7. Transmission and Distribution

Highlights

- *Ameren Missouri will construct nineteen of twenty transmission projects that have been approved by the Midcontinent Independent System Operator ("MISO") Board of Directors in Missouri for completion before 2025.*
- *Ameren Missouri has developed the Smart Energy Plan ("SEP"), a comprehensive, forward-looking plan designed to upgrade the electric grid and bring significant benefits to customers.*
- *The plan includes $6.4 billion of electric investments from 2020 through 2024[1] that will, among other things, accelerate our investment in smart grid technologies, system hardening efforts, and upgrading infrastructure.*

Ameren Missouri is continuously maintaining or replacing aging infrastructure in order to meet its obligation to provide safe and adequate service and to endeavor to meet its customers' reliability expectations. Rapid growth during the 1960s and 1970s, spurred by a housing boom and the advent of air conditioning, resulted in a replacement of the previous vintage infrastructure and an even larger, new system. As growth has slowed over time, the infrastructure has not experienced optimal turnover. This lack of asset turnover means our existing grid is heavily populated with 40 to 60 year old equipment that is at risk of failure, obsolescence, and inefficiencies as compared to modern equipment. While the company has always worked to improve its electric grid, the Smart Energy Plan has allowed Ameren Missouri to markedly increase its efforts in this area with its plans to make investments to replace its aging grid infrastructure so that it can continue to provide safe and adequate service.

On the transmission side, a total of 20 transmission projects have been approved by the MISO Board of Directors for construction in Missouri for completion before 2025. Ameren Missouri will construct 19 of these projects. The projects will address future reliability issues and provide for continued safe and reliable service to customers.

C

[1] Planned investment level assumes Ameren Missouri receives SB-564 extension approval.

7.1 Transmission

7.1.1 Existing System[2]

Ameren Missouri owns and operates a 2,970 mile transmission system that operates at voltages from 345 kV to 138 kV. The system is composed of the following equipment:

- 1,297 miles of 138 kV transmission circuits.
- 718 miles of 161 kV transmission circuits.
- 955 miles of 345 kV transmission circuits.
- Substations that make up the Bulk Electric System:
    - 21 extra high voltage substations with a maximum voltage of 345 kV.
    - 36 substations with a maximum voltage of 161 kV.
    - 31 substations with a maximum voltage of 138 kV.

7.1.2 Regional Transmission Organization Planning[3]

Since 2004, Ameren Missouri has been a member of MISO, a Regional Transmission Organization ("RTO"). MISO was approved as the nation's first RTO in 2001 and is an independent nonprofit organization that supports the delivery of wholesale electricity and operates energy and capacity markets in 15 U.S. states and the Canadian province of Manitoba.

A key responsibility of the MISO is the development of the annual MISO Transmission Expansion Plan ("MTEP"). Ameren Missouri is an active participant in the MISO MTEP development process. Participation in the MISO MTEP process is the method by which Ameren Missouri's transmission plan is incorporated into the annual MTEP document. The overall planning process can be described as a combination of "Bottom–Up" projects identified in the individual MISO Transmission Owners' transmission plans which address issues more local in nature and are driven by the need to safely and reliably provide service to customers, and projects identified during MISO's "Top-Down" studies, which address issues more regional in nature that provide economic benefits or address public policy mandates or goals.[4]

Through these MTEP related activities, Ameren Missouri works with MISO, adjacent RTOs and Transmission Planning Regions, adjacent MISO Transmission Owners and stakeholders to promote a robust and beneficial transmission system throughout the Midwest region. Ameren Missouri's participation helps ensure that opportunities for

[2] 20 CSR 4240-22.045(1)
[3] 20 CSR 4240-22.045(3)
[4] 20 CSR 4240-22.045(3)(B)1

system expansion that would provide benefits to Ameren Missouri customers are thoroughly examined. This combination of Bottom-Up and Top-Down planning helps insure all issues are addressed in an effective and efficient manner.[5]

Guidance is provided to MISO on the assumptions, inputs, and system models that are used to perform the various analyses of the overall MISO transmission system. Ameren Missouri's participation in the MTEP development process includes: review of MISO and stakeholder developed material, comments and feedback, and working to insure the projects approved in the MTEP are in the interests of the Ameren Missouri customers. Ameren Missouri is regularly represented by attendance and participation in the MISO stakeholder organizations which are key components of the MTEP development process including the:

- Planning Advisory Committee ("PAC") – The PAC provides input to the MISO planning staff related to the process, adequacy, integrity and fairness of the MISO wide transmission expansion plan.
- Planning Subcommittee ("PSC") – The PSC provides advice, guidance, and recommendations to MISO staff with the goal of enabling MISO to efficiently and timely execute its planning responsibilities, as set forth in the MISO Tariff, MISO/Transmission Owner Agreement, Federal Energy Regulatory Commission ("FERC") Orders applicable to planning and other applicable documents.
- Interconnection Process Working Group ("IPWG") – The IPWG has the goal of reducing study time and increasing certainty associated with new requests to connect generation to the transmission grid within MISO.
- Sub-regional Planning Meetings ("SPM") – The SPMs are hosted by MISO in accordance with FERC Order 890, to encourage an open and transparent planning process. Stakeholders are encouraged to participate in discussions of planning issues and proposals on a more local basis and discuss projects, issues and concepts that are potentially driving the need for new transmission expansions.
- Loss Of Load Expectation Working Group ("LOLEWG") – The LOLEWG works with MISO staff to perform Loss of Load Expectation analysis that calculates the congestion free Planning Reserve Margin requirements as defined in the Module E of the MISO Tariff.
- Regional Expansion Criteria and Benefits Working Group ("RECBWG") – The RECBWG is a forum for stakeholders to provide input in the various processes used in the MISO tariff to allocate the cost of transmission system upgrades and improvements to the appropriate beneficiaries.
- Interregional Meetings – Numerous meetings are held each year with PJM RTO, SPP RTO, and the Southeastern Regional Transmission Planning Region to

[5] 20 CSR 4240-22.045(3)(B)1; 20 CSR 4240-22.045(3)(B)2; 20 CSR 4240-22.045(3)(B)3

discuss, evaluate and consider interregional transmission issues and identify opportunities for transmission expansion, consistent with the respective RTO's regional planning processes.
- Other Committees, Task Forces and Working Groups as appropriate.

The result of the MTEP process is a compilation of transmission projects that are needed to address system reliability requirements, improve market efficiency, and/or provide specific system benefits as delineated in the MISO Tariff. The MTEP identifies solutions to meet regional transmission needs and to create value opportunities through the implementation of a comprehensive planning approach.

Each MTEP document is identified by the year in which it was completed. Appendix A of each MTEP lists and briefly describes the transmission projects that have been evaluated, determined to be needed and subsequently approved by the MISO Board of Directors. The MTEP19 document is the culmination of more than 18 months of collaboration between MISO planning staff, MISO Transmission Owners, and stakeholders. Each MTEP cycle focuses upon identifying system issues and improvement opportunities, developing alternatives for consideration, evaluating those options to determine the most effective solutions and finally identifying the preferred solution. As described in more detail in the MISO Tariff, the primary purposes of the MTEP process are to identify transmission projects that:

- Ensure the transmission system supports the customer's needs in a continued safe and reliable manner.
- Provide economic benefits such as increased market efficiency and resultant overall lower energy cost.
- Facilitate public policy objectives such as integrating renewable energy resources.
- Address other issues or goals identified through the stakeholder process.

The interconnection of new generation resources to the transmission system under MISO's control is also an important part of the overall transmission planning effort. Ameren Missouri actively participates in regional generation interconnection studies for proposed generation interconnections inside and outside of the Ameren Missouri area. Participation in these transmission studies ensures that they are performed on a consistent basis and that the proposed connections and any system upgrades needed on the Ameren Missouri transmission system are properly integrated and scheduled to maintain system reliability.

With the approval of MTEP19, a total of 20 transmission projects have been approved by the MISO Board of Directors for construction in Missouri before 2025. A summary of the projects is shown in the table below. Table 7.1 also includes the proportion of transmission

service charges arising from the projects that will be assigned to the Ameren MO load zone.[6] The costs of these projects are not impacted by whether the project is constructed by Ameren Missouri or an affiliate.

Table 7.1 MTEP Transmission Projects in Missouri in MTEP19 or Prior– Summary

Project Type	Number of Projects	Estimated Total Project Cost ($Million)	Estimated Percentage of Transmission Service Charges Arising from the Projects to be assigned to the Ameren Missouri Load Zone
Baseline Reliability or Reliability/Other Projects Not Cost Shared	19	240	100%
GIP projects	1	1	1%

A brief description of the 19 transmission projects can be found in Appendix A.[7]

A key component of fulfilling Ameren Missouri's obligation of continuing to provide safe and adequate service is the identification of potential future needed transmission upgrades. A list of projects that are under consideration by Ameren Missouri and MISO and that are located totally or partially in Missouri is provided in Appendix A in Table 7A.2.

Current and previous transmission system expansion plans can be found on MISO's website: https://www.misoenergy.org/planning/planning/[8]

Revenue Credits from Previously Constructed Regional Transmission Upgrades[9]

Regional transmission upgrades, such as Multi-Value Projects ("MVP") and Market Efficiency Projects, are eligible for cost sharing under Attachment GG or MM of the MISO Tariff. Ameren Missouri does not have any Multi-Value or Market Efficiency projects which result in revenue credits. However, Ameren Missouri does have four Baseline Reliability Projects that were approved for regional cost sharing under a prior version of Attachment GG. The last project completed in 2016 (Lutesville-Heritage) was included in Schedule 26 rates in June 2017. Ameren Missouri expects approximately $13.4 million of Schedule 26 revenue in 2020. It should be noted that over 90% of Ameren Missouri's Attachment

[6] 20 CSR 4240-22.045(3)(A)4
[7] 20 CSR 4240-22.045(6)
[8] 20 CSR 4240-22.045(3)(C)
[9] 20 CSR 4240-22.045(3)(A)5

GG revenue requirement will be allocated to the AMMO pricing zone and reflected in the rates paid by Ameren Missouri retail and wholesale customers.

