

7. Transmission and Distribution

Highlights

- *Ameren Missouri will construct fifty-six of sixty-two transmission projects in Missouri that have been approved through the MISO Transmission Expansion Plan process by the Midcontinent Independent System Operator (MISO) Board of Directors.*
- *Ameren Missouri developed and continues to refine 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 \$5.2 billion of transmission and distribution investments from 2026 through 2030 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 some replacement of the previous vintage infrastructure and the buildout of an even larger, new system. As growth slowed over time, the infrastructure did not experience optimal turnover. However, with growth accelerating, this lack of asset replacement 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, SEP has allowed Ameren Missouri to markedly increase its efforts to make investments to replace its aging grid infrastructure so that it can continue to provide customers safe and adequate service.

On the transmission side, a total of 62 transmission projects in Missouri have been approved by the MISO Board of Directors through the MTEP process that are not yet in service. These projects are scheduled to be completed and in-service by June of 2032. Ameren Missouri will construct 56 of these projects which will mitigate future reliability issues and provide for continued safe and reliable service to customers.

7.1 Transmission

7.1.1 Existing System¹

Ameren Missouri owns and operates a 3,113-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.
- 838 miles of 161 kV transmission circuits.
- 978 miles of 345 kV transmission circuits.
- Substations that make up the Bulk Electric System:
 - 23 extra high voltage substations with a maximum voltage of 345 kV.
 - 39 substations with a maximum voltage of 161 kV.
 - 34 substations with a maximum voltage of 138 kV.

7.1.2 Regional Transmission Organization Planning²

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 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, board-approved projects. 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.³ MISO's Long Range Transmission Plan (LRTP) 2.1, which resulted in approval of approximately \$21.8 billion of new transmission projects,² including approximately \$1 billion of investments in Missouri is an example of the top-down approach. These projects were approved as a part of the MTEP24 process.

Through these MTEP related activities, Ameren Missouri works with MISO, adjacent RTOs and Transmission Planning Regions, adjacent MISO Transmission Owners and

¹ 20 CSR 4240-22.045(1)

² 20 CSR 4240-22.045(3)

³ 20 CSR 4240-22.045(3)(B)1

stakeholders to promote a robust and beneficial transmission system throughout the Midwest region. Ameren Missouri's participation helps ensure that opportunities for system expansion that would provide benefits to Ameren Missouri customers are thoroughly examined. This combination of Bottom-Up and Top-Down planning helps ensure all issues are addressed in an effective and efficient manner.⁴

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 assure the projects approved in the MTEP are in the interests of Ameren Missouri customers. Ameren Missouri is regularly represented by attendance and participation in MISO stakeholder groups, 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 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.

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

- Interregional Meetings – Numerous meetings are held each year with PJM RTO, SPP RTO, and the Southeastern Regional Transmission Planning Region to discuss, evaluate and consider interregional transmission issues and identify opportunities for transmission expansion, consistent with the respective RTO's regional planning processes.
- Large Load Working Group – is a new group recently formed to study the integration of large loads into the MISO transmission system. This group will recommend and evaluate various tariff proposals and reliability criteria to ensure that system integrity is not adversely affected by the introduction of these loads to the transmission system.
- 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 portfolio of projects is identified by the year in which the MTEP process 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. Each of the approved projects set forth in an MTEP Appendix A document is the culmination of more than 18 months of collaboration between MISO planning staff, MISO Transmission Owners, and stakeholders⁵. 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.

⁵ Note: Some projects in Appendix A are approved through MISO's new Expedited Project Review (EPR) process. Projects that are approved through the EPR process get approved within approximately 30 to 60 days of being submitted.

