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Witness: *Shawn E. Lange, PE*
Sponsoring Party: *MoPSC Staff*
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MISSOURI PUBLIC SERVICE COMMISSION

INDUSTRY ANALYSIS DIVISION

ENGINEERING ANALYSIS DEPARTMENT

REBUTTAL TESTIMONY

OF

SHAWN E. LANGE, PE

UNION ELECTRIC COMPANY, d/b/a AMEREN MISSOURI

CASE NO. EA-2023-0286

Jefferson City, Missouri
October 2023

*** Denotes Highly Confidential Information ***
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UNION ELECTRIC COMPANY,
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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, 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 Senior Professional Engineer in the Engineering Analysis Department of the Industrial Analysis Division.

Q. Please describe your educational and work background.

A. Please see Schedule SEL-r1.

Q. What is the purpose of your testimony?

A. The purpose of my rebuttal testimony is to respond to Ameren Missouri's witness Matt Michels' direct testimony regarding Ameren Missouri's need for capacity and energy. I also raise Staff's concerns with Ameren Missouri's failure to evaluate power purchase agreements in its evaluation of these solar projects. Finally, I respond to Ameren witness Scott Wibbenmeyer regarding the Transmission/Sub-transmission interconnections for the proposed projects.

Q. Do you support any of Staff's recommended conditions if the Commission were to grant a certificate of Convenience and Necessity ("CCN") for the project?

A. Yes. I present Staff's recommended conditions related to in-service testing, IEEE 2800 standards, and curtailment reporting.

NEED FOR THE PROJECTS

Q. What factors does the Commission currently consider in CCN cases?

A. The Commission considers what are commonly referred to as the Tartan Criteria when making a determination on whether a utility's proposal meets the standard of being necessary or convenient for the public service. The Tartan criteria include:

- Is the service needed?
- Is the applicant qualified to provide the service?
- Does the applicant have the financial ability to provide the service?
- Is the applicant's proposal economically feasible?
- Does the service promote the public interest?

Staff witness Sarah L.K. Lange provides the overview of the Commission's obligations in reviewing CCN applications. My testimony provides information to the Commission to assist in determining whether or not the four solar projects[1] are needed.

Q. What evidence did you evaluate of what Ameren Missouri presented to demonstrate the four solar projects are needed?

A. Generally, Ameren Missouri witness Matt Michels discusses the forecasted need for capacity and a purported forecasted energy shortfall.

Q. What is capacity?

A. Capacity is the maximum output a generator can physically produce and is measured in megawatts ("MW"). The capacity of all the resources together forms the capacity

[1] The four solar projects include the 50 MW Vandalia Solar Project, the 50 MW Bowling Green Solar Project, the 150 MW Cass County Solar Project, and the 300 MW Split Rail Solar Project.

for an electric utility's system. Electric utilities must ensure there is enough power being produced and delivered to meet their customers' demand. No generation resource will always produce its maximum output (i.e. planned and unplanned outages are expected to occur); therefore, utilities are required to reasonably build more capacity to ensure there are enough resources available at times of peak demand.

Q. What is energy?

A. Energy is the amount of electricity produced or used over a specific time period. To keep the system in balance, in every second, the same amount of energy must be placed into a system as is used by the system.

Energy Need

Q. Please give a brief explanation of how utilities have historically planned to avoid energy shortfalls.

A. In the earliest years, utilities had to match load requirements with their own generation output in each instant. It has been common for Missouri utilities to interconnect and to use various contractual arrangements to exchange energy so that load among the utilities may be met more economically. Since 2005, Ameren Missouri has participated in the Midcontinent Independent System Operator ("MISO") integrated energy market, under which a third party manages the dispatch of generation facilities across a region to economically meet the load requirements within the region in each instant.

Historically, utilities had to plan to have the plants and flexibility available to meet their load and shift with load. Today, utilities in regions with integrated energy markets plan to meet energy needs through those markets, but may optimize their generation fleet to minimize the

net cost of obtaining energy for their load, or to meet statutory, regulatory, or internal management energy and environmental policy goals.

Q. With changes in the regional generation fleet, is the electric industry generally moving toward new approaches to planning?

A. Yes. For example, MISO is considering the hours of highest risk rather than focusing on peak load. MISO has stated in the MISO's Renewable Integration Impact Assessment ("RIIA") dated 2021:

> Resource Adequacy centers around the system's generation resources' ability to meet load at the most critical hours. These hours of highest risk of load not being served are the hours when generation resources are least available to meet that load. Historically, these have been periods of the highest system load, generally in the afternoon on a hot summer day. This assessment has found that as renewables serve the load during the traditional peak, the net-load peak hours become the more critical periods, even if these periods do not have the highest absolute load.[2]
>
> The assessment finds that as renewables serve load during the middle of the day, the net-load peak moves from the traditional peak-load hour of 3 p.m. to several hours later in the evening, depending on the amount of solar capacity on the system.[3]

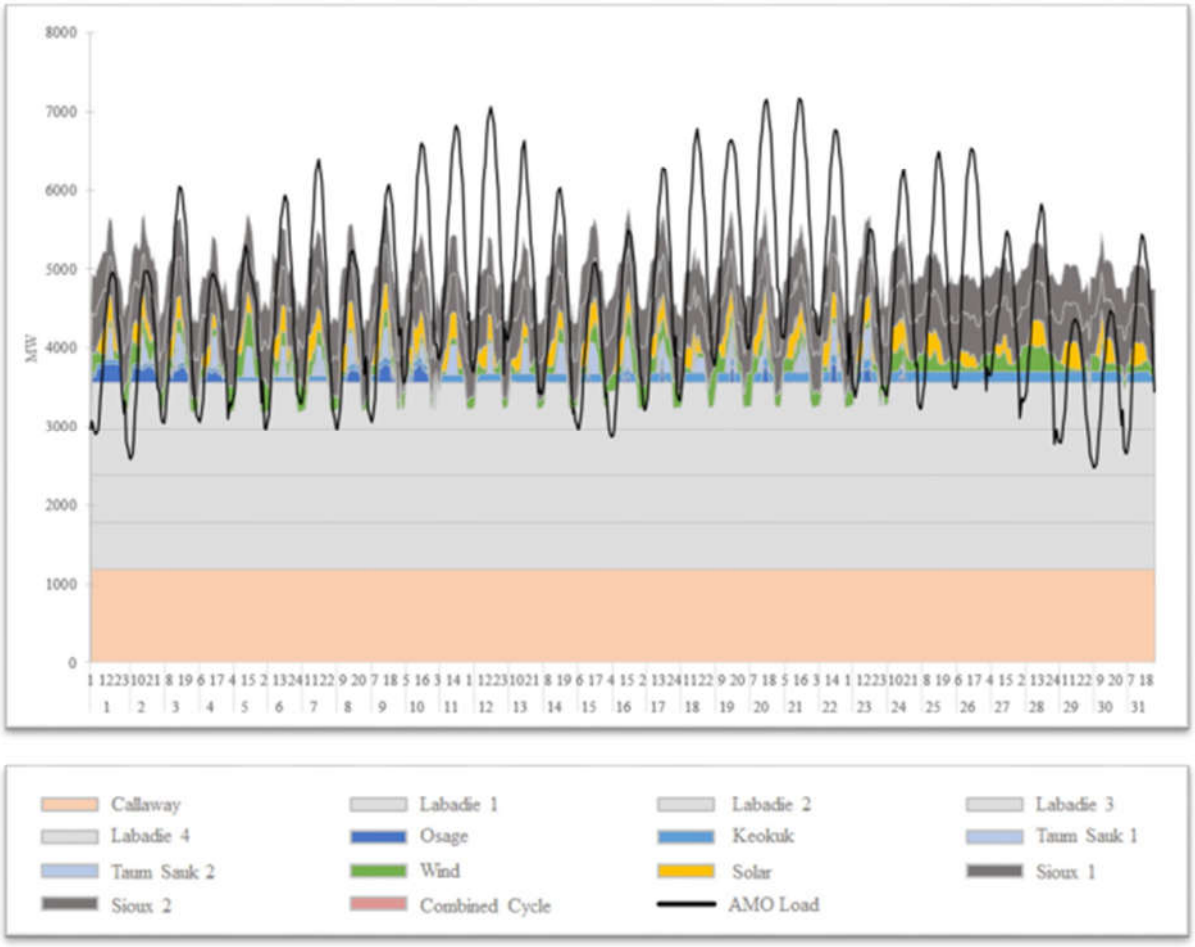
Q. Mr. Michels represents that Figure 14, shown below, shows the energy resources for the expected projected July 2026 load requirement, and contrasts the energy those resources may generate against Ameren Missouri's projected load. Is this an accurate depiction?

A. No. Figure 14 does not include any of the natural gas Combustion Turbine Generators (CTGs) that would be available for dispatch in 2031.[4] Those would include the 608 MW Audrain Energy Center, the 172 MW Peno Creek Energy Center, the 316 MW

[2] https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf Pg. 27.
[3] https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf Pg. 28.
[4] EA-2023-0286 Ameren Missouri response to Staff Data Request ("DR") No. 0077.

Pinckneyville Energy Center, the 438 MW Goose Creek Energy Center, the 304 MW Racoon Creek Energy Center, and the 210 MW Kinmundy Energy Center.

Figure 14 – July 2026 Retail Load and Energy Resource (No New Renewables)



Q. Does Ameren Missouri's CTG fleet generate energy?

A. Yes. It is not reasonable to assume that these resources cannot be relied upon to generate energy. These resources are subject to all applicable rules and regulations and are subject to dispatch by MISO per Ameren Missouri's bidding constraints, like any other generation asset. However, many of those resources have availability only in non-winter periods because of pipeline and/or natural gas contracts.

