data, which  
6 leads to Staff's second issue: missing data.

7 For the decade of December 15, 2011, to December 14, 2021,<sup>12</sup> the Conception  
8 weather station had 84 days that missed a temperature reading; either a daily high, low, or both.  
9 This includes a period in May-June 2018 of fourteen days in a row without complete  
10 temperature records, and a thirteen-day period in September-October 2016, and a nine-day  
11 period in May-June 2019.<sup>13</sup> In contrast, KCI, the First-Order Weather Station, had no missing  
12 temperature records over the same period. For the dates that the weather is missing for the  
13 Conception station, Staff computes a close approximation of the daily weather by using the  
14 average of three nearby weather stations.<sup>14</sup>

15 Thirdly, the ultimate weather normalization adjustment for the billing determinates  
16 based on the temperature series developed on the raw data for Conception, Missouri, was not  
17 materially different than the weather normalization adjustment for the same service area based  
18 on the weather from KCI.

19 And finally, while Staff is not proposing a Weather Normalization Adjustment  
20 Rider ("WNAR"), Staff is aware that Empire has proposed a WNAR in this case that will rely

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<sup>12</sup> This unusual time period was chosen because it was a complete decade from the day this testimony was first drafted.

<sup>13</sup> In addition, Staff has some concern that the temperature records for Conception may vary by date; there is some indication that the weather recorded on a given date shifts from the actual weather on that date to the actual weather from the prior day.

<sup>14</sup> The three stations are in Maryville, MO, Albany, MO and Grant City, MO.



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1 on daily temperature from Conception, Missouri. Liberty Utilities, as in the old Atmos  
2 Company and not the Empire District Gas Company in this case, has a WNAR that relied on  
3 weather from the weather station in Kirksville, Missouri. That weather station stopped  
4 recording temperature data on February 6, 2020, and has only sporadically recorded  
5 temperature since that time. While Staff's weather normalization analysis indicates the  
6 Conception weather station is sufficiently reliable to use for historical data, Staff would have  
7 concerns on relying on the station for future data. The WNAR will be further addressed in  
8 rebuttal testimony.

9 Q. What do you conclude from your direct testimony?

10 A. Natural gas usage and revenue vary from year to year based on weather  
11 conditions, which necessitates a weather normalization adjustment to determine the typical  
12 usage. The KCI weather station provides reliable weather data and should be used for  
13 Empire's weather normalization adjustments.

14 Q. Does this conclude your testimony?

15 A. Yes it does.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the Matter of The Empire District Gas )  
Company's d/b/a Liberty Request to File Tariffs ) Case No. GR-2021-0320  
to Change its Rates for Natural Gas 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 *Direct Testimony of Michael L. Stahlman*; and that the same is true and correct according to his best knowledge and belief.

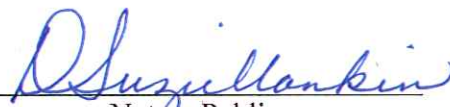
Further the Affiant sayeth not.

  
\_\_\_\_\_  
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 20<sup>th</sup> day of January 2022.

D. SUZIE MANKIN  
Notary Public - Notary Seal  
State of Missouri  
Commissioned for Cole County  
My Commission Expires: April 04, 2025  
Commission Number: 12412070

  
\_\_\_\_\_  
Notary Public

## Michael Stahlman

### Education

- 2009 M. S., Agricultural Economics, University of Missouri, Columbia.  
2007 B.A., Economics, Summa Cum Laude, Westminster College, Fulton, MO.

### Professional Experience

- 2010 - Regulatory Economist, Missouri Public Service Commission  
2007 – 2009 Graduate Research Assistant, University of Missouri  
2008 Graduate Teaching Assistant, University of Missouri  
2007 American Institute for Economic Research (AIER) Summer Fellowship Program  
2006 Price Analysis Intern, Food and Agricultural Policy Research Institute (FAPRI), Columbia, MO  
2006 Legislative Intern for State Representative Munzlinger  
2005 – 2006 Certified Tutor in Macroeconomics, Westminster College, Fulton, MO  
1998 – 2004 Engineering Watch Supervisor, United States Navy