7.1.3 Ameren Missouri Transmission Planning[10]

Ameren Missouri's transmission strategy is centered upon meeting the evolving needs of its customers and Ameren Missouri's commitment to provide them safe and adequate service, and to endeavor to meet their increasing reliability expectations. Each year the Ameren Missouri transmission system is thoroughly examined and studied to verify it will continue to provide Missouri customers with reliable and adequate service through compliance with all applicable North American Electric Reliability Corporation ("NERC") standards as well as Ameren's Transmission Planning Criteria and Guidelines.

The studies identify potential system conditions where reduced reliability may occur in the future. Additional studies are then performed to evaluate all practical alternatives to determine what, where, and when system upgrades are required to address the future reliability concern. This annual review identifies any transmission system reinforcements necessary to provide reliable and safe service in response to changing system conditions. These studies consider the effects of overall system load growth, the adequacy of the supply to new and existing substations to meet local load, the expected power flows on the bulk electric system and the resulting impacts on the reliability of the Ameren Missouri transmission system.

In order to successfully achieve the goal of a safe and reliable transmission system, Ameren Missouri participates in a multitude of transmission planning activities including:

- MISO Transmission Expansion Plan development
- MISO regional generation interconnection studies
- NERC reliability standards development,
- Participation in SERC regional planning and assessment activities,

This high level of involvement affords the opportunity to supply comments and provide input to these many transmission planning processes which supports the goal of maintaining a reliable and safe transmission system which will meet the current and future needs of our Missouri customers.

As part of the Ameren Missouri Transmission Planning Process, the ability of transmission system improvements to reduce transmission system losses is considered. A major aspect of Ameren Missouri's focus of providing continued safe and adequate service to our customers and to meet their reliability expectations is maintaining transmission equipment and replacing aging infrastructure when it approaches the end of its

[10] 20 CSR 4240-22.045(3)(B)1; 20 CSR 4240-22.045(3)(B)2; 20 CSR 4240-22.045(3)(B)3; 20 CSR 4240-22.045(3)(B)4

operational life. The Ameren Missouri area experienced rapid economic growth and substantial investment in transmission infrastructure during the 1960s and 70s. Considerable portions of the transmission system are now over forty years old and are reaching the end of their operational life with a commensurate increased risk of failure and higher maintenance expense. The existing equipment is also less efficient than comparable modern equipment. Ameren Missouri is working to address the most critical issues by making targeted investments to replace its aging grid infrastructure to maintain system reliability, consistent with available capital.

7.1.4 Avoided Transmission Cost[11]

The methodology that was used during the development of the previous Integrated Resource Plan was modified for the 2020 Plan. Avoided transmission costs are based upon integrated system effects and are difficult to quantify, as opposed to energy and capacity costs where there are markets that provide specific prices. As part of integration modeling, Ameren Missouri estimated the MW impacts of demand side management ("DSM") programs and a corresponding reduction in transmission capital expenditures.

The first step is to identify additional new transmission projects that would be needed if Ameren Missouri's load was to grow in the absence of DSM programs. Powerflow analysis was performed to identify additional transmission projects that would be needed to address reliability issues through 2028 assuming 1% annual future load growth would occur absent the DSM programs. Cost estimates were developed for the identified projects. Based on the cost of the new transmission projects and the MW amount of growth over the same time period, an estimated generic marginal cost of system transmission capacity was then calculated.

The results of the analysis are provided in Chapter 7 - Appendix A.

7.1.5 Transmission Impacts of Potential Ameren Missouri Generation Resource Additions/Retirements & Power Purchases/Sales[12]

As part of the determination of the proper combination of resources needed to serve the Ameren Missouri load, the size and location of potential future generation resources are estimated. This requires an assessment of the transmission system enhancements necessary to safely and reliably deliver the energy from these potential future resources. Table **7.2** provides a high level assessment of interconnection costs for the listed potential future generation resources. These estimates do not include cost of network upgrades, which may be impacted by other new resources connecting to the grid, revisions to resource timing, new transmission projects and other factors. Actual projects and costs

[11] 20 CSR 4240-22.045(2); 20 CSR 4240-22.045(3)(A)3
[12] 20 CSR 4240-22.040(3); 20 CSR 4240-22.040(3)(A); 20 CSR 4240-22.045(1)(B); 20 CSR 4240-22.045(1)(C); 20 CSR 4240-22.045(3)(D); EO-2020-0047 1.C

would be determined via the MISO generation interconnection process at the time these projects are developed.

Table 7.2 Transmission Project Costs for New Generation

**

Resource	Cost of Needed Transmission Upgrades	Approximate Cost to Ameren Missouri Customers (2019$)
Combined Cycle - Lutesville	800 MW	$5.5 Million
Simple Cycle - Lutesville	700 MW	$5.5 Million
Pumped Hydro - Church Mountain	600 MW	$73.8 Million
Nuclear - Callaway	1100 MW	$20.5 Million

**

As part of the determination of the proper combination of resources needed to serve the Ameren Missouri load, the need for continued operation of existing resources is examined. This requires determining the overall impact of retiring existing generation resources on the transmission system and identifying any system upgrades necessary to maintain safe and adequate service after the resource is no longer available.

Table 7.3 contains the results of a high level assessment of the cost to Ameren Missouri customers of transmission system upgrades needed to provide continued safe and adequate service if the indicated Ameren Missouri generators retire within the planning period. These estimates may be impacted by new resources connecting to the grid, revision of the shutdown timeframe, new transmission projects and other factors.

Table 7.3 Estimated Transmission Project Costs for Retirements at End of Useful Life

**

Generating Station	Cost of Needed Transmission Upgrades (2019$)
Rush Island	$93 Million
Sioux	$335 Million
Labadie 2 Units	$93 Million
Labadie 2 Units	$92 Million

**

The Ameren Missouri transmission system was also examined to determine if additional transmission system upgrades would be justified to facilitate power purchases and sales by Ameren Missouri. The analysis indicates an Ameren Missouri import capability of 1200 MW, which exceeds the 300 MW import or export minimum requirements. For IRP analysis purposes, Ameren Missouri has used a limit of 300 MW as the maximum allowed shortfall of resources to load and reserve requirements. Because resources would be

added to prevent a shortfall greater than 300 MW this represents the minimum import capability requirement to ensure reliable operation of the system. The transmission system analysis indicates no additional transmission system upgrades are justified based upon this requirement.[13]

Transmission Impacts due to New Generation Resource Connections within the MISO Footprint or Point-to-Point Transfers of Energy within the MISO Footprint to Ameren Missouri

Ameren Missouri participates in regional generation interconnection studies for proposed generation interconnections inside the MISO footprint. Participation in these activities ensures that the studies are performed on a consistent basis and that the proposed connections are integrated into the Ameren Missouri system to maintain system reliability. Power flow, short-circuit, and stability analyses are performed to evaluate the system impacts of the requested interconnections. If system deficiencies are identified in the connection and system impact studies, additional studies are performed to refine the limitations and develop alternative solutions.

New Generation Resources - Future generation resources within the MISO footprint seeking to connect to the transmission system will be subject to the interconnection requirements described in the MISO Tariff and applicable MISO Business Practice Manuals. In order to interconnect to the transmission system, the resource owner must provide project details including location, resource size, type of service requested, when it wants to connect, etc. After this information has been received, the impacted Transmission Owner and MISO will perform the system study and analysis necessary to determine the transmission upgrades needed to safely and reliably interconnect the generation resource to the transmission system.

Point to Point Transactions - The MISO Tariff and applicable MISO Business Practice Manuals describe the process by which transmission service requests can be made to have firm point-to-point transmission service within the MISO footprint. The entity requesting service would provide details including: source and delivery locations, quantity of energy to be transmitted, timing and duration of delivery, etc. After this information has been received, the impacted Transmission Owner(s) and MISO will perform the system study and analysis necessary to determine the transmission upgrades needed to safely and reliably support the requested transmission service. The transmission upgrades needed to support a transmission service request will not be determined until the completion of the system study and analysis. The MISO Tariff and MISO Business Practice Manuals that are in effect at the time when the point-to-point transmission service

[13] 20 CSR 4240-22.040(3)(B)

request is submitted will describe the process by which Financial Transmission Rights ("FTRs") are allocated and can be obtained by entities.

The total cost of any necessary transmission upgrades cannot be determined until a resource interconnection request and/or a transmission service request has been submitted to MISO via the process described in the MISO Tariff and applicable Business Practice Manuals and the necessary transmission system studies have been performed. The result of the studies will identify the transmission system upgrades necessary to safely and reliably fulfill the transmission service request or generation interconnection request. The studies will include a description of the needed transmission system reinforcements, their location, in service date and estimated total cost. Therefore the cost of any needed system upgrades will not be known until the system study and analysis is complete.

Transmission Impacts due to New Generation Resources outside the MISO Footprint affecting the MISO Transmission System or Point-to-Point Transfers of Energy from Outside the MISO Footprint to Ameren Missouri

Ameren Missouri participates in generation interconnection studies for proposed generation interconnections for generators located outside of the MISO footprint. Participation in these activities ensures that the studies are performed on a consistent basis and that the impact of the proposed connections do not adversely affect the Ameren Missouri system reliability. Power flow, short-circuit, and stability analyses are performed to evaluate the system impacts of the requested interconnections. If system deficiencies are identified in the connection and system impact studies, additional studies are performed to refine the limitations and develop alternative solutions.

Point to Point Transactions - The MISO Tariff and applicable MISO Business Practice Manuals describe the process by which transmission service requests can be made to have firm point-to-point transmission service into the MISO footprint from a generation resource located outside the MISO footprint. The entity requesting service would provide details including: source and delivery locations, quantity of energy to be transmitted, timing and duration of delivery, etc. After this information has been received, the impacted TO(s) and MISO will perform the system study and analysis necessary to determine the transmission upgrades needed to safely and reliably support the requested transmission service. The transmission upgrades needed to support a transmission service request will not be determined until the completion of the system study and analysis. The MISO Tariff and MISO Business Practice Manuals that are in effect at the time when the point-to-point transmission service request is submitted will describe the process by which FTRs are allocated and can be obtained by entities.