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 MTEP25 in December of 2025, a total of 25 new transmission projects have been approved by the MISO Board of Directors for construction in Missouri. A summary of the new projects and those projects approved in prior MTEP portfolios that are not yet in service are 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 Missouri 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 MTEP25 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	48	\$1,471	100%
GIP projects	9	\$354	1%
Multi-Value Projects	5	\$3,500	7%

A brief description of these transmission projects can be found in Appendix A in Table 7A.1.⁷

A key component of fulfilling Ameren Missouri's obligation of continuing to provide safe and adequate service is the identification of potential future need for 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/transmission-planning/mtep/>.⁸

⁶ 20 CSR 4240-22.045(3)(A)4

⁷ 20 CSR 4240-22.045(6)

⁸ 20 CSR 4240-22.045(3)(C)

Revenue Credits from Previously Constructed Regional Transmission Upgrades⁹

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. In MTEP 25, Ameren Missouri does not have any Multi-Value or Market Efficiency projects which result in revenue credits. However, the MISO Tariff also allocates 10% of Generation Interconnection 345kV Network Upgrades regionally through Attachment GG. Ameren Missouri's rate update effective 6/1/2025 included one such project and there will be more in the future. Ameren Missouri expects approximately \$11.1 million of Schedule 26 revenue for the June 2025-May 2026 period. It should be noted that over 90% of Ameren Missouri's Attachment 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 Planning¹⁰

Ameren Missouri's transmission strategy continues to be centered upon meeting the evolving reliability needs of its customers, along with Ameren Missouri's commitment to provide them safe and adequate service. Annually there is an assessment of the Ameren Missouri transmission system, which is performed in compliance with all applicable North American Electric Reliability Corporation (NERC) performance standards as well as Ameren's Transmission Planning Criteria and Guidelines, to verify system reliability. Similar studies are performed throughout the year for potential load additions.

The annual assessment is completed by studying the system under multiple scenarios, some of which are mandated by NERC, and some are which are selected by Ameren. These scenarios are then studied across varying seasons during a year and across different timeframes up to ten years out, to identify where and when potential system conditions with reduced reliability may occur in the future. Additional studies are then performed to evaluate mitigations and practical alternatives to determine what, where, and when system upgrades are required to address the future reliability concern. These studies verify the adequacy of Ameren Missouri transmission system to handle the expected power flows on the bulk electric system, to maintain system voltages and stability, considering the effects and location of overall system load and known generation.

To 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

⁹ 20 CSR 4240-22.045(3)(A)5

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

- MISO regional generation interconnection studies
- NERC reliability standards development
- Participation in SERC regional planning and assessment activities
- Along with being active participants in industry committees such as NATF, EEI, EPRI and ESIG

This high level of involvement affords the opportunity to supply comments and provide input to these many transmission planning processes. These support the goal of maintaining a reliable and safe transmission system to 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 and the system has seen a small reduction in losses, even with change from a centralized generating fleet, through strategic transmission projects such as reconducting existing lines to a larger diameter wire. In the future, if there are significant load additions, it is inevitable that system losses due to heating will rise.

A key part of maintaining safe, reliable service is the proactive management of transmission assets as they age and approach the end of their useful life. Much of the existing transmission infrastructure was installed decades ago and now presents an increasing risk of failure, higher maintenance costs, and lower operating efficiency compared with modern equipment.

The organization is also advancing asset-specific programs, including the creation of a management framework for transmission-level lightning arrestors. This pilot program will serve as a model for future efforts across other asset classes, helping ensure that equipment is systematically assessed and replaced before reaching end of life. Through these combined efforts, the transmission system can be maintained and modernized in a deliberate, data-driven manner that supports long-term reliability and responsible capital planning.

7.1.4 Transmission Impacts of Potential Ameren Missouri Generation Resource Additions/Retirements & Power Purchases/Sales¹¹

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 deliver energy safely and reliably from these potential future resources.

¹¹ 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)

Table 7.2 provides a high-level assessment of interconnection costs for the listed potential future generation resources. These estimates do not include costs for non-MISO affected systems but do include estimated cost of network upgrades in MISO footprint, 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 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

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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 when 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 Retirements¹²

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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

¹² Generation at Sioux location is not at the same point of interconnection/voltage level unlike Labadie or Callaway replacements.

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 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 transmission system reinforcements needed, their location, in service date and estimated total cost. Therefore, the cost of any system upgrades needed 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.

