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Witness: *Shawn E. Lange*
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MISSOURI PUBLIC SERVICE COMMISSION

COMMISSION STAFF DIVISION

OPERATIONAL ANALYSIS DEPARTMENT

ENGINEERING ANALYSIS UNIT

REBUTTAL TESTIMONY

OF

SHAWN E. LANGE

UNION ELECTRIC COMPANY
D/B/A AMEREN MISSOURI

CASE NO. ER-2016-0179

Jefferson City, Missouri
January 2017

** **Denotes Highly Confidential Information** **

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REBUTTAL TESTIMONY

OF

SHAWN E. LANGE

UNION ELECTRIC COMPANY
D/B/A AMEREN MISSOURI

CASE NO. ER-2016-0179

Q. Please state your name and business address.

A. My name is Shawn E. Lange and my business address is Missouri Public Service Commission, P.O. Box 360, Jefferson City, MO 65102.

Q. Are you the same Shawn E. Lange that provided sections in Staff's Revenue Requirement Direct report in this proceeding?

A. Yes, I am.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to address Union Electric Company d/b/a Ameren Missouri's ("Ameren Missouri") witness Mr. Peter's modeling of hydroelectric generation MWhs at Osage Energy Center ("Osage") and the generation shape of the MWhs at Osage and Keokuk Energy Center ("Keokuk") facilities.

Q. What amount of MWh did Ameren Missouri model?

A. The table below shows the MWhs Ameren Missouri provided in the direct workpapers[1].

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[1] Mark Peter's workpaper 7-hydro Monthly Net Generation - HC.xlsx

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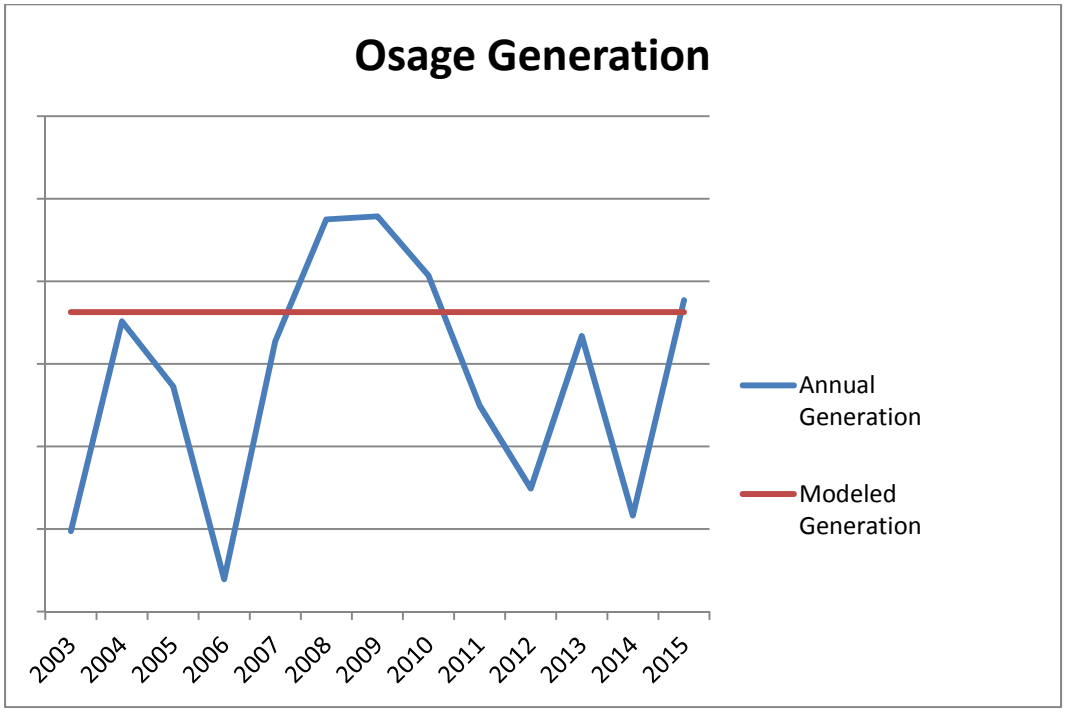
Q. How does Ameren Missouri's modeled annual generation compare to the annual actual history of generation at Osage?

A. The chart below shows the comparison of modeled generation level and actual generation at Osage for January 2003 through December 2015.