The total cost of any necessary transmission upgrades cannot be determined until a transmission service request has been submitted to MISO via the process described in the MISO Tariff and applicable Business Practice Manuals and the necessary transmission system studies have been performed. The results of the studies will identify the transmission system upgrades necessary to safely and reliably fulfill the transmission service request. The studies will include a description of the needed transmission system reinforcements, their location, in service date and estimated total cost. Therefore the cost of any needed system upgrades will not be known until the system study and analysis is complete.

7.1.6 Cost Allocation Assumptions for Modeling[14]

The MISO Tariff allocates 100% of the Baseline Reliability Projects revenue requirements to the local zone where the project is located. The MVP revenue requirements are collected under MISO Tariff Schedule 26-A, which is charged to Monthly Net Actual Energy Withdrawals, Export Schedules, and Through Schedules. MISO estimated charges include the MVPs approved in December 2011 by the MISO Board of Directors. No additional MVPs are currently being planned as part of the MISO MTEP process. Overall, Ameren Missouri expects approximately 8.0% of the MVP costs to be assigned to its load zone.

7.1.7 Advanced Transmission System Technologies[15]

The Company will continue to evaluate the latest technologies when developing long-range plans to maintain and strengthen the reliability, resiliency, and flexibility of the transmission system. With customer focus in mind, we will position ourselves to act if innovative technologies present opportunities to solve anticipated grid deficiencies at a higher value than traditional methods. Federal, state and RTO policies continue to develop to address operational and market issues related to emerging technologies. Ameren Missouri will monitor and work to shape these policies when applicable to result in the most favorable outcomes for our stakeholders. Increasing customer adoption of advanced technology, including distributed energy resources ("DERs"), will impact energy demand and usage of the transmission system. In line with Ameren's 2030 Vision, the transmission system of the future will be a vital component of a more integrated, bi-directional, and smarter electrical grid. Ameren Missouri will need to plan the system to transform from one designed to deliver central station generation to customer load into a modern system that will accommodate more variable and geographically dispersed generating facilities connected at both transmission and distribution voltage levels.

[14] 20 CSR 4240-22.045(3)(A)4
[15] 20 CSR 4240-22.045(3)(A)2; 20 CSR 4240-22.045(3)(A)4; 20 CSR 4240-22.045(3)(B); 20 CSR 4240-22.045(1)(D); 20 CSR 4240-22.045(4)(A); 20 CSR 4240-22.045(4)(C); 20 CSR 4240-22.045(4)(D); 20 CSR 4240-22.045(4)(E)1; 20 CSR 4240-22.070(1)(B)

Flexibility will be key to maintaining reliable service in the face of various uncertain future scenarios. Emerging technologies and their declining costs are also likely to introduce new areas in which Ameren Missouri will need to compete to retain and win customers by ensuring our service is reliable and affordable. To ensure customer value in the future, the entire electrical grid will be better utilized as a vehicle to offer individualized service to customers and market participants including the ability to buy and sell energy with the energy company and others.

Innovation and modern technology are the catalyst for creating customer value and enhancing efficiency that will keep our product affordable in the future. Just as the transition to renewables will influence expansion of the transmission grid, so too will new technologies and the need to integrate grid connected devices to the energy networks.

The Intelligrid project has created a high-speed communications ring across Ameren Missouri's service territory by establishing fiber optic communication paths embedded in the shield wire of transmission lines. The high-bandwidth network enables advanced protective relaying technologies and reliable communication channels to remote locations. This robust network is a critical platform to ensure efficient system operation and to support future technologies. As the program progresses additional communication rings will be built, expanding the fiber communication network out to more substations and operating centers on Ameren Missouri's system.

Invert based resources ("IBR") are starting to connect to the Ameren Missouri transmission system in larger numbers. IBRs consist of anything that converts direct current to alternating current, including STATCOMS, photovoltaic, new wind turbines, and battery energy storage systems. Ameren Missouri will put its first STATCOM into service at Meramec substation in 2022. As more IBRs connect to the transmission system the behavior and the interactions of these resources within the grid will change. New software, PSCAD, has been purchased to better simulate the interaction of IBRs with the electric power grid. The new PSCAD software will allow the performance of electromagnetic transient simulations. The simulations will help us identify any weak areas of the system and identify the best mitigation plan to maintain a reliable and resilient electric system.

Other energy technologies, such as distributed energy resources, energy efficiency and building standards are affecting the demand for energy, potentially changing the way transmission supports the reliability, resiliency and efficiency of the system. Electro-technologies that improve energy efficiency, product effectiveness and reduce emissions could also increase the demand for energy and affect the need for greater system reliability, resiliency and integration. These customer preferences impact demands on the transmission system and provide opportunities for investment

Aside from transmission-focused technologies, there are several other areas in which technology and innovation is being utilized for the benefit of customers, including efforts to drive-down O&M costs. Advances in unmanned aerial vehicles, or drones, have made it possible to use this technology to increase efficiencies in transmission maintenance activities. Consideration is being given to purchasing/developing a Network Model Manager which will coordinate all the power system models used for operation of the transmission system which would cut down on redundant work across groups.

Ameren Service Company's Central unmanned aerial system ("UAS") Department, is currently involved in a number of projects set to benefit Ameren Missouri. The "Drone Team" will be piloting the photographing of transmission structures to be supplied to users of the TransGIS Webviewer, a task currently handled by manned helicopters while flying LiDAR. The team is also working to develop various forms of artificial intelligence ("AI") designed to enable detection of issues and cataloging of assets as gathered from drone imagery taken on a project or ad hoc basis. The team is using various in-house development methods as well as cultivating partnerships with other utilities through Electric Power Research Institute and working with various third party vendors to create a complete workflow-based solution. The UAS department is also working on getting Federal Aviation Administration ("FAA") approval for beyond visual line of sight ("BVLOS") flights. The teams have completed several BVLOS including a 61-mile line flight in southern Illinois. The goal will be to produce repeatable BVLOS flights for the FAA to gain a level of comfort with our operations and release a wide-area authorization for BVLOS.

It should be noted that, as is the case for most utilities owning transmission, the construction of the models and cases needed as input to network analysis involves a large amount of duplicated, inconsistently triggered manual activity. Significant improvement can be made by unifying the development of network models as one information management problem which has the objective to support all network analysis functions across the enterprise. Substantial labor savings can be achieved by elimination of duplicate modeling processes and by improving the automation of model building processes. Another important outcome is increased confidence in the accuracy of models and hence in the accuracy of analytical results. A similar quality improvement can be achieved by reducing the time required to generate new study cases, and thereby improving the responsiveness of engineering processes. Installation of a Network Model Manager function will serve as the central vehicle for consolidating model data and automating network model management.

Technological advances and declining costs on the customer side are expected to continue. This will introduce the possibility of the need to compete for customers that may have cost competitive alternatives to grid-connected energy. Grid connected customer adoption of DERs and energy efficiency driven by product technology will affect the usage

of the transmission system. Planning will continue to be needed for a variety of uncertain future scenarios to ensure a reliable transmission system.

7.1.8 Ameren Missouri Affiliates Relationship[16]

Ameren Missouri's focus is upon continuing to provide safe and adequate service to its customers. Ameren Missouri has prioritized its capital investments to address local issues including: improving its aging distribution and transmission infrastructure and energy centers, accomplishing mandated environmental investments, implementing mandated transmission upgrades (e.g., for NERC compliance), and complying with other state and federal mandates (such as the Missouri Renewable Energy Standard ("RES"). These kinds of investments must be made to deliver safe and adequate service to Ameren Missouri's customers.

An Ameren Missouri affiliate, Ameren Transmission Company of Illinois ("ATXI"), invests capital in transmission infrastructure that provides a variety of benefits to transmission customers both inside and outside of the MISO Ameren Missouri pricing zone. For example, the recently constructed MISO multi-value projects ("MVPs") consisted of a portfolio of large transmission projects providing reliability, economic, and public policy benefits to customers throughout the Midwest. Alternatively, ATXI also invests in smaller, more localized projects that benefit multiple parties within the MISO Ameren Missouri pricing zone. ATXI is currently constructing a new substation near Rolla, Missouri that will more efficiently utilize existing high voltage lines, which will provide reliability enhancements to Ameren Missouri retail customers as well as Rolla Municipal Utilities. Ameren Missouri does not plan to construct these kinds of projects because it is in the best interests of its Missouri customers that it invests its limited capital only in generation, distribution and transmission investments needed to provide safe and adequate service to its load, including the transmission improvements needed to connect an Ameren Missouri generating unit to the grid. Because of its limited capital, Ameren Missouri has concluded that it should not invest in other transmission projects, such as MVPs because investing in regional transmission would undermine Ameren Missouri's ability to deliver safe and adequate service. The building of these projects by ATXI will not impact the cost of the project relative to construction by Ameren Missouri.

[16] 20 CSR 4240-22.045(3)(B)5; 20 CSR 4240-22.045(5)

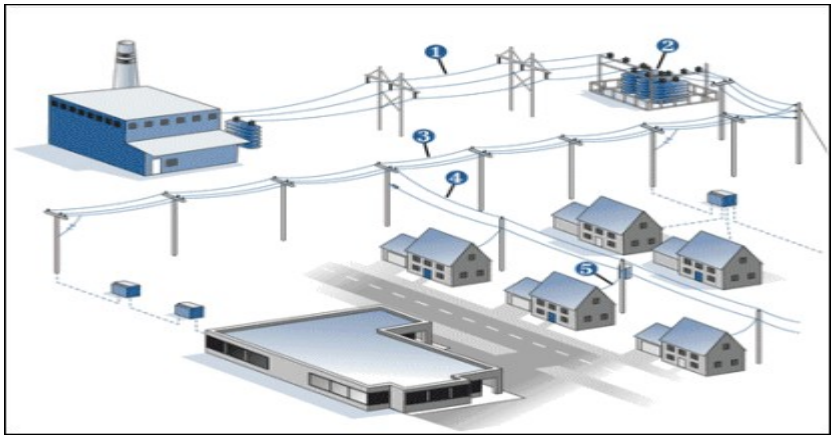
7.2 Distribution

7.2.1 Existing System[17]

Ameren Missouri delivers electricity to approximately 1.2 million customers across central and eastern Missouri, including the greater St. Louis area, through distribution system power lines that operate at voltage levels ranging from 2,400 volts ("V") through 69,000 V. Ameren Missouri has 33,000 circuit miles of electric distribution lines, which move electricity into the 63 counties and more than 500 communities where businesses operate and people live.