7.1.5 Cost Allocation Assumptions for Modeling¹³

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 and as part of MTEP20-MTEP25 and the LRTP projects approved in 2022 as part of MTEP21 by the MISO Board of Directors. Overall, Ameren Missouri expects approximately 7.13% of the MVP costs to be assigned to its load zone.

7.1.6 Advanced Transmission System Technologies¹⁴

The Company will continue evaluating emerging technologies as it develops long-range plans to maintain and enhance the reliability, resiliency, and flexibility of the transmission system. Innovation and modern technology are essential to creating customer value and improving operational efficiency, helping keep our services affordable over time. As transmission connected large loads and renewable generation drives the expansion of the transmission grid, new technologies and the need to integrate grid-connected devices will further influence system development. With a strong customer focus, Ameren

¹³ 20 CSR 4240-22.045(3)(A)4

¹⁴ 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)

Missouri will be in position to act when innovative solutions can address anticipated grid needs more effectively or at greater value than traditional approaches.

Federal, state, and RTO policies continue to evolve to address operational and market issues related to emerging technologies. Ameren Missouri will monitor and, when appropriate, help shape these policies to achieve the best outcomes for our stakeholders. Increasing customer adoption of advanced technologies - including distributed energy resources (DERs) - will affect energy demand and transmission system usage as load patterns become more dynamic.

The transmission system of the future will serve as a key component of a more integrated, bi-directional, and intelligent grid. Ameren Missouri will need to plan for the transformation from a system built primarily to deliver central-station generation to one capable of accommodating more variable, geographically dispersed resources at both transmission and distribution voltage levels. Flexibility will be critical to maintaining reliable service under a range of uncertain future conditions. As emerging technologies continue to advance and decline in cost, they will also create new competitive pressures, reinforcing the need to deliver reliable, affordable service. To maximize customer value going forward, the electric grid will be increasingly leveraged as a platform for providing personalized services and enabling customers and market participants to both buy and sell energy.

Ameren Missouri has been working with MISO to speed up the backlog of generator interconnections within the MISO Definitive Planning Phase (DPP) process. Working with MISO, Ameren Missouri updated its local planning criteria to facilitate the use of automated interconnection software, which can significantly reduce the time for modeling and impact studies, so that more time can be spent on efficient and cost-effective mitigations yet maintaining compliance with FERC Order 2023.

Inverter based resources (IBR) are connecting to the Ameren Missouri transmission system in larger numbers to replace the power lost by retiring synchronous generation. There is significant low-cost IBR penetration in neighboring states and their path to Missouri customers impact the Ameren Missouri transmission system. IBRs consist of anything that converts direct current to alternating current, including photovoltaic, new wind turbines, and battery energy storage systems. The location of the IBRs results in the loss of the load voltage regulation that used to be performed by the retiring local synchronous generation. Along with the softer voltages, system strength, as measured by short circuit current, will be weaker, which leads to larger voltage bumps when closing static reactive devices onto the system, potential for local frequency collapse and difficulty for transmission-based distance relays to determine direction.

Ameren Missouri now has 5 STATCOMs, from two different manufacturers, which provide the needed voltage regulation for the system when sourced from more remote generation, and also provides dynamic fault recovery voltage boosting to reduce system collapse

issues at summer peaks. All of these STATCOMs are capable of independent phase control to produce negative phase sequence current during a fault to polarize transmission relays so they can correctly determine the direction of a fault.

Ameren Missouri is updating its Transmission Energy Management System (EMS) to add a Voltage Dispatch Module. Managing voltage is far from a simple task and can be tedious when done manually, with an ever-increasing number of remedial actions needed due to the dynamic nature of the grid. After a voltage fluctuation, this new module quickly calculates how to best bring all voltages as close to nominal value as possible and sends automated commands to the relevant equipment, dictating next steps to restore proper voltage. Possible remedial actions might include switching capacitors and reactors. This automation to the voltage management process means significant improvements in efficiency and precision.

