Exhibit No.:	
Issue(s):	*Geographic Diversity and Related Economics Issues*
Witness:	*Krishna L. Poudel, PhD*
Sponsoring Party:	*MoPSC Staff*
Type of Exhibit:	*Rebuttal Testimony*
Case No.:	*EA-2023-0286*
Date Testimony Prepared:	*October 11, 2023*

MISSOURI PUBLIC SERVICE COMMISSION

INDUSTRY ANALYSIS DIVISION

ENERGY RESOURCES DEPARTMENT

REBUTTAL TESTIMONY

OF

KRISHNA L. POUDEL, PhD

UNION ELECTRIC COMPANY, d/b/a AMEREN MISSOURI

CASE NO. EA-2023-0286

Jefferson City, Missouri
October 2023

REBUTTAL TESTIMONY

OF

KRISHNA L. POUDEL, PhD

UNION ELECTRIC COMPANY,
d/b/a AMEREN MISSOURI

CASE NO. EA-2023-0286

Q. Please state your name and business address.

A. My name is Krishna L. Poudel, 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 an Economist for the Energy Resources Department.

Q. What is your educational background and work experience?

A. Please refer to the attached Schedule KLP-r1.

Q. Have you previously filed testimony before this Commission?

A. Yes. Please refer to the attached Schedule KLP-r1 for a list of cases in which I have previously filed testimony.

Q. What is the purpose of your rebuttal testimony?

A. My testimony will briefly discuss issues such as geographical diversity of the projects, energy reliability and some other relevant economic issues of Union Electric Company, d/b/a Ameren Missouri's ("Ameren Missouri") proposed four solar projects.[1]

[1] Savion Cass County, Invenergy Split Rail, Vandalia Solar, and Bowling Green Solar projects.

Q. Has Ameren Missouri proposed in this case to develop new projects to generate renewable energy?

A. Yes, Ameren Missouri is proposing to develop four new solar energy generation facilities.

Q. Did Ameren Missouri claim those solar projects provided "geographical diversification"?

A. Yes, the direct testimony of Ajay K. Arora states as such about geographical diversification. Of the four solar projects, Cass County is proposed in Illinois and the remaining three in the state of Missouri.

Q. Did the Company define what makes these projects geographically diversified in a sufficient way?

A. No. Ameren Missouri simply claims distribution of solar projects in Missouri and Illinois within the distance apart they are (some are not even distanced by 30 miles aerially[2]) geographically diversifies the energy production portfolio and ensures reliability and resiliency of energy supply in the state of Missouri.

Q. What is geographical diversity?

A. Geographical diversity is a technical concept but does not have any single interpretation of the working meaning. A biologist can view from one lens while business communities and economists from another lens. Geographic diversification refers to diversity in physical characteristics of a region or space, such as climate, vegetation, fauna, bodies of water, and landscape. It refers to the variety of physical, human, and cultural elements that exist

[2] Vandalia and Bowling Green google map distance is only 17 miles.

in a specific geographic space. A financier considers geographical diversity is a financial strategy that involves investing in securities from regions to minimize anticipated risk. Multi-stakeholder companies pursue diversifying an investment portfolio across different geographic regions so as to reduce the aggregate risk and sustained returns on the portfolio. The term also refers to the strategy employed by large companies of locating their operations in different regions in order to reduce business and operational risk.

Q. Does geographical diversification of energy production ensure reliability and sustainability in the long run?

A. Ameren Missouri witness Mr. Ajay Arora in his direct testimony[3] claims so. He claims "An important factor to ensure long-term system reliability and resiliency is to pursue a geographically diverse portfolio of renewable energy resources to ensure energy is always available to meet our customers' needs, even during peak energy time periods. Since solar and wind generation are dependent on weather conditions which vary by geographical location, a regionally diverse renewable resource portfolio will be more reliable under varying weather conditions." However, he has not defined geographical diversity and how significantly it contributes to adding reliability and sustainability. Under the given definition above, the proposed solar projects locations does not sufficiently reveal meaningful characteristics of geographic diversification.

Q. Please state your opinion regarding Ameren Missouri's emphasis on the "Risk of Inaction" to justify the geographical diversification.

[3] Direct Testimony of Ajay K. Arora, page 23.