Approximately 70% of Ameren Missouri's distribution system operates at 12,470 V, 12% operates at 4,160 V and 11% operates at 34,500 V. The remainder operates at other nominal voltage levels. (See Figure 7.1 for further information.)

Figure 7.1 Power Flow



Here is how the power flows from a power plant to an electric customer:

1) Electricity travels from the power plant over high-voltage transmission lines.
2) At a substation, the electricity's voltage is lowered so that it can travel over the distribution system.
3) Main distribution power lines, typically 3-phase circuits, bring electricity into communities.
4) Local distribution power lines serve neighborhoods and individual customers.
5) Service drops carry electricity from pole-mounted or pad-mounted transformers - which lowers the voltage again - to customer premises.

Much of the distribution system in rural areas is supplied via single substations operating in radial configurations. Long distribution feeders are usually required to serve multiple isolated communities. Long feeders are usually equipped with automatic reclosers to

[17] 20 CSR 4240-22.045(1)

interrupt fault currents and isolate damaged sections, thereby restoring service to upstream portions of the feeder and its respective customers. Where possible, normally open tie switches are installed in downstream sections of feeders to provide emergency service from another source during upstream forced outages. The company installs capacitors and/or voltage regulators, as necessary, to counteract voltage drop and maintain proper voltage levels along lengthy circuits.

A more interconnected distribution system is justified to serve densely populated urban areas. Although substations operate in radial configurations, two or more supply circuits are normally available on the primary side of substation transformers. Each customer is served by a single power source at any given time, but the company can re-configure the interconnected system to maintain service to customers via alternate sources when portions of the system must be de-energized to perform maintenance or complete repairs. Although voltage levels tend to be less of an issue in closely coupled, interconnected systems, the company does employ capacitors to maintain power factor[18] within prescribed limits.

Finally, a portion of the distribution system is networked, which means customers are continuously connected to more than one power source. Examples include the 208Y/120 V underground distribution network in downtown St. Louis and the 69 kV network that supplies communities throughout central Missouri, including Jefferson City, Kirksville, Moberly and Montgomery City. Networked systems offer the advantage of supplying customers from more than one power source, so they are not as susceptible to a total loss of power; but, since the system is networked, disturbances in the distribution system tend to affect a larger number of customers. Automatic isolation of faulted equipment and control of power flow in networked systems are more difficult than in radial systems. For these and other reasons, the Company employs networked systems on a limited basis in Missouri.

Ameren Missouri's distribution system includes both overhead and underground power lines at the low and medium voltage distribution levels. Underground lines (22% of the total) are more aesthetically pleasing and less vulnerable to weather-caused damage, but they take longer to repair upon failure and are significantly more expensive to install and replace.

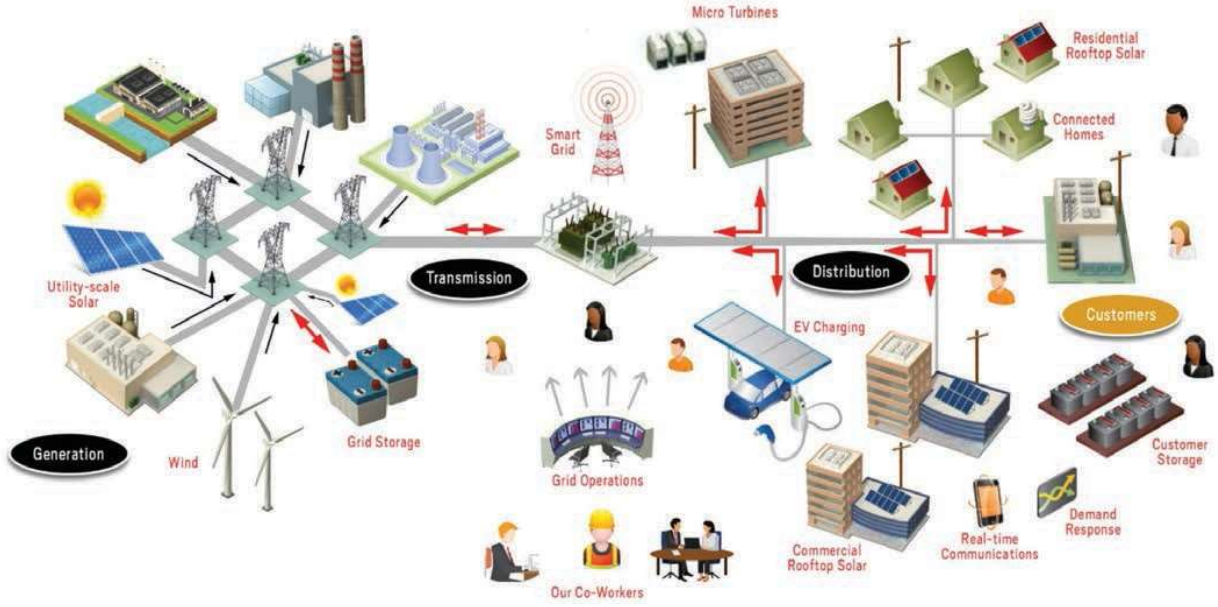
7.2.2 The Integrated Grid of the Future

Today's energy grid remains much the same as it has for the past 100 years. Yet, the electric grid of tomorrow will be more complex. We expect that the traditional central station generation, transmission and distribution system will evolve into the Integrated Grid, which will incorporate increasing levels of distributed energy resources and

[18] Power Factor – the industry seeks to have this measurement close to unity (1). The closer to 1, the less loss of energy there is on the lines during transmission.

customer interfaces (e.g., connected devices and homes, electric vehicles), all working together in a coordinated, bi-directional fashion to continuously and reliably maintain the balance between resources and demand, as seen in Figure 7.2. This grid will help support customers' growing expectations, provide them greater insight into their energy usage, and choices over how they use energy.

Figure 7.2 Power Flow – Future State



7.2.3 Smart Energy Plan

7.2.3.1 Introduction

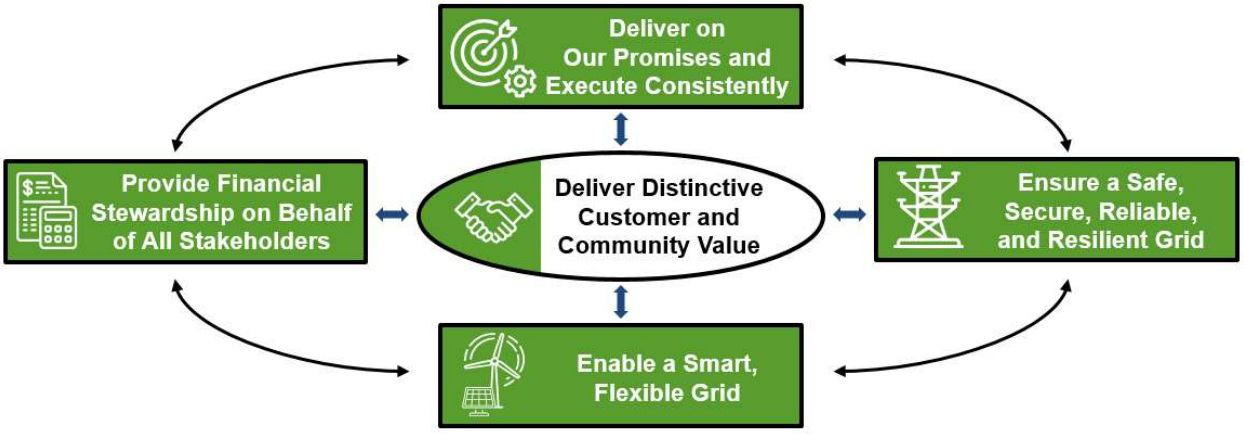
At Ameren Missouri, we are imagining this future for our customers, the communities we serve and our co-workers through Ameren Missouri's Smart Energy Plan. In 2018, the Missouri legislature, energy companies, customers, business organizations, and Missouri leaders collaborated on passing landmark energy legislation (Missouri Senate Bill 564) that modernized Missouri's energy policies, enabling the Smart Energy Plan. This forward-looking plan is designed to upgrade the electric grid and bring significant benefits to customers for decades. The plan includes $6.4 billion of electric[19] investments from 2020 through 2024 that will, among other things, support our investment in smart grid technologies, system hardening efforts, and upgrading infrastructure. As we build this grid of the future, Ameren Missouri is keeping electric rates stable and predictable, through the state's first-ever rate caps. The plan also accelerates smart energy infrastructure construction that will drive job creation and economic development in Missouri.

[19] Planned investment level assumes Ameren Missouri receives SB-564 extension approval.

7.2.3.2 SEP Strategic Goals

Based upon our vision of the Integrated Grid, Ameren Missouri has developed guiding principles that put customer value front and center to drive implementation of the Smart Energy Plan, as shown in Figure 7.3.