These IBRs tend to generate simultaneously when conditions allow, which can lead to curtailment due to transmission system constraints and the need to increase power flow on existing lines to reduce congestion. Congestion occurs when the demand to transport electricity across a specific transmission line exceeds the conventional rating of the line. Ameren Missouri continues to explore options to both move more power and serve more load from our existing right of ways. In 2025, Ameren Missouri installed dynamic line rating (DLR) equipment, which, when the weather allows, enables much higher ratings on lines. DLR equipment monitors the conditions on the line, such as wind speed, sun angle and temperature. Multiple sensors are installed on a given line to give grid operators real-time insight into highly localized weather data and the precise operating conditions of transmission lines. With this real-time information, operators can safely move electricity when and where it's needed most. By utilizing these potential capacity gains on some of the busiest transmission lines already in place, DLR helps strengthen reliability, improve safer operations and reduce costs, delivering direct benefits to customers across the region. Installation sites were strategically selected to test the technology on some of the most congested lines on Ameren Missouri's transmission system.

In addition, Ameren Missouri has explored multiple different advanced conductors to increase line ratings across existing transmission corridors. Advanced conductors offer several advantages over existing conductors, such as lower unit weight, higher core strength and sag less at high temperature, but not all advanced conductors will work well in Missouri. Ameren Missouri has for several years used Aluminum Conductor Steel Supported (ACSS) conductors, which are a high temperature, low sag conductor. Ameren Missouri explored the use of E3XD coating on its conductors and has already deployed the technology on several river crossings, before a more tactical deployment. This coating allows for increased ratings on ACSS conductors, higher than other advanced conductor types for a fraction of their incremental price increase. This coating allows for

25% increases in line rating and can be both applied to a new conductor at the factory, or to existing conductor in the field.

These increase conductor ratings have facilitated the need for substations with higher ratings, to avoid the substation terminal equipment or bus conductors from limiting the line ratings. Ameren Missouri has created new standards for substations at all voltage levels and will use the higher rated equipment when line flows or load demand it. To close the loop on ratings, Ameren Missouri has a full set of 765kV line and substation standards for when the voltage makes sense for deployment within the state.

Recently, Ameren having explored the technology, engineered and installed its first 138kV gas insulated substation, although not in Missouri. Gas insulated substations use a much smaller footprint than traditional open air insulated substations allowing them to be installed in dense urban environments, creating an option to serve new load in areas such as metro St. Louis.

Work continues on the network model manager to synergize the engineering planning modeling process, to avoid manual activity and to eliminate modeling errors. Ameren is currently working with an integrator to create clean data baselines for several substations in a test environment. As the grid becomes more dynamic, and the generation more intermittent and load variable, the requirement of accurate input data and the need to run a multitude of scenarios to cover possible future scenarios demands an adaptive integrated planning model that optimizes solutions that are reliable, affordable and resilient.

Technological advances continue to provide cost savings for our customers such as using solar powered transmission lights and using self-lighted, field-sourced conductor balls. Additionally, streamlined use of publicly available surveying, mapping, and geotechnical data allows Ameren Missouri to quickly evaluate options and reduce costs for initial project scoping and budgeting for customer interconnections.

7.1.7 Ameren Missouri Affiliates Relationship¹⁵

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.

¹⁵ 20 CSR 4240-22.045(3)(B)5; 20 CSR 4240-22.045(5)

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 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. For example, ATXI recently completed construction of a new substation in Sikeston, MO that created multiple reliability, economic benefits for Ameren Missouri retail customers as well as customers of the Sikeston Board of Public Utilities, and other members of MJMEUC. This project specifically supports economic development for SBMU and the City of New Madrid Utility. Ameren Missouri does not construct these kinds of projects because it is in the best interests of its Missouri customers that it invest its limited capital 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.

7.1.8 Avoided Transmission and Distribution Cost¹⁶

Avoided transmission and distribution 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 and distribution capital expenditures.