Q. Mr. Michels states in his direct testimony on page 7, lines 1-4, "When I use the phrase "new fleet" I am referring to our planned future resource portfolio, which includes a diverse mix of zero or low-carbon resources, primarily renewable resources like solar, wind and hydroelectric, along with zero-carbon nuclear and supported by dispatchable energy storage and natural gas resources." What does it mean for dispatchable natural gas resources to support renewable resources?

A. A situation can exist in winter mornings and afternoons, and in summer evenings, when solar resources are not generating at full capacity but load remains higher than the generation of other resources. Quickly dispatchable resources are needed in those hours to match generation to load, whether on a utility wide or region-wide basis. CTGs such as those currently owned by Ameren Missouri can meet this need for energy in non-peak load hours.

Q. Is there a term for these hours?

A. Yes. MISO refers to this situation as peak net-load hours. The industry is developing language to refer to developing conditions. It is possible that someone could term this energy shortage during peak net-load hours as an "energy need."

Q. Does MISO describe the risk of energy shortages in the RIIA?

A. Yes. MISO States:

> The risk of not having enough generation to meet demand shifts from the historic times of peak power demand to other periods, specifically hot summer evenings and cold winter mornings, when low availability of wind and solar resources is coincident with high power demand.[5]

So as more renewables are brought on, the critical energy hours are no longer the peak hour in the summer and winter. The more critical hours turn to hours in which the solar and

[5] https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf Pg. 3.

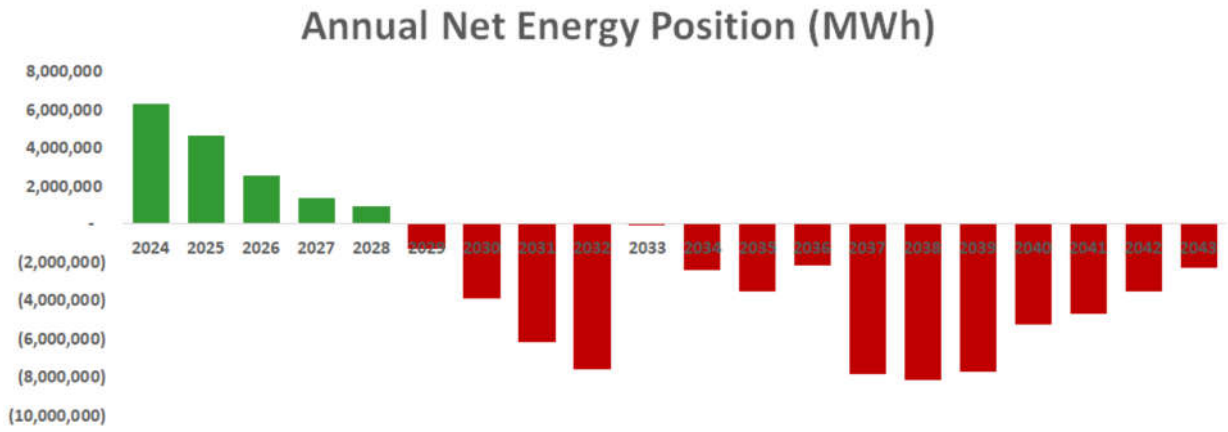
wind generation are at a lesser level of generation. This then requires dispatchable units to fill in the hours and provide regulation for the drop off in generation of solar and wind.

Q. Based on the evidence Ameren Missouri presents in its direct testimony in this case, is this net peak-load energy shortage what it has termed an "energy need?"

A. No. Ameren Missouri's evidence in this case appears to be more concerned with being a net seller as opposed to a net purchaser in the MISO market on an annual basis.

Q. How is Ameren Missouri presenting an energy need or energy shortage in this case and its IRP?

A. As part of the Ameren Missouri analysis in EO-2024-0020, Ameren Missouri presented the following as showing the net energy position[6]:



Q. Is the above chart show an energy need?

A. No. The above chart shows a utility that has the opportunity to purchase energy through the market from other utilities and Independent Power Producers at a lower price than it can operate its own generation. In other words, this chart demonstrates that Ameren Missouri would be a net purchaser rather than a net generator.

[6] September 14, 2023 Ameren Missouri 2023 IRP Preview Slide 15.

Q. What would Ameren Missouri need to show if there was an energy need?

A. If one were to assume that by energy need, one is referring to the inability to meet the non-peak or the net-peak peak hours load requirement. Ameren Missouri has not provided analysis to show that.

Q. Doesn't Mr. Michels' figure 14 through figure 21 show the energy need?

A. No. As stated before, none of those figures include Ameren Missouri's combustion turbine generation.

Staff witnesses Sarah L.K. Lange, Michael L. Stahlman also speak to the Tartan factor of "need."

Q. What is Staff's conclusion regarding Ameren Missouri's energy need?

A. Ameren Missouri has not demonstrated an energy need that justifies the solar projects for which permission is requested in this docket, even considering changes to its fleet that may be prompted by environmental laws, as described below.

Environmental Law Impact on Ameren Missouri's Generation Fleet and Market Energy Price Predictions

Q. Are there environmental regulations that may impact Ameren Missouri's generating fleet?

A. Yes. The Climate and Equitable Jobs Act ("CEJA") is recent legislation that became law in Illinois. This legislation has timelines for retirements of fossil generation types starting in 2030 and extending to 2045. Additionally, CEJA limits the emissions of Carbon Dioxide and copollutants.[7]

Q. How is Ameren Missouri impacted by CEJA?

[7] As of the effective date of the Act, no unit may emit, in any 12-month period, CO2e or copollutants in excess of that unit's existing emissions for those pollutants.

A. All of Ameren Missouri's fossil generation assets in Illinois[8] will have limitations on emissions and depending on certain factors in the legislation, may be required to retire more quickly than expected prior to the legislation passage. Both of these impact Ameren Missouri with the potential speeding up of retirements as well as limiting the output of the natural gas generation in Illinois.

Q. Has the Environmental Protection Agency ("EPA") enacted rules that will impact existing fossil generators?

A. Yes. As of August 4, 2023, the "Good Neighbor rule" of the Clean Air Act is in effect. This rule will limit nitrogen emissions in Missouri and 21 other states, by implementing an allowance-based trading program. Ameren Missouri anticipates the rule to result in reductions in output of coal plants, in Missouri, during May through September each year without additional nitrogen controls.[9]

Also, on December 23, 2020, EPA completed its review of the full body of currently available scientific evidence and exposure/risk information and decided to retain the existing ozone National Ambient Air Quality Standards (NAAQS). The existing primary and secondary standards, established in 2015, are 0.070 parts per million (ppm), as the fourth-highest daily maximum 8-hour concentration, averaged across three consecutive years. Missouri Department of Natural Resources ("MDNR") and Ameren Missouri have finalized consent decrees for a number of its coal plants that are included in the proposed Missouri State Implementation Plan Revisions for the 2015 Ozone Standard.[10]

[8] The Ameren Missouri facilities physically located in Illinois and capacities are the Venice Energy Center (489 MW), the Raccoon Creek Energy Center (304 MW), Pinckneyville Energy Center (316 MW), Goose Creek Energy Center (438 MW), and the Kinmudy Energy Center (210 MW).
[9] EA-2023-0286 Michels Direct, Pg. 32, ll. 3-10.
[10] https://dnr.mo.gov/document-search/proposed-missouri-state-implementation-plan-revision-st-louis-moderate-nonattainment-area-plan-2015-ozone-standard.

Q. Are there any others?

A. While not enacted, the EPA has published for comments Emission Guidelines for Greenhouse Gas Emissions From Existing Fossil Fuel-Fired Electric Generating Units.

Q. Has Ameren Missouri taken into account any potential rules for limiting greenhouse gas emissions in their Integrated Resource Plan ("IRP")?

A. Yes. In the 2021 Ameren Missouri Preferred Resource Plan, Ameren Missouri modeled those emission limitations via a Carbon Dioxide price.

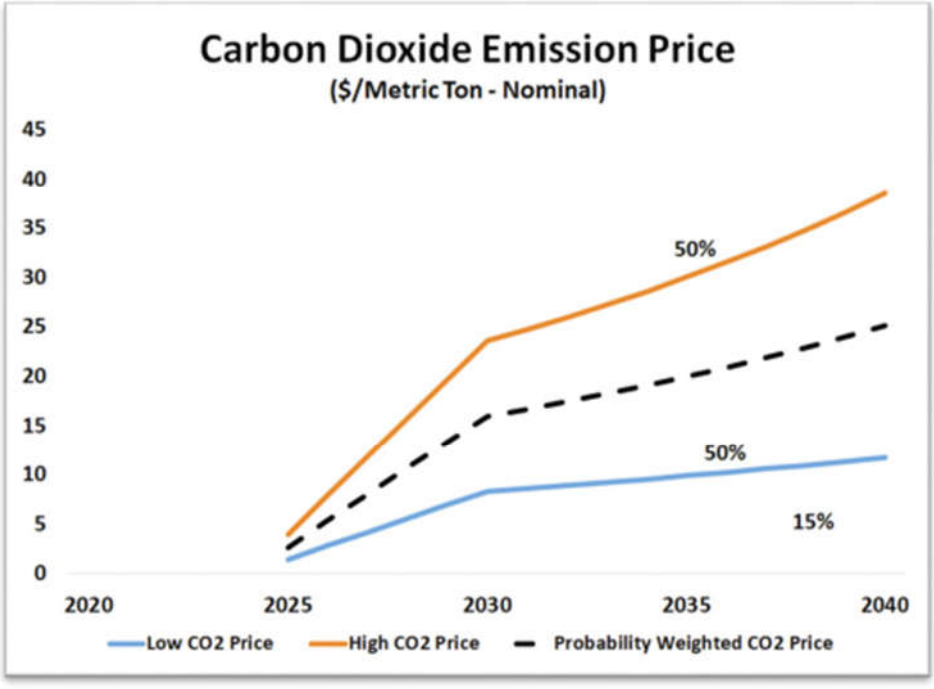
Q. What is a Carbon Dioxide Price?