Figure 7.3 Smart Energy Plan Guiding Principles



These guiding principles are underpinned by a number of outcome driven strategic goals:

- Automate the electric distribution system by deploying smart switching devices and accompanying communications technologies to help significantly reduce the length of outages.
- Harden the electric distribution system with a stronger, more secure energy delivery backbone that will better withstand severe weather.
- Upgrade aging and under-performing assets (e.g., substations, overhead and underground assets). As part of our plan, we are addressing the lowest performing circuits across our service territory to improve reliability for our customers.
- Employ smart grid technologies (e.g., relaying, monitoring, fault information, communications) as we upgrade existing infrastructure and install new substations to improve reliability for customers and mitigate risk.
- Selectively standardize Ameren Missouri's various distribution voltages at the 12 kV level where cost effective and operationally efficient which, over time, will streamline a system that currently has varying voltages resulting in a grid that operates more efficiently. This will improve system capacity, increase reliability for customers and better control ongoing costs, providing benefits to our operations and our customers.
- Accelerate investment in our underground revitalization program and continue upgrading infrastructure and incorporating route diversity and smart grid sensor technology into our operations. This will lead to higher levels of reliability, real-time information and faster response times to customer outages.

- Develop a communications network to monitor and enable analytics from connected grid devices.

7.2.3.3 Smart Energy Plan Highlights

Smart Meter Program

Ameren Missouri currently reads 1.2 million electric and 132,000 gas meters with an antiquated, one way Automated Meter Reading ("AMR") system. The system was installed between 1995 and 2000 and is using meter reading technology that is more than 20 years old. It delivers daily meter information (daily usage, meter flags and outage detection) and delivers time of use and interval meter data for a small proportion of the meters though manual meter programs / installations. However, the system does not have the bandwidth for additional data or capabilities readily available in today's energy landscape. Moreover, the AMR modules in the meters are projected to have a 15 to 20 year life and are rapidly approaching end of life.

The Ameren Missouri Smart Meter Program is replacing all electric meters, gas modules, and the associated communication network in the Missouri service territory over approximately seven years, 2019 through 2025:

- Installing 1.2 million Electric Advance Metering Infrastructure ("AMI") meters (Residential and Commercial/Industrial) providing greater usage insights and capabilities for customers.
- Installing 132,000 Gas AMI modules (Residential and Commercial/Industrial).[20] This does not include new gas meters, only the communication module of the meters).
- Deploying a modern RF mesh network, enabling two-way communication.
- Installing an Advanced Meter Data Management System.
- Upgrading the Ameren Missouri Meter Shop to facilitate the receipt and quality testing of purchased meters.
- Creating an Ameren Missouri Network Lab and a Missouri Integrated Operations Center.

These upgrades are expected to have a number of benefits associated with them:

- Smart sensors, switches, self-healing equipment and smart meters work together to rapidly detect and isolate outages and more quickly restore power in the event of a service disruption.
- Smart meters will enable Ameren Missouri to pinpoint outages, so we can quickly restore customers' service and keep customers informed of restoration progress.

[20] Gas module deployments are not funded through the Smart Energy Plan.

- Improved mobile and web-based tools and two-way information flow will provide customers with greater visibility into their energy usage, education and comparison of energy options and, ultimately, greater control to manage their energy costs.
- Smart Meter rate options such as time-of-use rates will more readily enable improved customer options.
- Customer rates kept affordable through reduced meter infrastructure operating costs (e.g., eliminating the existing AMR system reduces meter reading) once fully implemented.

Substations

Ameren Missouri has a population of approximately 575 distribution substations and 100 bulk substations on its system. As the population of substations continues to age and approach end-of-life, they start to contribute significantly to reliability issues and increasing maintenance costs.

Ameren Missouri's Smart Energy Plan calls for 70 new or upgraded substations in the first five years (2019 through 2023)[21] to improve energy service reliability through a network that is more cost-effective and efficient.

The new substations will feature automated sensors and smart technology equipment to create a self-healing system that more rapidly detects and inform us of outages and reroutes power and restores service. They will also include other "smart" technology equipment (see 7.2.7.3 Smart Substation Technologies).

Distribution Automation

Approximately 10 years ago, Ameren Missouri started the deployment of distribution automation ("DA") devices across the system. Historically, we see a significant improvement in reliability with these types of upgrades. And today, only a small fraction of the Company's circuits have DA devices on them. With the SEP, Ameren Missouri will greatly accelerate this process and facilitate having ever greater portions of the system equipped with smart, automated equipment that improves remote visibility and control. Because of this, the system will be able to more rapidly detect outages, reroute power, and restore service. The result of full deployment will be self-healing capabilities across the distribution system.

Technical Application Center ("TAC")

Over the course of the next three years, Ameren Missouri will develop and construct the TAC, which will support the rapid testing of new technologies, the development of a more intelligent grid, and the means to deliver benefits to customers more quickly. This innovative facility will be used to demonstrate grid technologies, actively test new

[21] Planned investment level assumes Ameren Missouri receives SB-564 extension approval.

automation products and reliability technologies like microgrid and explore emerging technologies aimed at delivering clean energy to our customers, including solar, battery storage, modern natural gas generation and faster electric vehicle charging. Thus, the center will provide a channel for education, allowing our co-workers opportunities to more thoroughly evaluate these technologies before they are developed across our service territory.

Through this research and testing of new technologies Ameren Missouri will be able to leverage this rapid testing cycle to accelerate the deployment of proven technologies within operations to improve reliability and resiliency.

Underground Revitalization

Our plan for Underground Revitalization is to increase reliability by upgrading aging and end-of-life infrastructure. Historically, underground distribution has exhibited a very high level of reliability, however as the underground infrastructure ages beyond its useful life, complications and delays can arise when performing unplanned outage repair work. New underground pathways are being built to upgrade aged paper insulated lead covered cable with more environmentally friendly Ethylene Propylene Rubber cable. These new pathways and cables are being installed in a route-diverse configuration to eliminate the possibility of multiple underground cable failures from a single event.

Additionally, the Underground Revitalization strategy is contributing to grid modernization by requiring the installation of modern switching equipment to remotely manage the grid. Automated switching can reduce outages experienced by customers from hours to seconds and minimize time required to locate and make repairs to underground assets.

The Underground Revitalization strategy is focused on downtown St. Louis and the surrounding Ameren Missouri service territories with significant amounts of underground assets.

Private LTE

Our plan is initially to deploy private Long Term Evolution ("PLTE") transmitters to approximately 50 sites in the greater St. Louis metropolitan area to provide uniform PLTE coverage. This expansion will provide a uniform, private cellular network to operate additional smart devices and will provide better real-time system operational information. In the future, we plan to evaluate expanding this network to other areas of Missouri with higher customer density such as Cape Girardeau and Jefferson City, where communications infrastructure may become saturated. This is part of a larger effort further described in section 7.2.7.4, Multi-Layered Network Architecture.

Solar/Storage

Ameren Missouri is committed to finding innovative solutions to deliver customer value. In recent years, the cost of both energy storage technology and solar panels have fallen precipitously. These economic factors, combined with both technical and operational advances, have helped to make non-wires alternatives like solar plus storage a viable alternative to traditional wires solutions. As such, Ameren Missouri has started to evaluate non-wires alternatives, including solar plus storage, to improve reliability and grid resiliency. Such alternatives may also potentially meet generation-related needs.

As an example of this, the Company is continuing to evaluate opportunities to use solar generation and complementary battery storage to increase reliability to customers served through remote substations. Should these projects be shown to provide cost-effective improvements in reliability or provide other benefits, including in meeting generation-related needs, Ameren Missouri will submit applications for any required Certificates of Convenience and Necessity to construct solar generation to be used for this purpose.

7.2.4 Initiatives

7.2.4.1 System Inspection[22]

Ameren Missouri assesses the age and condition of distribution system equipment with regular inspection, testing and equipment replacement programs, as described below.

Circuit and Device Inspections

Ameren Missouri inspects distribution circuits (4,160 V to 69,000 V) at least every four years in urban areas and every six years in rural areas, in compliance with Missouri PSC Rule 20 CSR 4240-23.020, to protect public and worker safety and to proactively address problems that could diminish system reliability. The program includes follow-up actions required to address noted deficiencies. Inspections include all overhead and underground hardware, equipment and attachments, including poles. Infrared inspections are performed on overhead facilities, underground-fed transformers and switchgear to detect any abnormalities in equipment. Wooden poles are treated every 12 years as appropriate for purposes of life extension. Inspectors may also measure impedance of the static-protected grounding system. Radio-controlled capacitors, reclosers, and sectionalizers are inspected on a 4-year or 6-year cycle in conjunction with circuit inspections. Locally controlled capacitors, voltage regulators, and sectionalizers are tested or inspected on an annual or bi-annual basis. Any inoperable capacitor cells are repaired or replaced, helping to ensure optimal power factor system-wide. Ameren Missouri also replaces a number of transformers each year with higher efficiency units when corrosion, oil leaks or other visually detectable issues occur.

[22] 20 CSR 4240-22.045(1)(A)

Substation Asset Management

Ameren Missouri schedules substation maintenance to maximize reliability of equipment and selectively performs various diagnostic tests to obtain meaningful data to predict and prevent failures. Many tests, such as infrared scanning to detect abnormal equipment heating, can be performed with the equipment in-service. Corrective maintenance is scheduled largely on the basis of diagnostic data, with the intent of restoring equipment to full functionality. As discussed in section 7.2.7, Advanced Distribution System Technologies, when it is no longer practical to make repairs, old equipment is replaced or upgraded with new equipment, and where practical, advanced technology that places an emphasis on system automation, efficiency and reduction of losses.

7.2.4.2 System Planning[23]

Ameren Missouri expects and plans for today's electric grid to evolve into a more integrated and complex system. We have developed a broad modernization strategy, which is a key aspect of our SEP vision, to incorporate increasing levels of distributed energy resources and customer interfaces, all working together in a coordinated, bi-directional fashion. While our approach is in its early stages, we are taking significant steps to build the necessary tools, capabilities, competencies and organizational structures to proactively deliver this energy future.