Ameren Missouri has previously calculated the marginal cost of system capacity in lieu of avoided transmission/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.¹⁷ The Current Values Approach estimates an average cost of serving the load by taking the net transmission/distribution plant in service and dividing it by the weather-normalized peak load. Ameren Missouri further applied the

¹⁶ 20 CSR 4240-22.045(2); 20 CSR 4240-22.045(3)(A)3

¹⁷ <https://mendotagroup.com/wp-content/uploads/2018/01/PSCo-Benchmarking-Avoided-TD-Costs.pdf>

condition/reliability factor as it has done in its previous IRPs to the average cost of serving the load estimated using the Current Values approach, as not all expenditures can be deferred by the DSM programs. The resulting avoided transmission and distribution costs can be found in Appendix A, Table 7A.3.

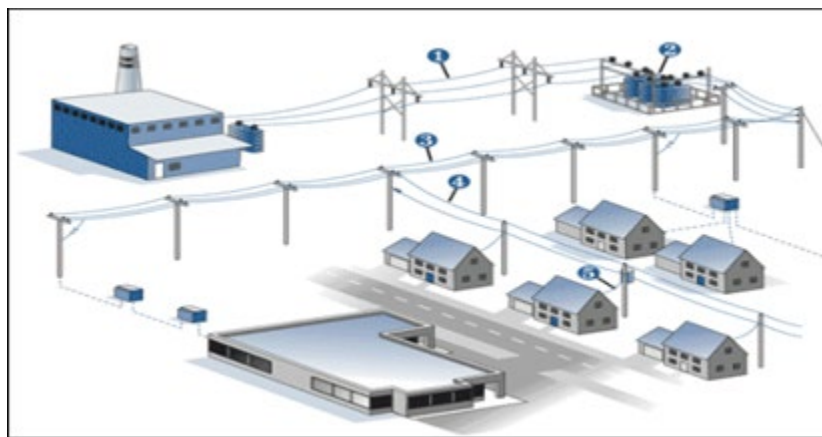
7.2 Distribution

7.2.1 Existing System¹⁸

Ameren Missouri delivers electricity to approximately 1.3 million customers across its service territory in Missouri, including the greater St. Louis area, through the primary distribution system power lines that operate at voltage levels ranging from 2,400 volts (V) through 69,000 V. Ameren Missouri has over 33,000 circuit miles of electric distribution lines, which supply electricity to 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 remaining 7% operates at other nominal voltage levels. (See Figure 7.1 for further information.)

Figure 7.1 Power Flow



Here is how electricity 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 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 lower the voltage again, to customer premises.

¹⁸ 20 CSR 4240-22.045(1)

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 in urban areas. Each customer is served by a single power source at any given time, but, when possible, 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 within prescribed limits.

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 rural communities. Long feeders are usually equipped with automatic reclosers to 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 planned or unplanned outages. The company installs capacitors and/or voltage regulators, as necessary, to counteract voltage drops and maintain proper voltage levels along lengthy circuits.

Finally, a portion of the distribution system is networked, meaning 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 that they are less susceptible to a sustained total loss of power. However, 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. Underground lines (24% of the total distribution line miles) are more aesthetically pleasing and are significantly less vulnerable to weather-caused damage but can take longer to repair upon failure.

7.2.2 The Aging Grid

As previously stated, much of Ameren Missouri's existing electrical grid was built during the 1960s and 1970s. This was a period of increased electricity use driven by significant suburbanization, increased use of air conditioning, and industrial growth. Today, more than 50 years later, much of this infrastructure is rapidly approaching obsolescence and

total capacity usage, with the associated increased risk of failure and inefficiencies as compared to modern equipment.

One scenario where we can especially see the impact of the aging system is evidenced by the challenges we face in operating effectively during extreme weather while under peak demand conditions. As recent winter storms have shown us, there are areas of the grid where a lack of capacity to meet growing peak loads, combined with little operating flexibility, leaves limited ability to switch and restore customers in the event of downed power lines, much less during extreme weather.

Another example is distribution substations. Currently over 300 of our distribution substations contain either a transformer or circuit breaker that was installed more than 50 years ago. These substations with critical components beyond their expected lives serve over 620,000 of our 1.3 million customers.