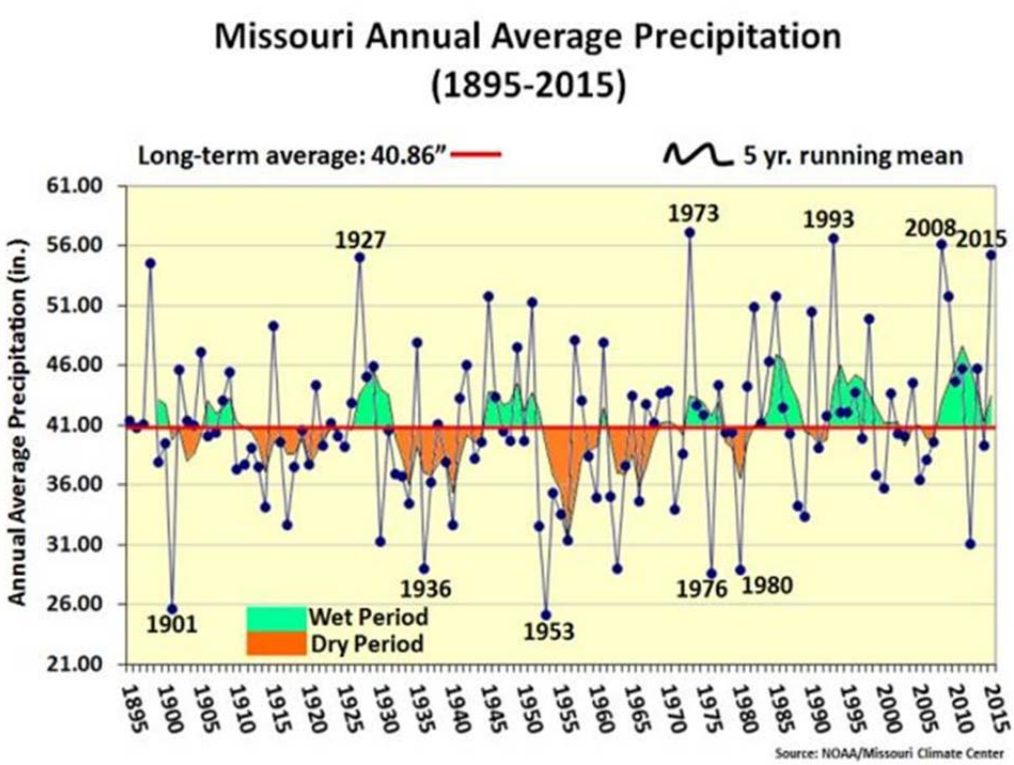


Q. How many years did the Osage generation meet or exceed the level of generation for Osage that Ameren Missouri used in its ProSym model?

A. Looking at the thirteen (13) years from 2003 through 2015, there are four (4) years that the actual level of generation met or exceeded Ameren's modeled level of generation (2008, 2009, 2010, and 2015). In the five (5) years 2011 through 2015, there was one year that met or exceeded Ameren's modeled level of generation (2015).

Q. During those thirteen (13) years, what was Missouri's average annual level of precipitation?

A. Please see the chart[2] below.



Q. What does the chart show?

A. The annual average precipitation for Missouri in 2008 and 2015 was on par for average annual rainfall with that of 1993 and 1973. Also, 2009, while not on par for historical high annual average precipitation in 1993 and 1973, was approximately 10 inches higher than the long term average for precipitation in Missouri.

Q. How does this correspond to the generation levels of Osage?

A. Out of the four (4) years that the actual generation level met or exceeded the Ameren Missouri's modeled generation level, 2008 and 2015 had average precipitation levels mirroring historical flooding levels of 1993, 2009 had annual precipitation levels approximately

[2] http://climate.missouri.edu/charts/chart6.jpg

10 inches higher than the long term average, and 2010 had higher annual precipitation than the long term average annual precipitation for Missouri.

While it is expected[3] that the generation in historically high annual precipitation years would be higher than the amount of generation modeled, Ameren Missouri's modeled level of generation was only exceeded in years that either showed historically high levels of precipitation or years immediately after years of historically high levels of precipitation.

Q. What effect does using Ameren Missouri's modeled annual level of generation have on fuel expense?

A. The market prices will determine the dispatch of the generation assets. When modeling the fuel expense, keeping market prices constant, increasing the generation from a zero (0) fuel cost generation source, will increase the generation in the hour and thus increase the margin in that hour.