A significant step in this process is the coordination and centralization of key planning functions to better enable a true integrated distribution planning approach. Although Ameren Missouri has had a consolidated System Planning function for the subtransmission system for many years, it wasn't until 2019 that the company began consolidating key elements of distribution planning and created a Low Voltage Planning Group. These centralized groups are providing subject matter expertise and working toward streamlining a number of efforts including load analysis, engineering methods/best practices, identification and prioritization of worst performing circuits, the analysis of the impact of larger solar installations on the distribution system, the incorporation of "Non-Wires Alternatives" into the planning process, and further innovation in the distribution system.

Annual Load Analysis and System Planning Process

Ameren Missouri records summer and winter peak load conditions (power, power factor, phase balance and voltage levels) at bulk and distribution substations. Distribution loads are temperature-corrected to represent 1-in-10 year maximum values using multipliers derived from statistical analyses of historic load data for several types of area load characteristics. Temperature adjustments for bulk substations are derived from historical temperature vs. loading profile curves for each particular bulk substation.

[23] 20 CSR 4240-22.045(1)(A)

Engineers also calculate bulk substation loads using a power flow computer model that simulates the electric power delivery system. Using temperature-corrected distribution substation loads and current equipment ratings as inputs, the software calculates bulk substation loads. These are compared to temperature-corrected values and used to evaluate what, if any, diversity factors apply at each bulk substation.

After verifying the validity of the system model, engineers conduct seasonal planning studies of winter and summer peak conditions, evaluating worst case single-contingency failure scenarios for all bulk substations, 34,500 V and 69,000 V circuits, distribution substations, and distribution circuits. These studies pinpoint system limitations and enable engineers to identify upgrades required to maintain adequate system capacity. The evaluation of distribution system losses and maintenance of adequate system voltage levels are included in these analyses.

Planning system upgrades to withstand single-contingency outage conditions ensures that load levels will remain within circuit capabilities for such events. Under normal conditions (the majority of the time) individual circuit elements operate at lower load levels with correspondingly lower losses.

An integral part of the entire load analysis process is the establishment of equipment ratings and/or loading limits. Ameren Missouri evaluates transformer and conductor losses as part of the methodology used to establish distribution equipment ratings.

Distribution System Engineering Analyses

The Transformer Load Management ("TLM") System relates customers to the distribution transformers serving them, allowing Ameren Missouri to predict transformer peak demand and apparent power from the customers' total monthly energy usages. Ameren Missouri uses this information to analyze distribution circuits and to reduce distribution losses through the more efficient loading of transformers. Additionally, customer meters are automatically read during peak load periods to confirm the transformer peak demands calculated with the TLM system.

Synergi Electric software by Det Norske Veritas – Germanischer Lloyd and PSS/E software by Siemens PTI are used to analyze distribution circuits, ensuring reliable, safe, and efficient operation of the distribution system. Synergi or PSS/E is used for: load estimation, power flow analysis, protective device coordination, fault current calculation, voltage flicker, phase balancing, and capacitor placement. Both software systems allow engineers to analyze existing, alternate, or proposed configurations for over/under voltages/currents, line losses, appropriate conductor sizing, and optimal capacitor placement.

Supervisory Control and Data Acquisition ("SCADA") is used to remotely monitor and control the electric distribution system. Engineers use SCADA data to ensure that system models properly reflect real distribution system conditions, therefore enabling better planning of future system development.

Capital Project Evaluation[24]

As part of SEP, Ameren Missouri continuously assesses the feasibility and cost effectiveness of potential system expansion and modernization projects. Both conventional and advanced technologies are regularly considered. Due to recent trends in load growth, the majority of approved projects focus on system reliability improvement and modernization. Potential capital projects are identified by various operating, engineering and planning personnel. All bulk substation, subtransmission feeder and distribution substation projects are reviewed by Distribution System Planning prior to consideration for funding. Distribution feeder and customer service projects are reviewed by Service Division and Distribution Operations staff prior to consideration for funding.

Integrated Distribution Planning[25]

The fully integrated grid of the future envisions fewer traditional central generation stations and an increased number of distributed generating resources connected directly to the distribution system such as wind, large scale solar and residential/commercial rooftop solar. While in its early stages the planning process is evolving to consider the benefits and risks to the overall distribution system from these future widespread generating sources. This is to ensure the risks are identified and mitigated through proper planning, design and capital investment in distribution infrastructure.

To help facilitate this integrated grid, Ameren Missouri incorporates hosting capacity studies into its planning process on an as-needed basis for specific sites. Hosting capacity studies are tools and techniques, such as refined system modeling and analysis tools, that are used to identify locations on the distribution system for new energy sources and determine the need for distribution system modification required to increase hosting capabilities. Examples of modification requirements recommended as a result of a study include line conductor upgrades, substation or distribution automation protective relaying upgrades, and substation equipment capacity upgrades. As these tools and techniques approach maturity, the Company plans to perform a distribution system-wide hosting capacity study.

The frequency of requests, by both internal and external entities, for hosting capacity studies has been increasing recently. Externally, groups are largely interested in using

[24] 20 CSR 4240-22.045(4)(C); 20 CSR 4240-22.045(4)(D); 20 CSR 4240-22.045(4)(D)1; 20 CSR 4240-22.045(4)(D)2; 20 CSR 4240-22.045(4)(E); 20 CSR 4240-22.045(4)(E)1
[25] EO-2020-0047 1.E

the study to evaluate the economic impact of installing distributed generating sources. Today the analysis is a highly manual process but is expected to evolve, through the development of analytic tools and the refinement of system models such that this analysis has faster turnaround.

Non-Wire Alternatives[26]

Examples of non-wires alternatives include solar plus storage, batteries, natural gas generators, energy efficiency and demand response. Ameren Missouri is developing a tool and the associated processes to evaluate these non-wires alternative approaches with traditional upgrades (new lines, upgrading substations, building new substations etc.). This tool is expected to streamline parts of the evaluation process and allow us to objectively assess the costs and benefits of using innovative technologies, such as "non-wires alternatives," to reach the same improvements. While the tool and methodology are still some time from being completed, Ameren Missouri, through its current process, has identified a number of potential sites for solar plus storage installation

In addition to the other non-wires alternatives listed above, Ameren Missouri is still evaluating locations to further deploy energy efficiency and demand response. In some cases, this could help by reducing the need to otherwise upgrade distribution infrastructure. For example, some communities prefer not to have traditional electric infrastructure built in their jurisdictions but the distribution system is challenged with large loads in these areas. As such, these particular non-wires alternatives offer a solution that could satisfy the communities' wishes without sacrificing reliability. Another prime candidate for the early deployment of these programs are economically challenged areas. While the Company strives to provide affordable rates to all customers, these communities in particular could benefit from programs that directly help lower customer bills.

7.2.5 System Efficiency[27]

7.2.5.1 Periodic System Loss Study

Ameren Missouri evaluates the efficiency of its overall electric delivery system on a periodic basis by performing a comprehensive loss study. Losses in each portion of the system are calculated under peak load conditions using the computer software noted previously. Loss data from these evaluations are used in ongoing system planning activities and as supporting information for rate reviews.

[26] EO-2020-0047 1.E
[27] 20 CSR 4240-22.045(1)(A)

7.2.5.2 System Upgrade and Expansion Projects

By their nature, many types of energy delivery upgrade and expansion projects improve system efficiency by reducing load current, I^2R losses, or both. Examples of such projects include:

- Constructing new circuits or rebuilding existing circuits that make use of higher operating voltages, as in the conversion of power lines from 4 kV to 12 kV or the migration toward 138kV-fed distribution substations
- Constructing new circuits or rebuilding existing circuits with larger conductors
- Reconnecting single phase loads on three phase circuits to achieve balanced system phase currents
- Upgrading existing substations or strategically placing new substations to serve areas with increasing load density; and
- Reconfiguring distribution feeders as appropriate when connecting new customers

7.2.5.3 Avoided Distribution Cost[28]

Avoided transmission and distribution ("T&D") costs come from integrated system effects and are difficult to quantify, as opposed to energy and capacity costs where there are markets with specific prices. As part of integration modeling Ameren Missouri attributed the MW impacts of DSM programs with a corresponding reduction in capital expenditures associated with T&D expansion.

Ameren Missouri has previously calculated the marginal cost of system capacity in lieu of avoided distribution costs; however, this approach presents complications due to the fact that projects serve a variety of purposes - capacity upgrades to serve incremental system load, capacity upgrades to serve relocated system load, and refurbishment or replacement of equipment to avoid imminent failure. Therefore, Ameren Missouri decided to follow the 'Current Values Approach,' which is a more straightforward approach and is used by other utilities.[29] The Current Values Approach estimates an average cost of serving the load by taking the net distribution plant in service and dividing it by the weather-normalized peak load. Ameren Missouri further applied the condition/reliability factor as it has done in its previous IRPs to the average cost of serving the load to estimated using the Current Values approach, as not all expenditures can be deferred by the DSM programs. The resulting avoided distribution can be found in Appendix A, Table 7A.3.

7.2.6 Distributed Generation

Ameren Missouri evaluates distributed generation ("DG") as a means of deferring distribution system expansion projects. One example is the Ameren Missouri owned and

[28] 20 CSR 4240-22.045(2)

[29] https://mendotagroup.com/wp-content/uploads/2018/01/PSCo-Benchmarking-Avoided-TD-Costs.pdf

operated Maryland Heights Energy Center, a landfill gas project in St. Louis County. This project includes 3 x 5 MW combustion turbine-generator sets, operating on landfill gas. The project feeds into the local 34.5 kV distribution system and is capable of producing maximum output of 15 MW.

Potential projects are analyzed on a case-by-case basis. At this time, Ameren Missouri is evaluating the potential installation of photovoltaic generating capacity at a number of locations. There are a multitude of factors that influence the evaluation of potential DG installations such as noise and/or emissions ordinances, operational complexities associated with fuel availability, equipment maintenance, and the fact that traditional system expansion projects usually provide secondary benefits like improving reliability which can offset the costs of installing DG.

Ameren Missouri generally cannot dispatch customer-owned DG, so this type of resource is not included when performing load analysis and system improvement evaluations. Chapter 8 explores distributed generation as a demand-side resource.