A. A Carbon Dioxide Price, in this context, is an additional price leveed upon carbon dioxide emission to incentivize the transition away from combustion processes to generate electricity.

Q. What prices did Ameren Missouri use in their modeling?

A. Matt Michels presents Figure 27, shown below, as the level of carbon dioxide price Ameren Missouri is using.

Figure 27



Q. Does Staff have concerns about using a Carbon Dioxide price?

A. Yes. While it is unclear if a future emission guideline rule from the EPA will come with a cap and trade type system or a carbon dioxide price system, Ameren Missouri has only modeled one type of emission limitation attainment method.

Q. Why is that concerning?

A. The most recent Good Neighbor Rule for nitrogen emissions has a cap and trade type set up. The CEJA legislation in Illinois has a limit on the emissions with no carbon pricing. Finally, the Acid Rain Program of the EPA used a cap and trade system for emission limitation attainment. The current proposed rule language on carbon emissions, starting in 2030, would generally require more CO2 emissions control at fossil fuel-fired power plants that operate more frequently and for more years and would phase in increasingly stringent CO2 requirements over time. The proposed requirements vary by the type of unit (new or existing, combustion turbine or utility boiler, coal-fired or natural gas-fired), how frequently it operates (base load, intermediate load, or low load (peaking) and its operating horizon (i.e., planned operation after certain future dates).[11] Pair the proposed rule language on carbon emission and the tax incentives provided for in the Inflation Reduction Act, it appears that at least currently; there is a push to incentivize renewables and place caps on emissions.

Q. How does using a carbon dioxide price influence the market prices generated in a modeling scenario?

A. A carbon dioxide price not only impacts the cost profile for the fossil generation units, it also, by default, impacts the energy market prices. These impacts tend to create

[11] https://www.epa.gov/system/files/documents/2023-05/FS-OVERVIEW-GHG-for%20Power%20Plants%20FINAL%20CLEAN.pdf Pg. 3.

generally higher energy market prices in more hours than would be the case if alternative environmental measures were modeled instead. In the case that there are emission limits, there is a build out of renewables to fulfil the load requirements with renewable generation but this generation is either zero or negative with the tax incentives. The additional zero or negative cost renewable generation would lower the market prices as time goes on.

Q. What is the expectation for Carbon Dioxide prices in the Ameren Missouri 2023 IRP?

A. Mr. Michels states:

> I would expect the economics of renewable energy resources to improve using the 2023 IRP assumptions for CO2 prices because the probability weighted average CO2 price for the 2023 IRP will be higher than that used in the analysis that supported the Company's 2022 change in PRP.[12]

Q. Does this seem to be consistent with Staff's concern?

A. Yes. Generally speaking, if a scenario has a higher Carbon Dioxide Price that scenario will also have higher market prices. Those higher market prices are an incentive to increase the amount of renewable generation, and will result in models showing that renewable generation is more economical than models with lower market prices. Ameren Missouri stated in EO-2024-0020:

> The higher the CO2 price, the higher the power price. Wind and solar generation, along with other non-carbon-emitting generating sources like hydro and nuclear, therefore see a benefit from CO2 prices through the revenue they receive in the market.[13]

Q. Has Ameren Missouri included a scenario that models the IRP with an emission limit and not a Carbon Dioxide Price?

[12] EA-2023-0286 Michels Direct .Pg. 64. ll. 3-6.
[13] EO-2024-0020 Chapter 10, Pg. 13.

A. No.[14]

Q. Have other Missouri utilities switched from using a carbon price or carbon tax to an emission limitation?

A. Yes. Evergy in its IRP annual update in EO-2023-0212 stated:

> Evergy currently expects future carbon policies to be in the form of incentives (such as those in the IRA), or requirements for physical emissions reductions, rather than carbon taxes.[15]

Capacity Needs

Q. Does Ameren Missouri's 2020 IRP show that capacity is needed during the planning period?

A. Yes. Based on Ameren Missouri's analysis, there is a need for winter capacity starting in 2026 and summer capacity in 2031. Note, as discussed by Staff experts J Luebbert and Brad J. Fortson, Ameren Missouri has significant discretion in this analysis.

Q. Is the addition of these four solar projects a reasonable way for Ameren Missouri to address its winter capacity needs?

A. No.

Q. Please provide additional context regarding Ameren Missouri's capacity needs.

A. Figures 24 and 25[16] in Mr. Michels' direct testimony, shown below, show a need for winter capacity starting in 2026 and continuing throughout the time-period. As far as summer capacity, there is a slight deficit in 2031 but a much larger pronounced deficit in 2037-2040.

[14] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0108.
[15] EO-2023-0212 Annual Update, Pg. 19.
[16] The 350 MW include the 200 MW Huck Finn and the 150 MW Boomtown solar projects.

Figure 24

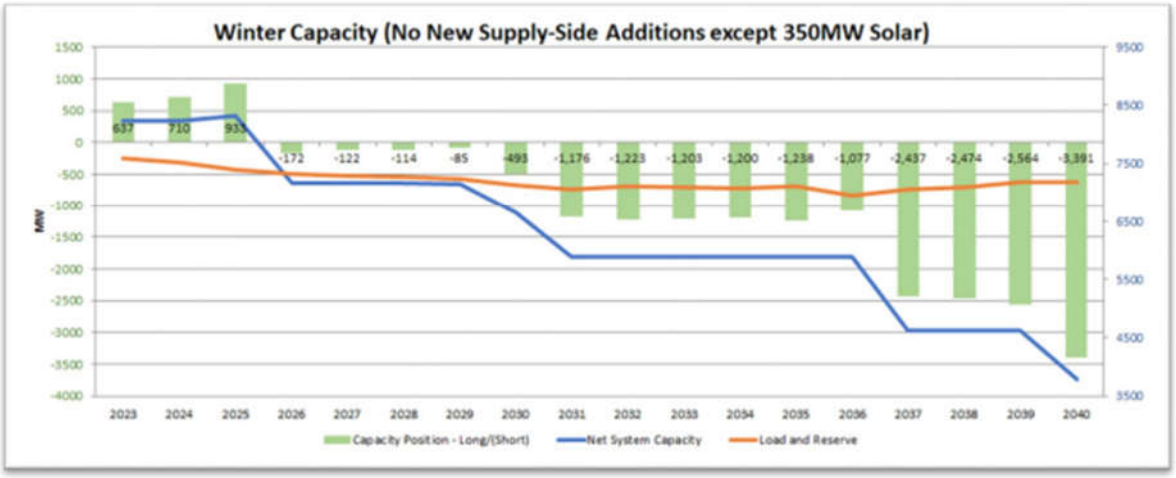
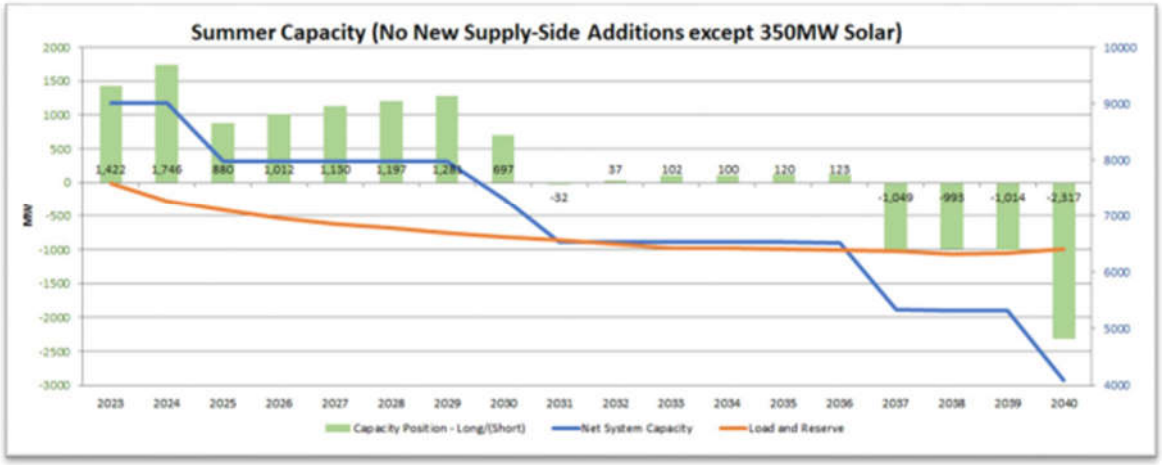


Figure 25



Q. How would the proposed projects help with that winter capacity need?

A. As Mr. Michels provided in his Table 1 of his direct testimony, shown below, the expectation is that 5% of the rated capacity can be used to offset the projected peak in winter.