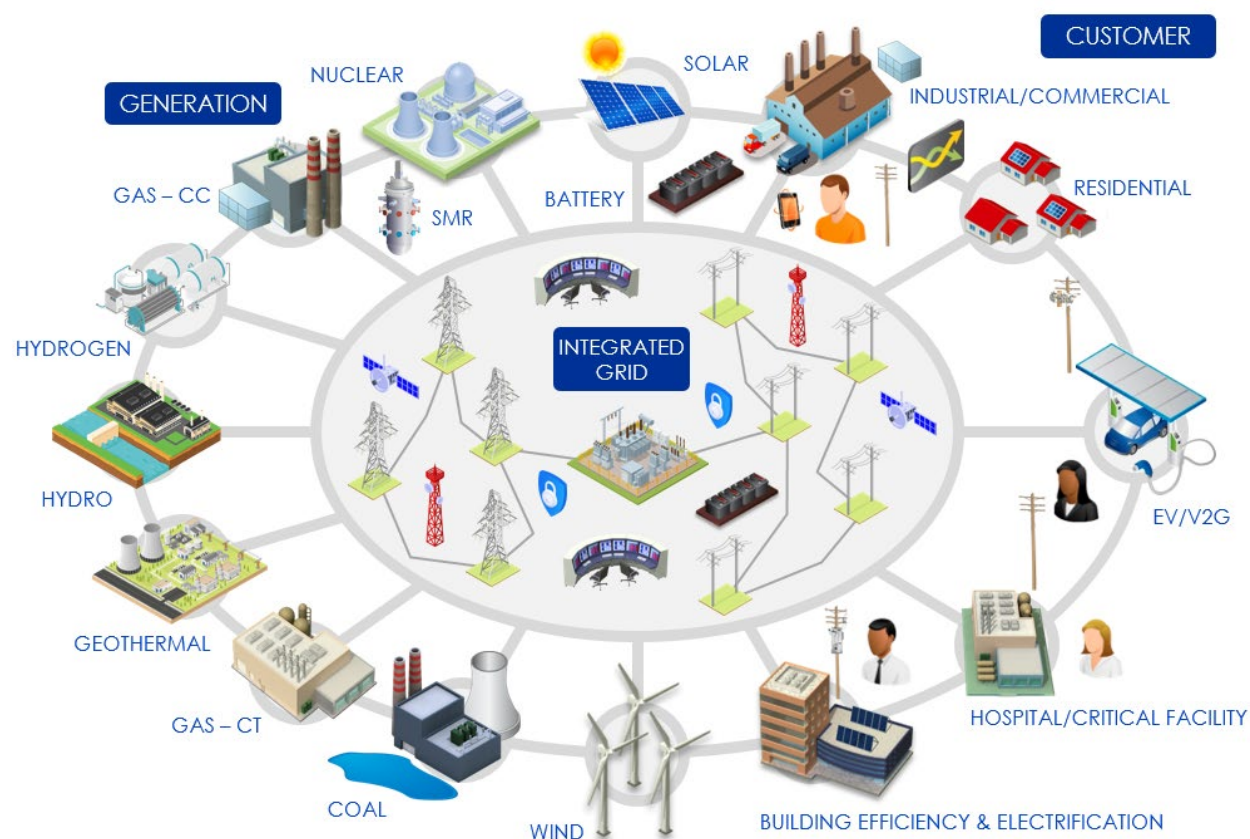
An example of the distribution grid approaching obsolescence is our underground system, which continues to increase in age as over 2,700 miles -over 38% of our underground system- has already exceeded its expected life, presenting an increasing risk to customer reliability and safety.

In addition, a large portion of our overhead system is over its expected life. One indicator of the age of the overhead system is pole age. The expected life of Ameren's poles is 45 years and more than a third of Ameren Missouri's poles are over the age of 45 years. This equates to approximately 1,600 miles of Ameren Missouri's sub-transmission system with an increased risk to customer reliability and resiliency.