### Expert Witness Testimony

- Union Electric Company d/b/a AmerenUE GR-2010-0363  
In the Matter of Union Electric Company d/b/a AmerenUE for Authority to File Tariffs Increasing Rates for Natural Gas Service Provided to Customers in the Company's Missouri Service Area
- Union Electric Company d/b/a Ameren Missouri GT-2011-0410  
In the Matter of the Union Electric Company's (d/b/a Ameren Missouri) Gas Service Tariffs Removing Certain Provisions for Rebates from Its Missouri Energy Efficient Natural Gas Equipment and Building Shell Measure Rebate Program
- KCP&L Great Missouri Operations Company EO-2012-0009  
In the Matter of KCP&L Greater Missouri Operations Company's Notice of Intent to File an Application for Authority to Establish a Demand-Side Programs Investment Mechanism
- Union Electric Company d/b/a Ameren Missouri EO-2012-0142  
In the Matter of Union Electric Company d/b/a Ameren Missouri's Filing to Implement Regulatory Changes Furtherance of Energy Efficiency as Allowed by MEEIA
- Kansas City Power & Light Company EO-2012-0323  
In the Matter of the Resource Plan of Kansas City Power & Light Company
- KCP&L Great Missouri Operations Company EO-2012-0324  
In the Matter of the Resource Plan of KCP&L Greater Missouri Operations Company
- Kansas City Power & Light Company EO-2012-0135  
KCP&L Great Missouri Operations Company EO-2012-0136  
In the Matter of the Application of Kansas City Power & Light Company [KCP&L Great Missouri Operations Company] for Authority to Extend the Transfer of Functional Control of Certain Transmission Assets to the Southwest Power Pool, Inc.

Kansas City Power & Light Company, KCP&L Great Missouri Operations Company, and Transource Missouri	EA-2013-0098 EO-2012-0367
In the Matter of the Application of Transource Missouri, LLC for a Certificate of Convenience and Necessity Authorizing it to Construct, Finance, Own, Operate, and Maintain the Iatan-Nashua and Sibley-Nebraska City Electric Transmission Projects	
Kansas City Power & Light Company KCP&L Great Missouri Operations Company	EU-2014-0077
In the Matter of the Application of Kansas City Power & Light Company and KCP&L Greater Missouri Operations Company for the Issuance of an Accounting Authority Order relating to their Electrical Operations and for a Contingent Waiver of the Notice Requirement of 4 CSR 240-4.020(2)	
Kansas City Power & Light Company	EO-2014-0095
In the Matter of Kansas City Power & Light Company's Notice of Intent to File an Application for Authority To Establish a Demand-Side Programs Investment Mechanism	
Veolia Energy Kansas City, Inc	HR-2014-0066
In the Matter of Veolia Energy Kansas City, Inc for Authority to File Tariffs to Increase Rates	
Grain Belt Express Clean Line, LLC	EA-2014-0207
In the Matter of the Application of Grain Belt Express Clean Line LLC for a Certificate of Convenience and Necessity Authorizing It to Construct, Own, Operate, Control, Manage, and Maintain a High Voltage, Direct Current Transmission Line and an Associated Converter Station Providing an Interconnection on the Maywood - Montgomery 345 kV Transmission Line	
Union Electric Company d/b/a Ameren Missouri	ER-2014-0258
In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariff to Increase Its Revenues for Electric Service	
Empire District Electric Company	ER-2014-0351
In the Matter of The Empire District Electric Company for Authority to File Tariffs Increasing Rates for Electric Service Provided to Customers in the Company's Missouri Service Area	
Kansas City Power & Light Company	ER-2014-0370
In the Matter of Kansas City Power & Light Company's Request for Authority to Implement a General Rate Increase for Electric Service	
Kansas City Power & Light Company	EO-2014-0240
In the Matter of Kansas City Power & Light Company's Filing for Approval of Demand-Side Programs and for Authority to Establish a Demand-Side Programs Investment Mechanism	
KCP&L Great Missouri Operations Company	EO-2014-0241
In the Matter of KCP&L Greater Missouri Operations Company's Filing for Approval of Demand-Side Programs and for Authority to Establish a Demand-Side Programs Investment Mechanism	