A. I don't agree that these projects are geographically diversified in such a way that will be instrumental to subside any unexpected risks and uncertainties. Mr. Arora in his direct testimony on page 6 wrote:

> Delaying the inevitable shift to renewables creates significant implementation risk. The transition will require a very large-scale expansion of renewable generation at the same time that other utilities and states are pursuing the same. A task of this magnitude must be implemented over time to be successful. This is the case since each renewable energy project takes 5 to 8 years to develop and construct, requires geographical diversity of projects for reliability, and requires navigating several implementation risks, such as delays in the development or completion of projects, lost opportunities for more viable projects, and the potential for financing constraints and increases in financing costs.

I do not agree. Once again, my opinion is that there is lack of sufficient indicators in order to say these solar plants are geographically diversified. The situation Mr. Arora describes neither provides logical factual support regarding reliability benefits and nor does it explain how it helps navigate the risks such as completion of power generation projects nor lost economic opportunity. For the finance and tax credit dynamics, Staff witnesses Seoung Joun Won, PhD and Michael L. Stahlman address these in detail in their rebuttal testimony.

Q. Please explain Staff's position about Mr. Arora's discussion on importance of a geographical diverse portfolio of renewable energy to ensure the reliability and load meeting consumer demand in all time periods.

A. Mr. Arora in his direct testimony on page 23 again stated an emphasis to support his claim how a geographical diverse portfolio would enhance energy supply reliability to meet its customer's needs, even during peak energy time periods, without any quantitative

information. The solar projects do not have that high of capacity factors[4] and do not provide ample evidences of coping with changing environmental parameters. Staff agrees with Mr. Arora's statement that "Since solar and wind generation are dependent on weather conditions which vary by geographical location, a regionally diverse renewable resource portfolio will be more reliable under varying weather conditions". However, Staff disagrees with the explanation of geographical diversity. These projects are not "regionally diverse"

[4] Direct Testimony of Scott Wibbenmeyer, page 6.

Table 2. Summary of Solar Projects

	Split Rail Solar Project	Cass County Solar Project	Vandalia Solar Project	Bowling Green Solar Project
Agreement Date	May 2023	May 2023	September 2022	June 2023
Agreement Type	Build-transfer	Development-transfer	Self-development	Self-development
Developer	Invenergy Renewables, LLC	Savion, LLC	Ameren Missouri	Ameren Missouri
Facility Size *(nominal)*	300-MW_{AC}	150-MW_{AC}	50-MW_{AC}	50-MW_{AC}
Location	Central Missouri	Central Illinois	Northeastern Missouri	Northeastern Missouri
First Year Expected Annual Energy Production *(MWh)*	651,717	337,981	121,624	122,219
Tax Strategy[2]	ITC	ITC	ITC	ITC
Expected Tax Benefit[3]	30%	40%	30%	40%
Land Under Control	4,750 Acres	2,220 Acres	420 Acres	440 Acres
Interconnection Status[4]	MISO GIA[5] complete	MISO GIA complete	Ameren Missouri Distribution Interconnection	Ameren Missouri Distribution Interconnection
Interconnection Voltage	345-kV Transmission	138-kV Transmission	69-kV Sub-transmission	69-kV Sub-transmission

enough to provide geographical diversity benefits for weather conditions. Ameren Missouri witness Mr. Scott Wibbenmeyer in his direct testimony,[5] provides in Figure 1 (recreated below) the solar projects map and is included here to evaluate how much these sites lack geographic diversity. Mr. Wibbenmeyer in his direct testimony provides Table 2 above, the general location of each of the four solar projects. By the general location provided in Table 2, one might agree that could demonstrate geographic diversity. However, when you look at the actual map in Figure 1 below, all sites line up rather closely in a relatively short contour.

Figure 1. Map of Solar Projects

Q. How does geographical diversity affect the cost of energy production?

[5] Direct Testimony of Scott Wibbenmeyer, pg. 3.

A. Geographic diversity can have a significant impact on energy production. For example, in the context of electric generating resources, geographic diversity means the degree to which a facility is physically separated from other resources to reduce the likelihood of disruptions due to climatic conditions or natural disasters. Geographic diversity may ensure that energy production is more resilient and less susceptible. For instance, solar power is often generated in different regions due to variations in climate and geography. By diversifying the locations of renewable energy sources, it is possible to increase the overall reliability and stability of the energy grid.

Q. Does geographical diversity assure reliability and cost effectiveness?

A. Not necessarily. If the plants are nearby each other, it may help reduce cost of operation and some other associated variable cost due to proximity, but it does not eliminate the risks associated with solar projects that are not geographically diverse. In this case, Ameren Missouri seems to be calling these solar projects geographically diverse simply to make a claim that they are.