Generation Shape

Q. What is a generation shape?

A. Typically on hydroelectric, wind, or solar plant, the amount of generation is variable and typically determined by wind speed, water levels, and amount of overcast of a day. Since these all vary sometimes day to day if not hour to hour or minute to minute, a generation shape is used to allocate the annual amount of generation to the hourly level.

Q. What is the generation shape that Ameren Missouri's ProSym model used?

A. According to Ameren Missouri's Response to Staff DR 212: "Generally, monthly values for minimum generation, maximum generation and total energy are specified. Since ProSym operates in weeks (Monday – Sunday) rather than months, the monthly total energy is

[3] In certain flooding events, it may be imperative to open the flood gates to release the water in lieu of using that water for generation purposes.

allocated to each week. The unit will be operated at least at the minimum generation in each hour. The model then allocates the remaining amount of the total energy for that week to those hours with the highest loads (respecting unit ramp capability limits) until exhausted."[4]

Q. What type of hydroelectric facility is Keokuk?

A. Keokuk is a diversion hydroelectric facility.

Q. How does a diversion facility operate?

A. "A diversion, sometimes called run-of-river, facility channels a portion of a river through a canal or penstock."[5] This type of generator tends to have less control of generation compared to an impoundment hydroelectric facility or pump storage since it is mainly reliant on the real time river levels.

Q. How does Ameren Missouri's load correspond to the actual generation of Keokuk?

A. Staff looked at the correlation coefficients for the annual hourly load and the generation of Keokuk for the time period of January 2009 through December 2015.

Q. What is a correlation coefficient?

A. A correlation coefficient is a measure of how the variations in one dataset are consistent with the variations in another. Generally speaking, the closer the correlation coefficient is to1, the more the datasets vary consistently. If the correlation is negative, the variation in one dataset gets more positive while the variation in the other dataset gets more negative.

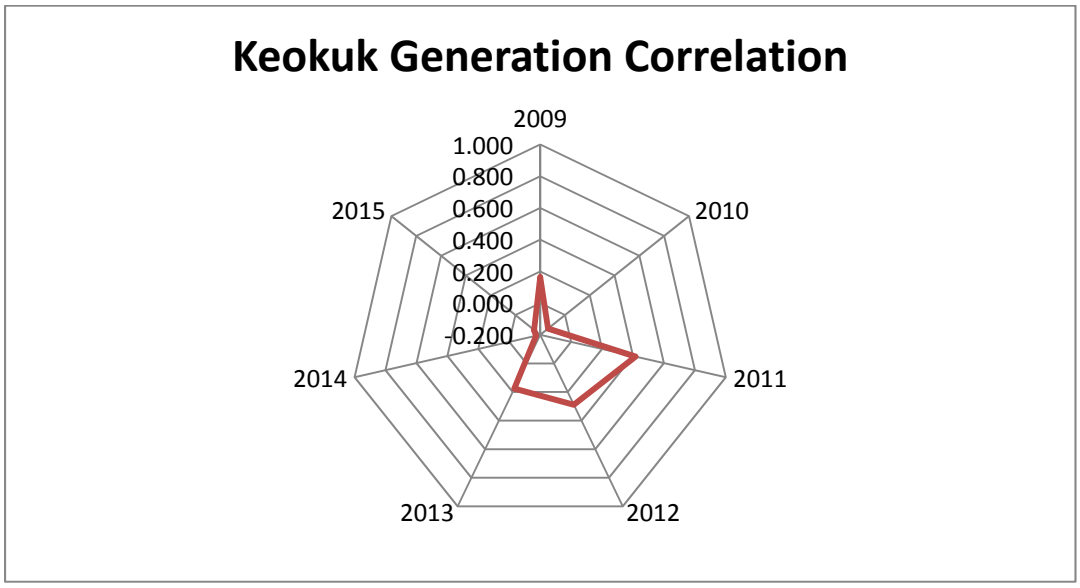
[4] Ameren Missouri Response to Staff DR 212
[5] https://energy.gov/eere/water/types-hydropower-plants accessed 1/17/2017

A general rule of thumb is for interpretation of the correlation coefficient is:

Size of Correlation	Interpretation
.70 to 1.00 (−.70 to −1.00)	High positive (negative) correlation
.40 to .70 (−.40 to −.70)	Moderate positive (negative) correlation
.00 to .40 (.00 to −.40)	Low positive (negative) correlation