Wind and Solar Capacity Accreditation Multipliers				
	2023-2024		2040	
	Summer	Winter	Summer	Winter
Wind	18.10%	40.30%	18.10%	30%
Solar	50%	5%	40%	5%

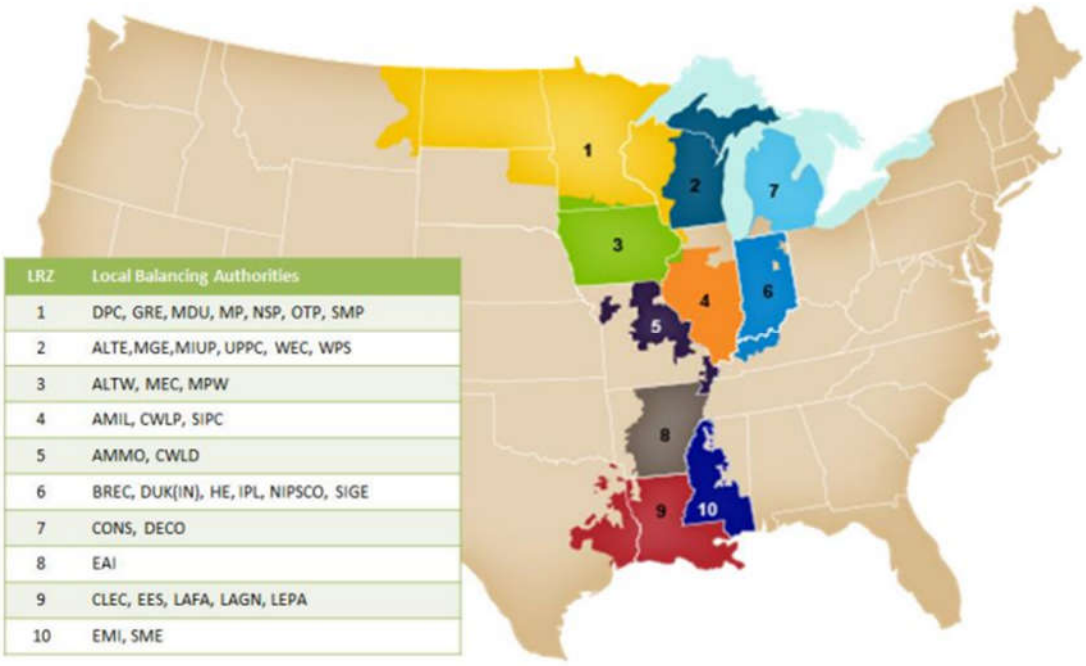
Q. Does solar have the best winter capacity accreditation?[17]

A. No. As Mr. Michels points out, MISO does not allow a utility to count the entire nameplate capacity of solar projects as available capacity for its market and reliability purposes. The winter accredited value for solar, as seen in the above table, is only 5%. Of renewable options to address a winter capacity need, wind is a more reasonable option to explore.

Resource Adequacy

Q. How does MISO look at resource adequacy?

A. MISO requires load serving entities within each zone[18] to have sufficient resources to meet load and required reserves.[19] A map[20] showing the different zones is shown below.



LRZ	Local Balancing Authorities
1	DPC, GRE, MDU, MP, NSP, OTP, SMP
2	ALTE,MGE,MIUP, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, SIPC
5	AMMO, CWLD
6	BREC, DUK(IN), HE, IPL, NIPSCO, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA
10	EMI, SME

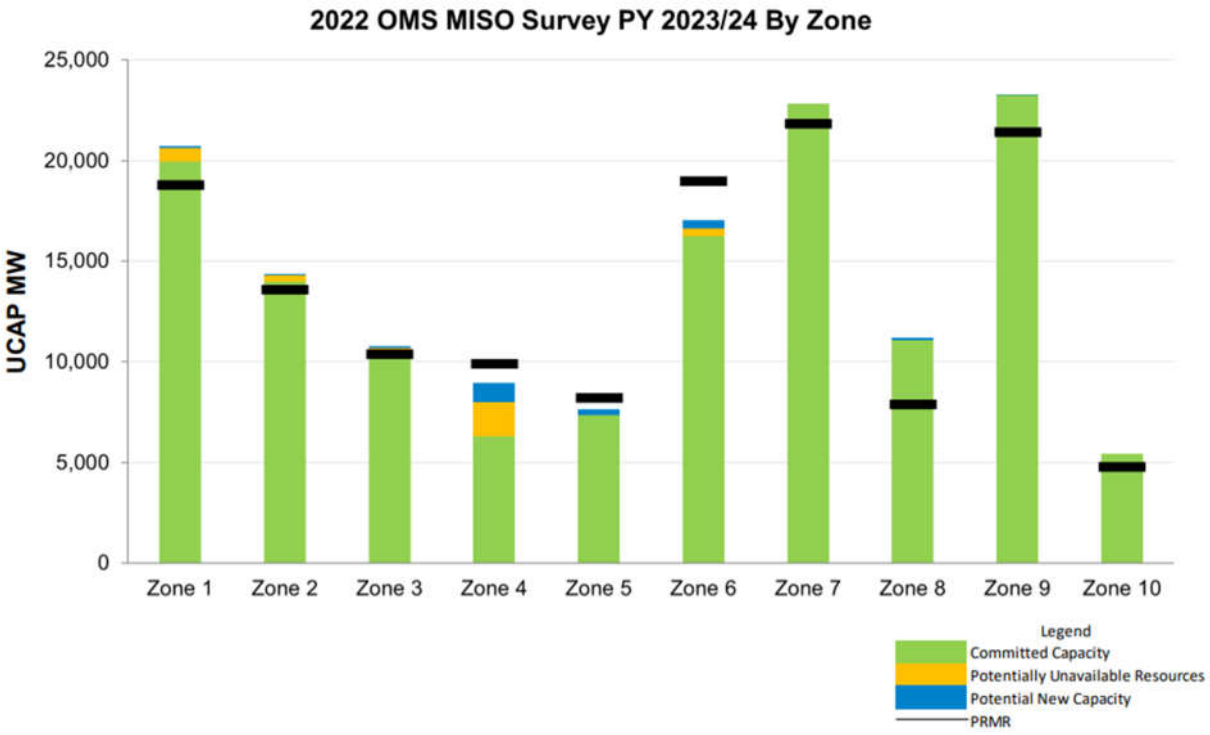
[17] Resource accreditation is the process of accurately measuring and assigning a capacity value to a resource based on its contribution to system reliability during periods of highest risk. MISO's role is to measure current accreditation values, and forecast future values to inform investment and retirement decisions. https://cdn misoenergy.org/MISO%20Draft%20Resource%20Accreditation%20Design%20White%20Paper628865.pdf#:~:text=Resource%20accreditation%20is%20the%20process%20of%20accurately%20measuring,future%20values%20to%20inform%20investment%20and%20retirement%20decisions.

[18] Ameren Missouri is in local resource zone 5. Ameren Missouri has ownership in generation in local resource zone 4.

[19] Surplus resources may be shared among load serving entities with resource deficits to meet reserve requirements.

[20] https://cdn misoenergy.org/20220610%20OMS-MISO%20Survey%20Results%20Workshop%20Presentation625148.pdf

Below is the results of the MISO Organization of MISO States ("OMS") survey for 2023/2024 by zone.



This chart shows for zone five (5) the Planning Reserve Margin Requirement ("PRMR") as being higher than the sum of the committed capacity and the potential capacity. Saying it another way, the amount of available capacity in zone five is less than the required amount.

Q. What is the PRMR?

A. The PRMR is essentially the amount of load plus reserve margin to be served by the Load Serving Entity ("LSE") (i.e. Ameren Missouri). MISO uses credits called Zonal Resource Credits ("ZRCs") as a currency to ensure LSE's have enough planning resources to reliability serve load.[21]

[21] "The Planning Reserve Margin Requirement (PRMR) is the number of Zonal Resource Credits (ZRCs) required to meet a Load Serving Entity's (LSE) Resource Adequacy Requirements (RAR). The RAR is established to ensure that LSEs have enough Planning Resources to reliably serve load. LSEs that have a PRMR will be obligated to procure capacity equal to their PRMR pursuant to the relevant Auction Clearing Price (ACP) for the Local

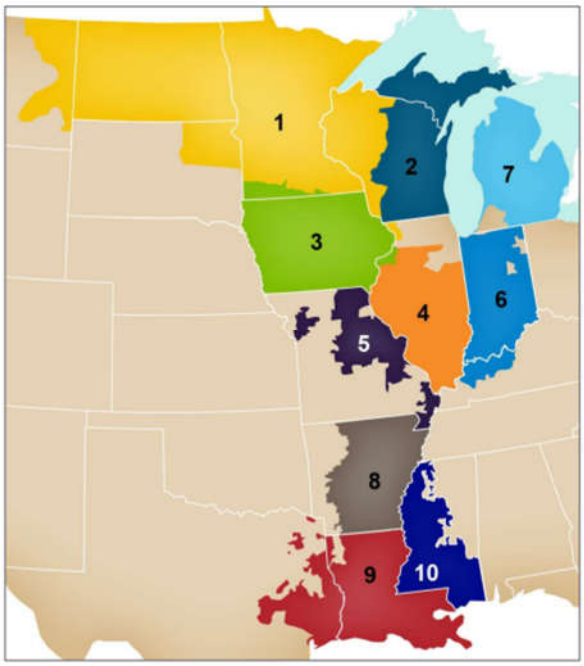
Q. For zone five (5) when the PRMR is higher than the aggregate of the committed capacity and potential capacity, does that mean Ameren Missouri is short on capacity for 2023-2024?

A. No. The chart shows the PRMR is higher than the committed capacity and potential capacity for zone five (5). Ameren Missouri generation resources in zone four (4) would be shown as a committed capacity resource for zone four (4).[22]

Q. What was the MISO Capacity Auction results for 2022-2023?

A. The MISO capacity auction for 2022-2023 resulted in a capacity auction price of $236.66 MW-Day, as shown below.[23]

Zone	Local Balancing Authorities	Price $/MW-Day
1	DPC, GRE, MDU, MP, NSP, OTP, SMP	$236.66
2	ALTE, MGE, UPPC, WEC, WPS, MIUP	$236.66
3	ALTW, MEC, MPW	$236.66
4	AMIL, CWLP, SIPC, GLH	$236.66
5	AMMO, CWLD	$236.66
6	BREC, CIN, HE, IPL, NIPS, SIGE	$236.66
7	CONS, DECO	$236.66
8	EAI	$2.88
9	CLEC, EES, LAFA, LAGN, LEPA	$2.88
10	EMBA, SME	$2.88
ERZ	KCPL, OPPD, WAUE (SPP), PJM, OVEC, LGEE, AECI, SPA, TVA	$133.70-236.66



Resource Zone (LRZ) where they have PRMR unless, and to the extent that, the LSE meets its PRMR via a Fixed Resource Adequacy Plan (FRAP)." https://help.misoenergy.org/knowledgebase/article/KA-01099/en-us

[22] The Ameren Missouri facilities physically located in Illinois are the Venice Energy Center (489 MW), the Raccoon Creek Energy Center (304 MW), Pinckneyville Energy Center (316 MW), Goose Creek Energy Center (438 MW), and the Kinmudy Energy Center (210 MW).