7.2.7 Advanced Distribution System Technologies[30]

Ameren Missouri has developed the SEP to transform our electric grid and create a distribution infrastructure that is more secure, modern, resilient, reliable, and efficient. As part of this plan, the company has a number of previously discussed strategies to foster and disseminate proven advanced distribution system technologies broadly across our system.

7.2.7.1 Conventional vs. Advanced Technology Equipment

While the basic function of power delivery systems is not changing (we still need generators, transformers, overhead and underground circuits, switches, circuit breakers, fuses, etc.), what is new is the ability to better sense system conditions, evaluate the health of system equipment, and employ either local or remote control schemes via high-speed 2-way digital communications technology. Advanced equipment, offering this type of control and communication capability is replacing older types of less advanced equipment. Some replacements are programmatic (on a set schedule), while others are implemented as equipment is replaced due to age or failure. Several types of conventional equipment and their advanced technology replacements are outlined below. This list is representative of present options, but certainly does not include every advanced technology item available today or in the future.

[30] 20 CSR 4240-22.045(1)(A); 20 CSR 4240-22.045(1)(D); 20 CSR 4240-22.070(1)(B); 20 CSR 4240-22.045(4)(B); 20 CSR 4240-22.045(4)(E)1

Conventional Equipment	Advanced Technology Equipment
Solid Blade Manual Switch	Remote Control Switch with SCADA communication and current/voltage monitors or Electronic Recloser
Oil Type Recloser	Electronic Recloser with SCADA communication and current/voltage monitors and fault location capability
Faulted Circuit Indicator	Faulted Circuit Indicator with SCADA communication
Capacitor Control (Time / Temp / 1-way comm.)	Local/Remote Capacitor Control with 2-way comm. and current, voltage, kVA and status monitors
Underground Manual Switch	Padmount Switch with SCADA communication and current/voltage monitors and fault location capability
Network Protector	Advanced Network Protectors with SCADA comm. and current/voltage/load and equipment condition monitoring capability
Electromechanical Relays	Microprocessor Based Relays with SCADA comm. and current/ voltage/ load/ fault impedance/equipment condition monitoring/etc. capability
Transformer Bushing Tests	Online Bushing Power Factor Monitoring
Transformer Oil Tests	Online Transformer Oil Monitoring
Fuse	Trip Saver Fuse – acts as a recloser after initial fault; if fault does not clear it then operates as a fuse and isolate the fault
Circuit Breaker Timing Tests	Online Breaker Timing and Contact Wear Monitoring

7.2.7.2 Automated Switching Applications

Ameren Missouri's design strategy for the subtransmission (34.5 & 69 kV) system includes providing redundant service to distribution substations with load in excess of 10 MVA. Substations with loads below 10 MVA typically employ radial configurations with single supplies. When load exceeds 10 MVA, a second supply with automatic high-side transfer equipment is typically installed. As load approaches 15 MVA, a second (larger) substation transformer and automatic low-side transfer capability usually is added. As load approaches 20 MVA, the first transformer is normally replaced with a unit equal in rating to the second transformer, and the transfer scheme is upgraded to an automatic high/low selective scheme. In densely populated areas, redundant subtransmission circuits are typically available at each substation, but redundant circuits are not always available at all substations in less populated areas. In such locations, redundant subtransmission supplies are typically provided via automated switching devices in nearby circuits and a radial supply circuit is extended to the substation in question.

Ameren Missouri focuses on minimizing the length and exposure associated with such radial supply circuits until further development achieves full redundancy at the substation.

Whether a line switch or part of a substation, Ameren Missouri employs modern, SCADA-controlled, automatic smart switching devices in order to limit the time and effort required to execute switching actions. Substation transfer schemes are always designed for automatic operation, while line switches may be designed for automatic or remote control operation, depending upon the circumstances involved. Conventional manual switches are only employed in less critical locations, where they are not involved in automated service restoration. In recent years, several existing manual switches have been upgraded to remote control capability or replaced by new SCADA-controlled equipment.

As previously discussed in section 7.2.3.3 Smart Energy Plan Highlights, Ameren Missouri's strategy for automating 12kV distribution circuits is to install SCADA-equipped smart switching devices (at least one bisecting the feeder backbone and at least one tying the downstream section to a different feeder) to limit the load dropped due to a single line contingency to roughly half the feeder's peak load. Although this is a general design objective, it can only be implemented in those cases where the existing circuit topology supports the restoration of unfaulted line sections to a different feeder. Ameren Missouri is prioritizing projects based on the Worst Performing Circuit ("WPC") list, Customers Experiencing Reliability above Targets ("CERT") list, and Automatic Load Reduction feeders ("ALR"). The first priority is the WPCs, with the second priority to add DA on CERT feeders, and then the ALR feeders. Within these groups, Ameren Missouri uses reliability history, number of total customers impacted, truck rolls, patrol times, and effect to existing high-impact locations to prioritize upgrades. Our long-term goal is to have one smart switch (DA device) per approximately 400 customers to provide more reliable service throughout our territory.

7.2.7.3 Smart Substation Technologies

For many years Ameren Missouri has been building substations that are considered "smart" by today's standards. As a means of ushering in the next generation of substation intelligence in the industry, Ameren Missouri has adopted Smart Substation Design Guidelines to incorporate combinations of the following features into the standard design of capital projects:

- fault detection and location monitoring
- switchgear circuit breaker timing and contact wear monitoring
- circuit breaker trip coil failure monitoring
- multi-function temperature sensing

These projects include the construction or re-build of entire substations as well as the installation or replacement of substation transformers. Additionally, mobile substation

transformer and switchgear purchases going forward will feature a combination of these types of sensors.

Industry data indicates that over the long term, the capture and trending of substation transformer diagnostic sensor data can reduce substation outage events due to unforeseen transformer failures and extend the average operating lives of these large assets. The premium for the sensing technology involved is less than 5% over all construction scenarios. Ameren Missouri plans to install this sensor technology on substation transformers over time as an integral part of its capital substation projects going forward, including those undertaken for reasons of load growth, reliability upgrade, or condition-based maintenance.

7.2.7.4 Multi-Layered Network Architecture

Currently several isolated and overlapping networks are operating today in support of AMR meters, radio-controlled line capacitors, substation SCADA and automated switching, none of which is sufficient for the long-term expansion and widespread use of intelligent end devices. It is anticipated that more capacity will be required for ultimate end device populations in the tens of thousands, and more speed could be required to support large file transfers from remote diagnostic sensors in substations.

In response, Ameren Missouri has developed and is deploying a multi-layered network architecture intended to support existing smart applications and enable future applications – a Wide Area Network ("WAN") backbone for backhauling large amounts of field application data, Local Area Networks ("LANs") for aggregating intelligent end device data (typically at substation locations), and Field Area Networks ("FANs") for supporting communication with field end-devices beyond and downstream from the substation.

Ameren Missouri is developing a WAN that leverages various industry-proven transport systems such as fiber, digital microwave, and common carrier leased services, and likely features a mix of private and non-shared public infrastructure of either a wired or wireless nature. WAN infrastructure additions over time will focus on the connection of substations and other key network entry points, the delivery of information to the control center(s), and the application of necessary security layers throughout the network architecture.

Ameren Missouri is deploying local area network technology over time at substations as their specific locations are identified as effective aggregation points for planned feeder deployments of intelligent end devices like automated line switches, capacitors and regulators. Since these devices are being deployed on the distribution system by circuit or substation, the already owned or leased substation site becomes the preferred choice for this aggregation. Targeting these deployments at "smart" substation sites also allows for communications consolidation and maximizing the impact of the LAN infrastructure investment.

In some areas of the Ameren Missouri service territory the FAN will feature a radio frequency ("RF") mesh network that is both self-organizing and self-optimizing, dynamically routing data communications amongst a diverse set of paths that wirelessly interconnect multiple end devices. In other areas, the FAN will feature a more traditional point-to-multipoint RF network or a cellular-based alternative, depending on the application and its inherent reliability and latency requirements. Ameren Missouri plans to adopt the use of intelligent end devices with open architectures as endorsed by National Institute of Science and Technology standards, regardless of the smart applications involved and the other technology choices made.

7.2.7.5 Advanced Distribution Management System ("ADMS")

In 2014, Ameren Missouri implemented an Advanced Distribution Management System as a means of providing an integrated suite of software applications with which to manage the electric distribution system. ADMS is a highly integrated system of applications that provides distribution system operators a common user interface with which to monitor and control the distribution system on a daily basis. It not only replaced existing applications like outage management and switching orders, and enhanced features of Supervisory Control and Data Acquisition, it incorporates advanced applications such as dynamic circuit modeling, switching and restoration simulations, and a distribution system dashboard.

ADMS is foundational to future Ameren Missouri Smart Grid planning since it enables advanced applications that rely on the integration of functions formerly separate and distinct. In addition, ADMS allows for growth and scalability that is not feasible on the legacy platforms and provides the flexibility to add and integrate future applications.

7.2.7.6 Supervisory Control and Data Acquisition

Ameren Missouri's strategy for substation supervisory control and data acquisition is to programmatically introduce remote load monitoring at existing substations lacking such capability for purposes of improving daily operations and facilitating the long-term planning of substation assets. Remote outage detection and supervisory control features will be introduced at existing substations lacking such capability on an opportunistic basis in association with other capital projects.

Ameren Missouri's 30+ years of experience in this area has shown that continuously updated load information on substation components can defer or eliminate previously justified capital projects, quickly identifies unforeseen overloads, releases capacity by allowing for daily operation closer to margin, and greatly enhances outage restoration activities. Remote metering also enables automatic transfer capability in smart switching applications and enables feeder level optimization via phase balancing and the operation of line capacitors. Supervisory control of switching devices further enhance operations by

allowing for real-time outage notification and immediate intervention by dispatchers in restoration scenarios.