Q. What does the correlation coefficient show for generation of Keokuk and Ameren Missouri's load?

A. The Chart below illustrates the results of Staff's analysis for Keokuk.



Q. What does the chart show?

A. The correlation coefficient Staff calculated varied from -.173 to .416. Three (3) years showed negative correlation between -.137 and -.173 (2010, 2014, and 2015). One (1) year

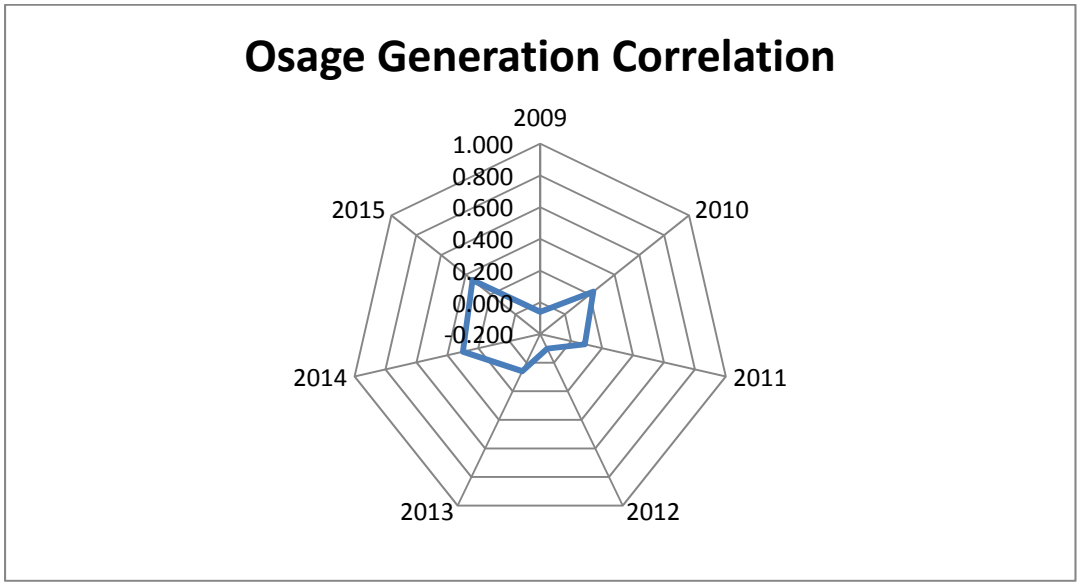
had moderate correlation, 2011, while the remainder showed low positive or negative correlation.

Q. Did Staff perform the same analysis for Osage?

A. Yes.

Q. What was the result?

A. It is expected that an impoundment[6] hydroelectric facility, like Osage, would lend itself to have higher coefficient of correlation and that is exactly what the analysis showed, however slightly.



The range was from -.098 to .468. Overall, four (4) years (2009, 2011, 2012, and 2013) showed approximately zero (0) correlation and two (2) years (2010 and 2015) showed a correlation of greater than .228.

Q. Does Staff agree that the use of ProSym's method of spreading the generation to the hours based on load is reasonable?

[6] Impoundment hydroelectric facilities use a dam to store up water typically creating a reservoir or lake. Water can be released to turn the turbine, generating electricity.

A. Not in the cases of Keokuk or Osage. While ProSym in this case utilizes a known method of deriving a generation shape, based on the correlation coefficients, there is not a strong correlation between Ameren Load and the generation of either Keokuk or Osage facility.

Q. What effect would using the method Ameren Missouri utilized for determining the hydro load shape have on fuel expense?

A. Hours that have higher load tend to have higher market prices. Keokuk and Osage would yield more generation from a no fuel price fuel source in more hours of higher market price, which would lead to higher margin levels and thus understate the amount of variable fuel expense.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

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 Increase Its Revenues for Electric Service	))))	Case No. ER-2016-0179

AFFIDAVIT OF SHAWN E. LANGE

STATE OF MISSOURI)
) ss.
COUNTY OF COLE)

COMES NOW SHAWN E. LANGE and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing Rebuttal Testimony; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

Shawn E. Lange
SHAWN E. LANGE

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 19th day of January, 2017.

D. SUZIE MANKIN
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: December 12, 2020
Commission Number: 12412070

D Suzie Mankin
Notary Public