[23] https://cdn misoenergy.org/2022%20PRA%20Results624053.pdf Pg. 4

Q. What does a capacity auction price of $236.66 indicate?

A. If the auction does not have enough installed capacity, the auction uses a price for the Cost of New Entry ("CONE").[24] The CONE for 2022-2023 capacity auction was priced at $236.66. The local resource zones for MISO north priced at $236.66 shows that as a whole, MISO north is short on capacity.

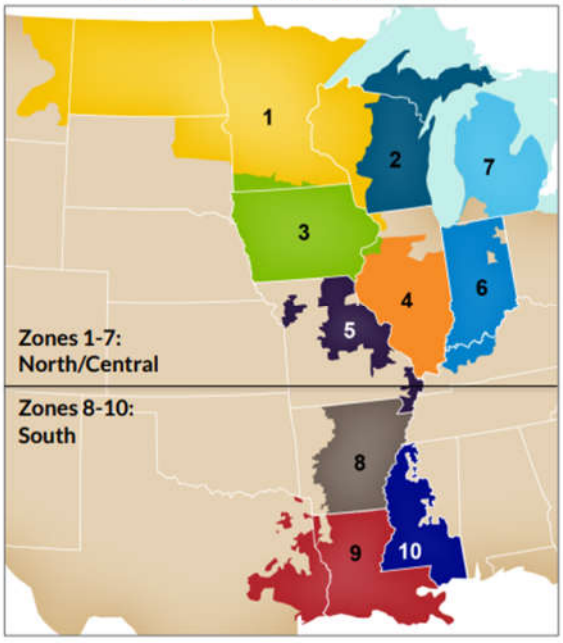
Q. What was the MISO Capacity Auction results for Planning Year 2023-2024?

A. As shown below, for local resource zone 5 priced out at $15.00 or less, depending on season.

2023 PRA Results

Zone	Local Balancing Authorities	Price $/MW-Day Summer	Fall	Winter	Spring
1	DPC, GRE, MDU, MP, NSP, OTP, SMP	$10.00	$15.00	$2.00	$10.00
2	ALTE, MGE, UPPC, WEC, WPS, MIUP	$10.00	$15.00	$2.00	$10.00
3	ALTW, MEC, MPW	$10.00	$15.00	$2.00	$10.00
4	AMIL, CWLP, SIPC, GLH	$10.00	$15.00	$2.00	$10.00
5	AMMO, CWLD	$10.00	$15.00	$2.00	$10.00
6	BREC, CIN, HE, IPL, NIPS, SIGE	$10.00	$15.00	$2.00	$10.00
7	CONS, DECO	$10.00	$15.00	$2.00	$10.00
8	EAI	$10.00	$15.00	$2.00	$10.00
9	CLEC, EES, LAFA, LAGN, LEPA	$10.00	$59.21	$18.88	$10.00
10	EMBA, SME	$10.00	$15.00	$2.00	$10.00
ERZ	KCPL, OPPD, WAUE (SPP), PJM, OVEC, LGEE, AECI, SPA, TVA	$10.00	$15.00	$2.00	$10.00

MISO Resource Adequacy Zones

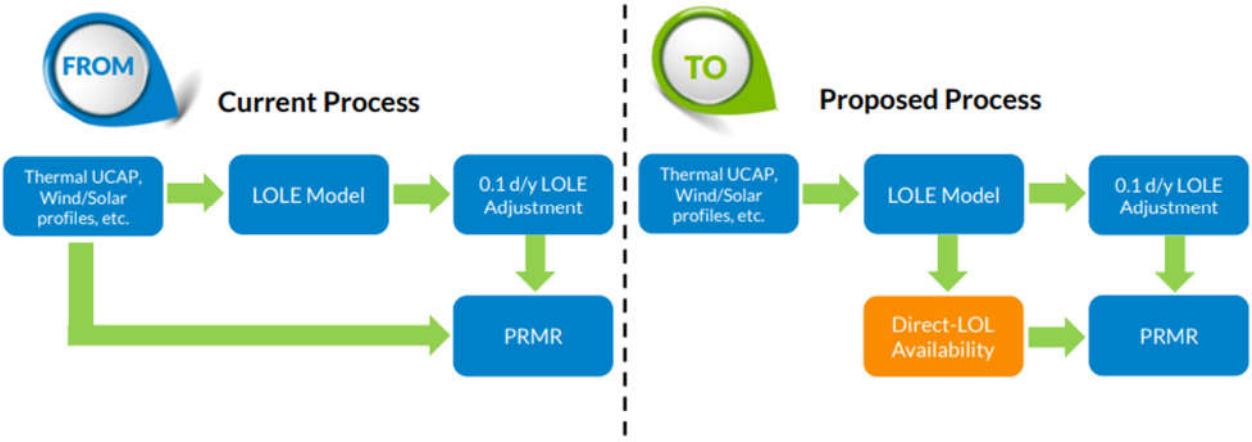


[25]

[24] Cost of New Entry is an industry-wide term, used to indicate the current, annualized, capital cost of constructing a power plant. https://cdn misoenergy.org/20221012%20RASC%20Item%2004c%20CONE%20Update626542.pdf slide 4.
[25] https://cdn misoenergy.org/2023%20Planning%20Resource%20Auction%20(PRA)%20Results628925.pdf slide 4.

Q. Is MISO considering changes to its Planning Reserve Margin Requirement calculation methodology?

A. Yes. MISO is proposing a 3-year transition with step-changes in accreditation with the goal of implementing Direct-Loss Of Load[26] ("DLOL") after 3 years.[27]



Q. Is there risk that these changes would impact the accreditation that Ameren Missouri is relying upon to calculate its reserve margin?

A. Yes. MISO provided its recommendation at the November 2022 Resource Adequacy Subcommittee to use the DLOL for wind and solar accreditation. MISO is expected to review this potential change in late 2023, and is postured to phase this change in over the

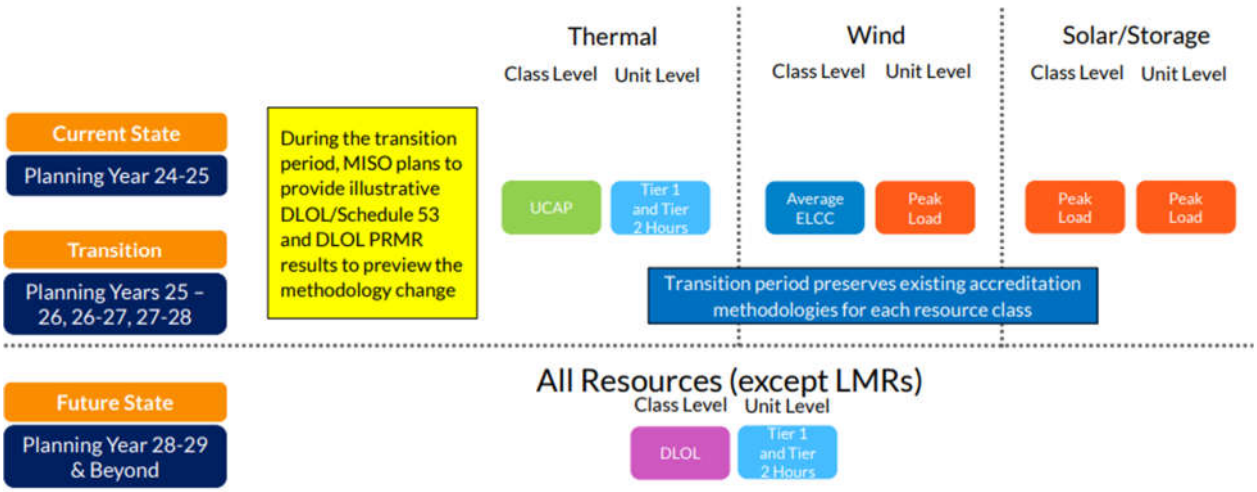
[26] Direct Loss-of-Load (DLOL) is a methodology to calculate the marginal capacity value of resources in resource adequacy studies. It measures the marginal contribution of a resource to reliability, by calculating the average generation of said resource during critical times in the system, also known as loss-of-load (LOL) hours.
[27] https://cdn misoenergy.org/20230418-19%20RASC%20Item%2012a%20Non-Thermal%20Accreditation%20Presentation628530.pdf slide 2.

next three years. The table[28] below indicates winter for the solar class would go from a UCAP[29] of 6% to a DLOL of 0%, and the wind class would go from 40% to 13%.

PY23-24 Resource Class	Summer - 2,703 hrs		Fall - 265 hrs		Winter - 201 hrs		Spring - 240 hrs	
	UCAP	DLOL	UCAP	DLOL	UCAP	DLOL	UCAP	DLOL
Gas	91%	89%	89%	88%	84%	70%	88%	72%
Coal	92%	91%	91%	87%	90%	72%	89%	74%
Hydro	97%	97%	97%	99%	42%	69%	62%	74%
Nuclear	95%	90%	96%	83%	95%	84%	92%	77%
Pumped Storage	99%	98%	91%	98%	94%	47%	89%	70%
Solar	45%	36%	25%	28%	6%	0%	15%	15%
Wind	18%	11%	23%	15%	40%	13%	23%	16%
Storage	95%	93%	95%	90%	95%	90%	95%	97%
Run-of-River	100%	100%	100%	100%	100%	100%	100%	100%

Q. Is the unit accreditation expected to change?

A. Yes. As shown below,[30] the unit level accreditation is expected to change.



[28] https://cdn.misoenergy.org/20230922%20LOLE%20Modeling%20and%20Accreditation%20Workshop%20Presentation630256.pdf slide 36.