Q. Are you making any recommendations in this testimony?

A. I support Staff's overall position in this case. However, my testimony is to provide the Commission with additional information to refute Ameren Missouri's claims of benefits due to geographical diversity. Theory of the location of industries[6] suggests a model that explains the location of the industries based on the potentials of minimization of three costs; transportation cost, labor cost and agglomeration cost. Location theory generally assumes that agents act in their own self-interest. Firms thus choose locations that maximize their

[6] Weber, Alfred. 1929. (Translated by Carl J. Friedrich from Weber's 1909 book). *Theory of the Location of Industries*. Chicago: The University of Chicago Press.

profits and individuals choose locations that maximize their utility. I conclude that if solar projects had met the geographical diversity requirement in full, the cost of projects would have appeared diminishing and hence lowered present value revenue requirement. Staff witness Dr. Hari K. Poudel rebuts Ameren Missouri's expected cost of the solar project subject to this case are higher than the assumptions used in Ameren Missouri's past IRP analyses. This may potentially impact rates payers negatively and dampen the total societal welfare.

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 the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and Certificates of Public Convenience and Necessity Authorizing it to Construct Renewable Generation Facilities	)))))	Case No. EA-2023-0286

AFFIDAVIT OF KRISHNA L. POUDEL, PhD

STATE OF MISSOURI)
) ss.
COUNTY OF COLE)

COMES NOW KRISHNA L. POUDEL, PhD and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing *Rebuttal Testimony of Krishna L. Poudel, PhD*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

KRISHNA L. POUDEL, PhD

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 5th day of October 2023.

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

Krishna L. Poudel, PhD

Education and Employment Background

I am an Economist of the Energy Resources Department, Industry Analysis Division of the Missouri Public Service Commission. Prior to my current position, I was employed at the Missouri Department of Natural Resources as an Economist from September 2016 through May 2019.

I received Bachelor of Science degree in Agricultural Economics in June 1998, Master of Science in Agricultural Economics in May 2003 from Tribhuvan University, Nepal and Doctoral degree in Applied Economics from University of Missouri, Columbia in 2017.

Prior to joining the Missouri Department of Natural Resources and Public Service Commission, I worked in various research positions in different countries including Nepal, SriLanka, Japan, Canada and USA. I worked for University of Missouri-Columbia as a Research Associate in Community Policy Analysis Center from August 2011 through December 2016.

I joined the Staff of the Commission in May, 2019.

Krishna L. Poudel

Case Participation History

Case Number	Company	Issue	Exhibit
EO-2021-0021	Union Electric Company	IRP Update	Staff Report
ER-2019-0374	The Empire District Electric Company	LED street lighting	Rebuttal Testimony
EO-2020-0280	Evergy Metro	IRP Update	Staff Report
EO-2020-0281	Evergy Missouri West	IRP Update	Staff Report
ER-2020-0311	The Empire District Electric Company	Fuel Adjustment Clause	Staff report
EO-2020-0227	Evergy Metro and Evergy Missouri West	MEEIA Prudence Review	Staff Report
EO-2021-0021	Union Elecetric Company	Triennial compliance filing	Staff Report
EO-2021-0035	Evergy Metro	Triennial compliance filing	Staff report
EO-2021-0036	Evergy Missouri West	Triennial compliance filing	Staff Report
EO-2021-0416	Evergy Missouri West	MEEIA prudence review	Staff Report
EO-2021-0417	Evergy Metro	MEEIA prudence review	Staff Report
YH-2022-0218	Vicinity Energy	Hedging	Staff Report
HT-2022-0212	Vicinity Energy	Hedging and Production Adjustment Cost Clause	Staff Report
ER-2022-0129	Evergy MO Metro	Hedging	Rebuttal Testimony
ER-2022-0130	Evergy MO West	Hedging	Rebuttal Testimony
EO-2021-0331	The Empire District Electric Company	Triennial compliance filing	Staff Report
EA-2022-0234	NextEra Energy Transmission Southwest	Economic Impact	Staff Report

EA- 2022-0244	Huck Finn	Economic Impact	Staff Report
EA- 2022-0244	Huck Finn	IRP New Preferred plan	Staff Report
EO-2023-0087	The Empire District Electric Company	Hedging (Fuel risk management policy)	Staff Report
ER-2023-0184	Evergy MO West	DSIM	Staff report
ER-2023-0178	Union Electric Company	Rider Energy Efficiency Investment Charge	Staff Report
EA-2023-0017	GRAIN BELT EXPRESS LLC	Integrated Resource Planning	Rebuttal Testimony
ER-2023-0410	Evergy MO Metro	DSIM	Staff report
ER-2023-0411	Evergy MO West	DSIM	Staff Report