There are approximately 170 Ameren Missouri distribution substations without outage detection and supervisory control capability. Ameren Missouri's plan is to convert these substations opportunistically over time as other capital projects are undertaken to replace their switching devices. Ameren Missouri is also funding the programmatic addition of metering and SCADA capabilities at some of these substations, which are not scheduled for other upgrade projects in the foreseeable future.

7.2.7.7 Capacitor Control

Smart line capacitor operation has helped Ameren Missouri maintain a consistent 98% distribution system power factor over the last twenty years. However, the capacitor control technology available today allows for feeder level efficiencies and degrees of optimization that were never before possible. The use of "smart" capacitor controls not only helps achieve these levels of efficiency and optimization, but also more effectively controls customer end-use voltages, and more reliably supports the reactive requirements of the transmission system. Ameren Missouri leverages the ADMS system capabilities to integrate substation load monitoring with "smart" line capacitor operation in order to achieve these goals.

Ameren Missouri's first step as part of this automation strategy is the deployment of the next generation of "smart capacitor" technology on the distribution and subtransmission systems. Ameren Missouri will leverage the need to replace the existing 25-year old line capacitor control system in operation today in the St. Louis metro area for this deployment. To this end, 2,300 capacitor controls will be upgraded over the next 5 – 10 years.

Additionally, Ameren Missouri will be installing "smart" capacitors in place of the remaining 425 non-fixed units in the service territory. This deployment will take place over time by circuit, substation, or group of adjacent substations, coincident with the deployment of automated switches in order to maximize the benefits associated with the communications investment.

7.2.7.8 Emerging Customer Technologies

Ameren Missouri continually follows the advancements and industry trends associated with emerging customer-owned products and technologies, especially as they influence the planning around their eventual penetration on Ameren Missouri's distribution system – these include electric vehicles ("EVs"), micro-grids, small-scale distributed generation and energy storage.

Ameren Missouri has taken a particularly focused interest in the emergence of electric vehicles and is actively engaged in opportunities for contributing to the region's overall

preparedness. Ameren Missouri has studied the potential penetration of electric vehicles in the service territory and the resultant impact of vehicle charging on the distribution system. We have identified and developed a business model associated with electric vehicles, the ownership and operation of public charging stations, and the possible rate structures associated with charging these vehicles at home, at work, and on merchant properties. We continue to work with industry partners Electric Power Research Institute and others to further quantify and outline both the size of the potential opportunity, as well as the skill-sets, tools and action plans necessary to ensure success.

Ameren Missouri has participated as a corporate member of the St. Louis Regional Clean Cities Plug-In Readiness Task Force as a means of following the discussions around being plug-in ready and identifying possible community partnering opportunities for technology promotion. We continuously evaluate how we can offer the latest economical, energy-saving and environmentally sound knowledge available, so that we can help communities benefit from these technologies, while providing our customers with affordable and reliable energy service.

Ameren Missouri has adopted EV technology since 2011 when a new generation of EVs debuted in the U.S., and continues to do so now with medium duty vehicles. Ameren Missouri recently added a 100% battery electric box truck and a 15-passenger electric shuttle bus to its fleet. We also initiated a 5-year conversion plan to electrify our full fleet of forklifts used throughout our Missouri operations. Fleet Services, Efficient Electrification Development, and Strategy and Innovation teams are working together to understand and test these vehicles in preparation for customer inquiries and expediting their learning curve. Ameren Missouri proactively installed charging stations at its corporate headquarters and at an expanding number of operating centers to support its growing electric fleet and early-adopting employees.

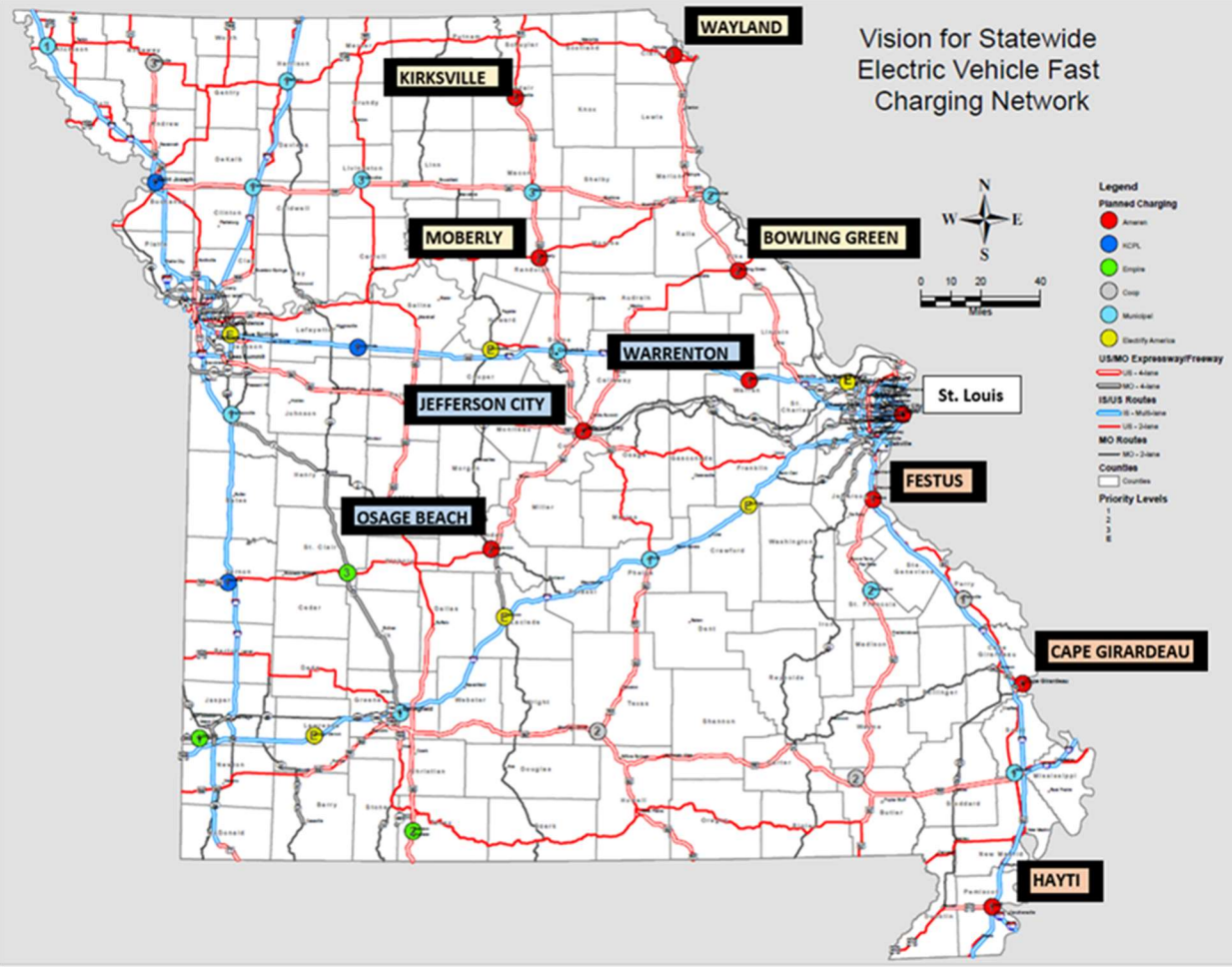
To help drive transportation electrification, Ameren became a founding member and board member of the Alliance for Transportation Electrification ("ATE"). ATE is a national non-profit organization, launched in November 2017, to accelerate the deployment of EVs and support grid transformation by promoting open standards, helping shape state policies and rate structures, and facilitating expansion of EV infrastructure. The Alliance comprises a broad and diverse membership from all parts of the transportation electrification ecosystem, including utilities, automotive companies, electric vehicle supply equipment companies, and engineering/consulting firms. Ameren Missouri is also working closely with the Edison Electric Institute and other member companies to establish timely and constructive policies to support the electrification initiative, including working with key environmental groups who also strongly support this initiative. By continuing to invest in electric vehicles Ameren Missouri stays at the forefront of technology updates, best practices and challenges that affect customers.

Ameren Missouri's electric vehicle strategy includes marketing activities to "Ignite Customer Desire" for EVs, developing charging infrastructure, and then making it easy to purchase and own 100% battery EVs. The marketing efforts include auto dealer training and engagement, electric vehicle test drive events, a website education platform, and social media engagement. In late 2019, Ameren Missouri received Missouri PSC approval to provide $11 million in incentives for the Charge Ahead - EV Program to address the lack of EV charging in strategic locations along highway corridors (see map) and, equally importantly, at workplaces, apartment complexes, and public around-town locations throughout the Company's service territory. These incentives allow us to encourage our business customers to own and operate EV charging stations, thereby raising consumer awareness about EVs and enabling local and long-distance travel with 100% battery EVs. Ameren Missouri worked in partnership with and received support for the Charge Ahead - EV program from several environmental groups including National Resource Defense Council and Sierra Club. We are also working with U.S. Green Building Council, Missouri Gateway Chapter.

EV charging infrastructure, in and of itself, is not a resource that can be used by the Company to meet its customers' energy or capacity needs. Rather, it is delivery infrastructure used to serve a particular use of energy and capacity. To that end, charging infrastructure cannot itself be screened as a resource. The very existence and availability of charging can, however, encourage EV adoption by customers, and Ameren Missouri has included a range of assumptions for EV adoption in its load forecasts, as described in Chapter 3. Those EVs represent a flexible load that may have the potential to become a valuable resource in time. Because EVs consume energy from batteries, the timing of the charging of batteries can be managed. Rate options and/or demand response programs can, therefore, be designed to take advantage of this flexible load resource. The first step in building this resource is to encourage the adoption of EVs, so that there is load to be managed and Ameren Missouri has taken steps as mentioned above.[31]

[31]EO-2020-0047 1.J

Figure 7.4 Vision for Statewide EV Fast Charging Network



Caption: Vision for Statewide Minimum Practical EV Fast-charging Network. Note the labeled communities are served by Ameren Missouri and are planned to have EV fast-charging in 2020.

7.3 Compliance References