[29] Unforced Capacity (UCAP) is the percentage of capacity that is available after forced outage rates and/or availability issues are taking into account.

[30] https://cdn misoenergy.org/20231004%20RASC%20Item%2005ai%20Resource%20Accreditation%20Presentation630408.pdf slide 10.

Q. How does MISO's resource adequacy construct relate to your previous discussion regarding Ameren Missouri's winter capacity needs?

A. The changes MISO is pursuing may cause the PRMR to be reduced. If there is a reduction of the PRMR, the amount of winter capacity that may be required would be less.

Reliability Analysis

Q. Does Ameren Missouri's direct evidence in this case include any type of reliability analysis?

A. Yes. Mr. Michels starts a discussion on page 59, line 7 of his direct testimony on renewable impacts on the reliability and brings up the Loss of Load Expectation ("LOLE") benefits of the proposed additions.

Q. What is a LOLE study?

A. The LOLE[31] study provides an assessment of whether installed and proposed capacity is adequate to serve the forecasted demand while determining an appropriate generation to maintain an LOLE of 1 day in 10 years.

Q. Will adding a new generator contribute positively to LOLE?

A. Yes. As long as the new generator(s) has availability, energy, and capacity, there will be less times where load will be higher than generation.

Q. What modeling did Ameren Missouri perform or have performed regarding LOLE?

A. Ameren Missouri contracted with Astrape for analysis. Astrape owns and uses the SERVM model. SERVM, as setup for Ameren Missouri, is defining a load shed event in

[31] $LOLE = \sum [Ci < Li]$ where P() is the probability function, N is the number of days in a year, Ci is the available capacity, and Li is the daily peak demand.

an hour when load plus regulating reserves cannot be met. The model was set up with Ameren Missouri generation units to be dispatched based on all physical realities that the units operate within and market purchases are used to meet the load within the model. The transmission system is largely treated as being able to deliver the generation to the load.[32]

Q. Do other Staff witnesses speak to Ameren Missouri's LOLE discussion?

A. Yes. Staff witness Sarah L.K. Lange also discusses LOLE and the Astrape modeling.

Power Attributes

Q. In the EA-2022-0245 day one (1) transcript starting on page 251, line 23 Mr. Steven M. Wills states:

> We're trying to pick the right attributes or resources to construct kind of what does our fleet look like in the future…

What attributes did Ameren Missouri look at when selecting the resources proposed in this proceeding?

A. Ameren Missouri's evaluation of power attributes mainly pertained to the capacity and energy contributions of these proposed projects.[33] Ameren Missouri's analysis does not explicitly assess the contribution of specific resources to voltage support, Volt-Ampere reactive ("VAr) support, and frequency. Instead, Ameren Missouri relies on Regional Transmission Organization ("RTO")-level analysis such as MISO's Renewable Integration Impact Assessment for identification of potential issues regarding grid reliability and stability.

[32] EA-2023-0286 Ameren Missouri response to Staff DR No. 0168.
[33] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0107.

Q. Will the retirement of coal generation and the addition of more variable renewable generation have impacts to the grid?

A. Yes. National Renewable Energy Laboratory ("NREL") states:

> Historically, in the U.S. power grid, inertia from conventional fossil, nuclear, and hydropower generators was abundant— and thus taken for granted in the planning and operations of the system. But as the grid evolves with increasing penetrations of inverter-based resources—e.g., wind, solar photovoltaics, and battery storage—that do not inherently provide inertia, questions have emerged about the need for inertia and its role in the future grid.[34]

Based on the answers Ameren Missouri provided to Staff DR No. 0107, it is unclear how and to what degree, the changes proposed in Ameren Missouri's IRP what analysis may have been performed to determine if other changes are necessary for grid support.

PURCHASE POWER AGREEMENTS

Q. Did Ameren Missouri include purchase power agreements ("PPAs") in its resource portfolio that it evaluated for its purported needs?

A. No.

Q. Did Staff inquire about the Company's reasoning behind its decision to exclude PPAs from consideration?

A. Yes. Staff sent DR Nos. 0170 and 0171 to inquire about why Ameren Missouri did not choose to include PPAs. As part of their response to Staff DR No. 0171, Ameren Missouri raises concerns regarding maintenance of PPA facilitates stating:[35]

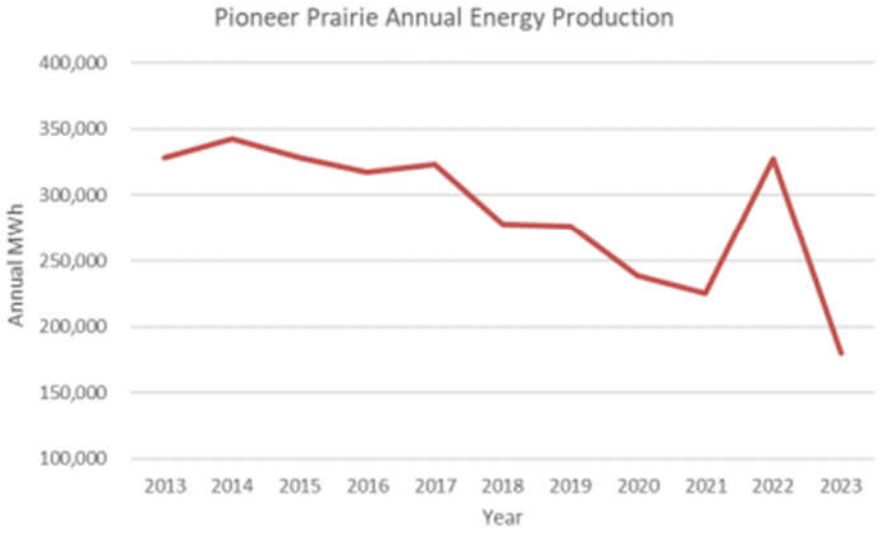
> Under a PPA structure the owner has one goal, to maximize profit, and its ability to do so is unconstrained by rate regulation or an obligation to

[34] https://www nrel.gov/docs/fy20osti/76534.pdf#:~:text=To%20educate%20policymakers%20and%20other%20interested%20stakeholders%2C%20NREL,reliability%20can%20be%20maintained%20in%20the%20evolving%20grid. Pg. 1.

[35] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0171.

> provide safe and reliable service to end use customers. This goal can often cause an owner to make short sighted decisions to save money at the expense of reliability…The output from the Pioneer Prairie wind facility has declined year over year at a rate of ~4% for the last 10 years, as depicted below in Figure 1.

Figure 1: Pioneer Prairie Annual Energy 2013-2023



Q. Does Staff have concerns with this depiction?

A. Yes, Ameren Missouri's graph does not depict the full history of generation for Pioneer Prairie. NREL found:

> Changes in climate and weather patterns will be reflected in the longer-term performance of Wind Power Plants (WPP). In this respect, wind power is similar to hydropower, especially run-of-the-river type, in that there are high energy production (wet) years and low energy production (dry) years. The available data show that during the highest production year, total wind energy from the same WPP can be almost 40% higher than the annual production of the lowest production year.[36]

[36] https://www nrel.gov/docs/fy12osti/53637.pdf Pg. 12.

The data Staff used show an annual variation from the mean of approximately 11%, well within the bounds that NREL found. The historical generation from 2010-2022 for Pioneer Prairie II[37] is shown below:

**

**

In June 2009, Ameren Missouri executed an agreement to purchase 102 MW of wind power from Phase II of Horizon Wind Energy's Pioneer Prairie Wind Farm in northeastern Iowa in Mitchell County.[38] The life of the Production Tax Credits (PTCs) for that facility is 10 years, meaning the PTCs would have expired in approximately 2019. Typically, PTCs allow the facility to be bid in at a negative value, when those expire, the unit would be bid in at a zero value, which would lower the amount of generation the unit would produce. As can be seen the lowest two points on Figure 2 happen to be in 2020 and 2021, after the PTCs would have expired.

[37] Data reported by Ameren Missouri per 20 CSR 4240-3.190.
[38] https://www.ameren.com/-/media/missouri-site/Files/Environment/Renewables/Chapter5RenewableStorageResources.pdf Pg. 4.

The bounce back in 2022 was likely due to higher natural gas prices as well as issues with rail transport in certain regions that caused some coal facilities to derate or change bidding strategies to allow for coal conservation measures. Those factors caused the market prices to be higher than the prior years.

Staff does not agree that Figure 1 shows or implicates short sighted decision making by Pioneer Prairie II's ownership is the cause of the reduction seen.

Q. With regard to Ameren Missouri's concerns that there are financial pressures in PPAs that will cause owners to make shortsighted decisions to save money at the expense of reliability: does Staff have any comments or concerns?

A. Ameren Missouri generally faces these same financial pressures or at least very similar financial pressures. In the aftermath of the failure of Taum Sauk, the Federal Energy Regulatory Commission ("FERC") investigated the incident. In the FERC report number 2277, FERC stated:

> The project had historically operated with a minimum of two feet of freeboard on the lowest section of the parapet wall. Following installation of a geomembrane liner in 2004, AmerenUE operated the project to fill the upper reservoir within one foot of the lowest section of the parapet wall. Post breach evidence shows the reservoir may have been routinely filled to within 0.25 foot of the lowest section of the parapet wall.[39]

Operating to within three inches of the lowest section of parapet wall left little margin of error.

In Staff's Initial Incident Report in ES-2007-0474, Staff presented allegations raised by an Ameren Missouri employee who felt pressure to keep Taum Sauk operating.[40] Ultimately,

[39] FERC report number 2277 Pg. 7.
[40] ES-2007-0474 Staff Initial Incident Report 10/24/07 Pgs. 81-82.

a maintenance outage for Taum Sauk was not scheduled, which contributed to the catastrophic failure of the Upper Reservoir.