Ameren Transmission Company of Illinois	EA-2015-0146
In the Matter of the Application of Ameren Transmission Company of Illinois for Other Relief or, in the Alternative, a Certificate of Public Convenience and Necessity Authorizing it to Construct, Install, Own, Operate, Maintain and Otherwise Control and Manage a 345,000-volt Electric Transmission Line from Palmyra, Missouri to the Iowa Border and an Associated Substation Near Kirksville, Missouri	
Empire District Electric Company	ER-2016-0023
In the Matter of The Empire District Electric Company's Request for Authority to Implement a General Rate Increase for Electric Service	
KCP&L Great Missouri Operations Company	ER-2016-0156
In the Matter of KCP&L Greater Missouri Operations Company's Request for Authority to Implement a General Rate Increase for Electric Service	
Kansas City Power & Light Company	ER-2016-0285
In the Matter of Kansas City Power & Light Company's Request for Authority to Implement A General Rate Increase for Electric Service	
Union Electric Company d/b/a Ameren Missouri	ER-2016-0179
In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariff to Increase Its Revenues for Electric Service	
Grain Belt Express Clean Line, LLC	EA-2016-0358
In the Matter of the Application of Grain Belt Express Clean Line LLC for a Certificate of Convenience and Necessity Authorizing it to Construct, Own, Operate, Control, Manage and Maintain a High Voltage, Direct Current Transmission Line and an Associated Converter Station Providing an Interconnection on the Maywood-Montgomery 345kV transmission line.	
Spire Missouri, Inc.	GR-2017-0215 and GR-2017-0216
In the Matter of Spire Missouri, Inc.'s Request to Increase Its Revenues for Gas Service	
Liberty Utilities	GR-2018-0013
In the Matter of Liberty Utilities (Midstates Natural Gas) Corp. d/b/a Liberty Utilities' Tariff Revisions Designed to Implement a General Rate Increase for Natural Gas Service in the Missouri Service Areas of the Company	
Spire Missouri, Inc.	GO-2019-0058 and GO-2019-0059
In the Matter of Spire Missouri, Inc. d/b/a Spire's Request to Decrease [Increase] WNAR	
Grain Belt Express Clean Line LLC	EM-2019-0150
Invenergy Transmission LLC	
Invenergy Investment Company LLC	
In the Matter of the Joint Application of Invenergy Transmission LLC, Invenergy Investment Company LLC, Grain Belt Express Clean Line LLC and Grain Belt Express Holding LLC for an Order Approving the Acquisition by Invenergy Transmission LLC of Grain Belt Express Clean Line LLC	

Union Electric Company d/b/a Ameren Missouri In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Increase its Revenues for Natural Gas Service	GR-2019-0077
Union Electric Company d/b/a Ameren Missouri In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Decrease Its Revenues for Electric Service	ER-2019-0335
Empire District Electric Company In the Matter of The Empire District Electric Company's Request for Authority to File Tariffs Increasing Rates for Electric Service Provided to Customers in its Missouri Service Area	ER-2019-0374
Union Electric Company d/b/a Ameren Missouri In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and a Certificate of Public Convenience and Necessity Under 20 CSR 4240-3.105	EA-2020-0371
Spire Missouri, Inc. In the Matter of Spire Missouri Inc.'s d/b/a Spire Request for Authority to Implement a General Rate Increase for Natural Gas Service Provided in the Company's Missouri Service Areas	GR-2021-0108
Union Electric Company d/b/a Ameren Missouri In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Adjust Its Revenues for Electric Service	ER-2021-0240
Union Electric Company d/b/a Ameren Missouri In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Adjust Its Revenues for Natural Gas Service	GR-2021-0241

### **Selected Manuscripts and Posters**

- Stahlman, Michael and Laura M.J. McCann. "Technology Characteristics, Choice Architecture and Farmer Knowledge: The Case of Phytase." *Agriculture and Human Values* (2012) 29: 371-379.
- Stahlman, Michael. "The Amorality of Signals." Awarded in top 50 authors for SEVEN Fund essay competition, "The Morality of Profit."
- Stahlman, Michael, Laura M.J. McCann, and Haluk Gedikoglou. "Adoption of Phytase by Livestock Farmers." Selected poster at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008. Also presented at the USDA/CSREES Annual Meeting in St. Louis, MO in February 2009.
- McCann, Laura, Haluk Gedikoglu, Bob Broz, John Lory, Ray Massey, and Michael Stahlman. "Farm Size and Adoption of BMPs by AFOs." Selected poster at the 5<sup>th</sup> National Small Farm Conference in Springfield, IL in September 2009.