Q. With regard to PPAs, what is Staff's position?

A. It is unreasonable for Ameren Missouri to wholly disregard PPAs when selecting projects. In prior years, Ameren Missouri entered into long term PPAs. Staff is not implying that the inclusion of PPAs will be a panacea for all that ails Ameren Missouri. However, when PPAs were advantageous to Ameren Missouri in the past, it appears as though some were evaluated and some were accepted. Staff witness J Luebbert goes into further detail regarding PPAs. Staff witness Cedric E. Cunigan discusses additional details regarding Ameren Missouri's selection process.

IN-SERVICE CRITERIA

Q. What are in-service criteria?

A. In-service criteria are a set of operational tests or operational requirements developed by the Staff to determine whether a new unit is "fully operational and used for service."

Q. Where does the phrase "fully operational and used for service" come from?

A. The phrase comes from Section 393.135, RSMo. 2000, a statute that was adopted by Initiative, Proposition No. 1, on November 2, 1976. Section 393.135, RSMo. 2000, provides as follows:

> Any charge made or demanded by an electrical corporation for service, or in connection therewith, which is based on the costs of construction in progress upon any existing or new facility of the electrical corporation, or any other cost associated with owning, operating, maintaining, or financing any property before it is fully operational and used for service, is unjust and unreasonable, and is prohibited. [Emphasis added.]

Q. Should the Commission grant a Certificate of Convenience and Necessity ("CCN"), does the Staff have a recommendation for the Commission with regard to in-service criteria?

A. Yes. For any CCN granted in this case, Staff recommends that the Commission note the in-service criteria contained in Confidential Schedule SEL-r2 and Confidential Schedule SEL-r3 are appropriate for use in a future case to determine whether each solar project is in-service. Staff prefers to have in-service criteria that the parties can agree to prior to the case(s) in which the plant is put into rate base. In this case, Ameren Missouri provided Staff with the in-service criteria they are proposing to use for the proposed solar projects in the confidential response to Staff DR No. 0005. Staff is in agreement that the in-service criteria is appropriate and should be used in a future case to determine whether the project be considered fully operational and used for service. These criteria are listed in attached Confidential Schedule SEL-r2. Staff is also including the capacity test procedure as Confidential Schedule SEL-r3.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS ("IEEE") STANDARDS

Q. Do any of the proposed solar projects interconnect into the transmission system or the distribution system?

A. The proposed Split Rail project and the Cass County project is intended to interconnect with the transmission system. The proposed Vandalia project and the Bowling Green project is intended to interconnect with the distribution system.

Q. What Institute of Electrical and Electronics Engineer ("IEEE") standard is applicable to interconnection at the transmission voltage level?

A. IEEE Standards Association ("IEEE SA") recently published a new standard related to projects such as Split Rail, Cass County, Vandalia and Bowling Green. Specifically, on April 22, 2022, IEEE published IEEE Standard 2800™. IEEE Standard 2800™ is the Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems. IEEE SA explained the need to establish a new standard: "Recent events in North America such as the Blue Cut Fire Disturbance as well as institutional challenges in North America that suggest the inappropriate use of IEEE Standard 1547™ for large-scale solar plants underscores this need."[41] IEEE Standard 1547™ is the IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces. The IEEE 1547™ is appropriate for distributed energy resources, such as net-metered customers.

North American Electric Reliability Corporation[42] ("NERC") also highlighted the need for developing a standard that is pertinent to inverters used for generation that will be connected to the transmission system in its *1,200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report*.

Staff is aware that IEEE Standard 2800™ will require its adoption by the regional authority governing interconnection requirements ("AGIR")[43].

[41] https://sagroups.ieee.org/2800/#:~:text=Given%20that%20IEEE%20standards%20are%20voluntary%20industry%20standards%2C,resources%20interconnecting%20with%20associated%20transmission%20electric%20power%20systems.

[42] The North American Electric Reliability Corporation is a not-for-profit international regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

[43] For IEEE 2800, AGIR is an entity that defines, codifies, communicates, administers, and enforces the policies and procedures for allowing electrical interconnection of inverter-based resources interconnecting with associated transmission electric power systems. Other IEEE standards may have slightly different definitions for AGIR, such as IEEE 1547-2018.

Q. In EA-2022-0244, did Ameren Missouri agree to use sound engineering judgement and commercially reasonable efforts to meet the IEEE Standard P2800TM for the Project and future transmission interconnected solar projects?[44]

A. Yes. For Split Rail and Cass County, Ameren Missouri has purported to have been working with each project developer, the selected inverter manufacturer for each project, and third party firms on the implementation of IEEE 2800. Each has stated that the capability requirements are being evaluated and required equipment modifications are in progress, but will likely take some time, as they wait for technical developments to be implemented by the industry. The general take on the 2800 standard is it is more of a qualitative definition of new features required for bulk system interconnection. A quantitative definition of the performance, in the form of test standards and specific requirements, has not been completed by MISO. All of the filed projects have a signed IA, but IEEE 2800 capability requirements are not called for. Ameren Missouri is proactively working with vendors on current projects to ensure IEEE 2800 is being evaluated and implemented as equipment is commercially available and processes and requirements are defined.[45]

Q. Should the condition to have Ameren Missouri use sound engineering judgment and commercially reasonable efforts to meet the IEEE Standard P2800^{TM} for the Project and future transmission interconnected solar projects continue?

A. Yes.

INTERCONNECTION

Q. Why is Staff presenting information on interconnection costs?

A. If a project has not completed the RTO/ISO generator interconnector process, the level of finality about the level of cost may be lacking. Included in the interconnection

[44] EA-2022-0244 Stipulation and Agreement Pg. 5.
[45] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0104.

studies is information about how the injection point will handle the level of proposed injection. For example, in Case No. EA-2019-0021 regarding the Brickyard Hills wind farm, the project had not completed the interconnection process. In that case, Staff put forth evidence that the interconnection costs may be a much higher level of cost than what Ameren Missouri used in their case and recommended a interconnection cost threshold that would result in additional analysis to be performed by Ameren Missouri prior to a Generator Interconnection Agreement being signed.[46] As it turned out the final level of interconnection costs were at a point where Ameren Missouri decided to walk away from the project.

Q. What are the anticipated costs of each project interconnecting to the grid?

A. The following discussion is a breakdown of the planned interconnection for each project.

Cass County Solar Project

The Cass County Solar Project is a 150 MW solar facility to be constructed in Cass County, Illinois. The Project will interconnect at the Ameren Illinois Company Flannigan 138 kV Switching Station, which is under the functional control of the MISO.[47]

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[46] EA-2019-0021 Staff Rebuttal Report, Pgs. 17-20.
[47] EA-2023-0286 Application paragraph 15.
[48] EA-2023-0286 Wibbenmeyer Direct SCHEDULE SW-D4 Pg. Original Sheet No. 98.

Split Rail Solar Project

The Split Rail Solar Project is a 300 MW solar generation facility to be constructed in Warren County, Missouri and will connect to Ameren Missouri's Belleau – Montgomery 345kV line.[49] Ameren Missouri provided a Generation Interconnection Agreement that shows this interconnection will require Ameren Missouri to construct a switching station near the 345 kV line and located in Ameren Missouri's service territory.

***[50]

[redacted]

[redacted] ***

Bowling Green Solar Project

The Bowling Green Solar Project is a 50 MW solar generation facility. It will be constructed in Pike County, Missouri adjacent to the Peno Creek Combustion Turbine Generator Energy Center, which is approximately 20 miles away from the Vandalia Solar Project. The Project will also interconnect to the Ameren Missouri 69-kV system at Ameren Missouri's Pike substation.[51, 52]

[49] EA-2023-0286 Application paragraph 7.
[50] EA-2023-0286 Wibbenmeyer Direct SCHEDULE SW-D2 Pg. Original Sheet No. 96.
[51] EA-2023-0286 Application paragraph 22.
[52] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0105, Pg. 3.

Item	Description	Estimated Cost
1	Construct 69 kV Feeder Position with line PTs and Relaying	$664,062
2	Construct 69 kV line (1.5 miles) including approximately 40 poles, 556 AA conductor, OPGW, insulators, hardware, etc. Install 69kV meter pole and motor-operated load-break switch.	$1,170,000
3	Install bi-directional meter cluster (69 kV PTs and 1000:5 CTs), labor, engineering effort and field installation.	$51,414
4	RTU, SCADA and other communication efforts	$20,000
	Total	$1,905,476

Vandalia Solar Project

The Vandalia Solar Project is a 50 MW solar facility to be constructed in Audrain County, Missouri. The facility will be located two miles south of Vandalia, Missouri city limits and will interconnect to Ameren Missouri's 69-kV sub-transmission system between Ameren Missouri's Vandalia and Wellsville substations.[53, 54]

Item	Description	Estimated Cost
1	Install 11 poles, 556AA conductor, OPGW, associated 69 kV insulators, hardware, etc. Install (1) 69KV 3-way load-break tap switch, (1) 69kV metering installation, and (1) 69kV motor-operated load-break switch. (See POI discussion for description of the work). Note that easements are not included in the cost estimate.	$396,677
2	Meter Cluster (69 kV PTs and 1000:5 CTs), Labor, Engineering effort and Field installation.	$51,414
3	Distribution feeder extension for station service (approx. 1.25 miles). Install 23 poles, 1/0AAC conductor and associated 4kv insulator, cross-arms etc. Install distribution transformer and metering. (This extension is needed only if station service is required at the solar plant.)	$230,000
4	Vandalia Substation Upgrade cost. (See Protection Requirements)	$75,506
5	Installation of fiber-optic cable (via OPGW) to Vandalia Substation	$570,000
6	Wellsville Substation Upgrade cost. (See Protection Requirements)	$155,358
7	Installation of fiber-optic cable (via OPGW) to Wellsville Substation	$516,000
8	RTU, SCADA and other communication efforts	$20,000
	Total	$2,014,955

[53] EA-2023-0286 Application paragraph 18.
[54] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0106, Pg. 3.

Q. Does Staff have any concerns about the interconnection information provided by Ameren Missouri?

A. Yes. Included in the Ameren Missouri interconnection study for the Vandalia Solar Project is the following language:

> System load flow analyses conclude that the Project can operate (at fixed output power factor of 97% leading) under normal system conditions with no adverse impact on the 69 kV network or local transmission system. However, operation during distribution system (n-1) contingency conditions can produce rapid voltage change (RVC) exceeding AMO's 2% limit and circuit overloading during light load conditions. To avoid exceeding acceptable RVC and circuit loading limits, AMO reserves the right to curtail Project operation during pertinent system contingency conditions[55].

Q. What are Staff's concerns?

A. The current interconnection point for Vandalia show that there are currently known conditions that will require generation unit curtailment. With renewables, the generation is available when the weather conditions permit the availability. Depending on when curtailments may occur, may impact the economics of the generation plant going forward.

Q. Does Staff recommend a condition regarding curtailing of these units?

A. Yes, Staff recommends the Commission order Ameren Missouri to retain and report curtailment information to Staff monthly. Curtailment information should include, for each curtailment event, the start date/time, the end date/time, number of hours curtailed and max output of the facility during curtailment.

Q. What is your conclusion?

A. Ameren Missouri has not demonstrated an energy need. Staff is also concerned that Ameren Missouri, by excluding PPAs, is not evaluating all possible solutions to the needs

[55] EA-2023-0286 Ameren Missouri Response to Staff DR No. 0106, Pg. 3.

identified by Ameren Missouri. Staff is concerned that the only emission limitation attainment method used by Ameren Missouri in their IRP was use of a carbon price that causes market prices to be higher.

Q. Do you support any of Staff's recommended conditions if the Commission were to grant a CCN for the project?

A. Yes, if the Commission were to grant Ameren Missouri a CCN for the project, Staff recommends the following:

- Ameren Missouri shall use sound engineering judgment and commercially reasonable efforts to meet the IEEE Standard P2800™ for the Project(s) and future transmission interconnected solar projects.
- Staff recommends that the Commission order the in-service criteria contained in Confidential Schedule SEL-r2 and Confidential Schedule SEL-r3 for use in a future case to determine whether the solar projects are in-service.
- Staff recommends the Commission order Ameren Missouri to retain and report curtailment information to Staff. Curtailment information should include, for each curtailment event, the start date/time, the end date/time, number of hours curtailed and max output of the facility during curtailment.

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 SHAWN E. LANGE, PE

STATE OF MISSOURI)
) ss.
COUNTY OF COLE)

COMES NOW SHAWN E. LANGE, PE and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing *Rebuttal Testimony of Shawn E. Lange, PE*; 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, PE

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

D Suzie Mankin

Notary Public

CREDENTIALS AND CASE PARTICIPATION OF SHAWN E. LANGE, PE

PRESENT POSITION:

I am a Professional Engineer in the Engineering Analysis Department, Industry Analysis Division, of the Missouri Public Service Commission.

EDUCATIONAL BACKGROUND AND WORK EXPERIENCE:

In December 2002, I received a Bachelor of Science Degree in Mechanical Engineering from the University of Missouri, at Rolla now known as the Missouri University of Science and Technology. I joined the Commission Staff in January 2005. I am a registered Professional Engineer in the State of Missouri and my license number is 2018000230.

TESTIMONY FILED:

Case Number	Utility	Testimony	Issue
ER-2005-0436	Aquila Inc.	Direct	Weather Normalization
		Rebuttal	Weather Normalization
		Surrebuttal	Weather Normalization
ER-2006-0314	Kansas City Power & Light Company	Direct	Weather Normalization
		Rebuttal	Weather Normalization
ER-2006-0315	Empire District Electric Company	Direct	Weather Normalization
		Surrebuttal	Weather Normalization
ER-2007-0002	Union Electric Company d/b/a AmerenUE	Direct	Weather Normalization
ER-2007-0004	Aquila Inc.	Direct	Weather Normalization
ER-2007-0291	Kansas City Power & Light Company	Staff Report	Weather Normalization
		Rebuttal	Weather Normalization
ER-2008-0093	Empire District Electric Company	Staff Report	Weather Normalization
ER-2008-0318	Union Electric Company d/b/a AmerenUE	Staff Report	Weather Normalization

Case Number	Utility	Testimony	Issue
ER-2009-0089	Kansas City Power & Light Company	Staff Report	Net System Input
ER-2009-0090	KCP&L Greater Missouri Operations Company	Staff Report	Net System Input
ER-2010-0036	Union Electric Company d/b/a AmerenUE	Staff Report	Net System Input
ER-2010-0130	Empire District Electric Company	Staff Report	Variable Fuel Costs
		Surrebuttal	Variable Fuel Costs
ER-2010-0355	Kansas City Power & Light Company	Staff Report	Variable Fuel Costs
ER-2010-0356	KCP&L Greater Missouri Operations Company	Staff Report	Engineering Review-Sibley 3 SCR
ER-2011-0004	Empire District Electric Company	Staff Report	Variable Fuel Costs
ER-2011-0028	Union Electric Company d/b/a Ameren Missouri	Staff Report	Net System Input
ER-2012-0166	Union Electric Company d/b/a Ameren Missouri	Staff Report	Weather Normalization
		Surrebuttal	Weather Normalization Maryland Heights In-Service
ER-2012-0174	Kansas City Power & Light Company	Staff Report	Weather Normalization Net System Input Variable Fuel Costs
		Surrebuttal	Weather Normalization
ER-2012-0175	KCP&L Greater Missouri Operations Company	Staff Report	Weather Normalization Net System Input
		Surrebuttal	Weather Normalization
ER-2012-0345	Empire District Electric Company	Rebuttal	Interim Rates
		Staff Report	Weather Normalization
EC-2014-0223	Noranda Aluminum v. Ameren Missouri	Rebuttal	Weather Normalization
EA-2014-0207	Grain Belt Express CCN	Rebuttal	Certificates of Convenience/Feasibility Analysis
		Surrebuttal	

Case Number	Utility	Testimony	Issue
ER-2014-0258	Union Electric Company d/b/a Ameren Missouri	Staff Report	Net System Input Variable Fuel Costs
ER-2014-0351	Empire District Electric Company	Staff Report	Net System Input Variable Fuel Costs
ER-2014-0370	Kansas City Power & Light Company	Staff Report	Net System Input Variable Fuel Costs
		True-up Direct	Variable Fuel Costs La Cygne In-service
EA-2015-0146	ATXI CCN	Rebuttal	Certificates of Convenience/Feasibility Analysis
		Surrebuttal	
ER-2016-0023	Empire District Electric Company	Staff Report	Net System Input Variable Fuel Costs
		Surrebuttal	Variable Fuel Costs
ER-2016-0179	Union Electric Company d/b/a Ameren Missouri	Staff Report	Variable Fuel Costs
EA-2016-0385	Grain Belt Express CCN	Rebuttal	Certificates of Convenience/Feasibility Analysis
		Surrebuttal	
ER-2018-0145	Kansas City Power & Light Company	Staff Report	Variable Fuel Costs Market Prices
		Rebuttal	Variable Fuel Costs Market Prices
		True-up Direct	Variable Fuel Costs Market Prices
EA-2018-0327	ATXI CCN	Rebuttal	Certificates of Convenience/Feasibility Analysis
EA-2019-0021	Ameren CCN	Staff Report	Certificates of Convenience/Feasibility Analysis
EA-2019-0010	Empire District Electric Company CCN	Staff Report	Certificates of Convenience/Feasibility Analysis
EC-2020-0408	MLA v. Grain Belt Complaint	Staff Recommendation	Formal Complaint
EA-2021-0167	ATXI CCN	Staff Recommendation	Certificates of Convenience/Feasibility Analysis

Case Number	Utility	Testimony	Issue
EA-2021-0087	ATXI CCN	Staff Report	Certificates of Convenience/Feasibility Analysis
ER-2021-0240	Union Electric Company d/b/a Ameren Missouri	Staff Report	Variable Fuel Costs Atchison wind farm Construction Audit and in-service review
		Rebuttal	Atchison in-service and Variable Fuel Costs
		True-up Direct	Variable Fuel Costs
ER-2021-0312	Empire District Electric Company	Staff Report	Transmission and Distribution Investment
EA-2022-0043	Evergy Metro and Evergy West Hawthorn Solar CCN	Staff Report	Certificates of Convenience/Feasibility Analysis
EA-2022-0099	ATXI CCN	Staff Direct Testimony	Certificates of Convenience/Feasibility Analysis
EA-2022-0244	Union Electric Company d/b/a Ameren Missouri	Staff Report	Certificates of Convenience/Feasibility Analysis
EA-2022-0245	Union Electric Company d/b/a Ameren Missouri	Staff Rebuttal Testimony	Certificates of Convenience/Feasibility Analysis
ER-2022-0337	Union Electric Company d/b/a Ameren Missouri	Direct Testimony	Variable fuel Costs
		Rebuttal Testimony	Variable fuel Costs
		Surrebuttal/True-up Direct	Variable fuel Costs
		True-up Rebuttal	Variable fuel Costs
EA-2022-0328	Evergy West	Staff Rebuttal Testimony	Certificates of Convenience/Feasibility Analysis
EA-2023-0017	GrainBelt Express	Staff Rebuttal Testimony	Certificates of Convenience/Feasibility Analysis
EA-2023-0226	Ameren Missouri	Staff Memo	Certificates of Convenience/Feasibility

Case Number	Utility	Testimony	Issue
			Analysis
ET-2023-0249	Ameren Missouri	Staff Memo	Cogeneration and Net Metering rate

SCHEDULE SEL-r2

and

SCHEDULE SEL-R3

HAVE BEEN DEEMED

CONFIDENTIAL

IN THEIR ENTIRETY