7.2.3 The Integrated Grid of the Future

Beyond the need to replace or upgrade aging and end-of-life components, and an increased prevalence of automation and "smart" devices, today's energy grid inherently operates much the same as it has for the past 100 years. However, the electric grid of today and tomorrow is more complex. With significant load growth and expansion of new technologies the traditional central station generation, transmission, and distribution system will be enhanced into an Integrated Grid, which will incorporate increasing levels of demand response, distributed energy resources and customer interfaces (e.g., connected devices and homes, electric vehicles). Such changes will work 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 better inform choices over how they use energy.

Figure 7.2 Power Flow – Illustrative Future State



7.2.4 Smart Energy Plan

7.2.4.1 Introduction

At Ameren Missouri, we are working diligently 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 a landmark energy legislation (Missouri Senate Bill 564) that modernized Missouri's energy policies, enabling the SEP. In 2025, the Missouri legislature reiterated their support of SEP through the passage of SB 4. This bill ensured the continuance of these critical grid modernization efforts, which are vital to our customers and the communities we serve.

This forward-looking plan includes \$3.6 billion of electric distribution investments from 2026 through 2030 that will, among other things, support our investments to replace and upgrade aged infrastructure, to harden the system and expand resiliency efforts, and add smart grid technologies. These investments are supporting customer reliability – they prevented over 44 million minutes of customer outages in 2025. As we build this grid of the future, Ameren Missouri continues working to keep rates as low as possible while making the necessary investments to build a stronger, smarter and cleaner energy

system for our customers. That's why our residential rates remain 25% below the Midwest average compared to other electric utilities. The plan also accelerates the construction of smart energy infrastructure that will drive job creation and economic development across Missouri.

7.2.4.2 SEP Strategic Goals

Based upon our vision of the Integrated Grid, Ameren Missouri has developed a number of strategic goals to deliver customer value from the implementation of the Smart Energy Plan:

- 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.
- Automate portions of the electric distribution system by deploying smart switching devices with associated circuit upgrades and accompanying communications technologies to help significantly reduce the length of outages.
- Harden the 34 kV and 69 kV electric distribution system with a stronger, more secure energy delivery backbone, strategically using stronger poles, standoff insulators, shield wire, and wind tolerant conductors that will better withstand severe weather. Hardened circuits are designed to avoid momentary outages due to lightning strikes, as well as the possibility of extended outages from high winds and other severe weather.
- Employ smart grid technologies (e.g., relaying, monitoring, fault information, communications) as we upgrade aging and end-of-life infrastructure and install new substations to support reliability for customers and mitigate risk.
- Improve operating flexibility and increase capacity, by upgrading substations and lines and adding smart switches. When severe weather or other events occur, customers can have power restored through switching to prevent or reduce extended outages, but only if lines and substations have the capacity to serve additional load. Additionally, these upgrades will enable future bi-directional power flow from DERs.
- Complete the execution of the underground revitalization program in the City of St. Louis and surrounding communities. The program significantly reduces aging and end-of-engineered-life infrastructure, some of which is over 100 years old, while increasing route diversity, thus reducing the risk of very long and widespread outages due to a single incident.

7.2.4.3 Smart Energy Plan Highlights

Smart Meter Program

The Ameren Missouri Smart Meter Program completed the upgrade of all electric meters, gas modules, and the associated communication network in the Missouri service territory in 2025. This work included:

- Installed 1.3 million Electric Advance Metering Infrastructure (AMI) meters (residential and commercial/industrial), which provide greater usage insights and capabilities for customers.
- Installed 132,000 Gas AMI modules (residential and commercial/industrial). This does not include new gas meters, only the communication module of the meters.
- Deploying a modern RF mesh network, enabling two-way communication.
- Implemented an Advanced Meter Data Management System.
- Modernizing the Ameren Missouri Meter Shop to facilitate the receipt and quality testing of purchased meters.
- Creating an Ameren Missouri Network Lab.

These upgraded electric meters and gas modules replaced all the antiquated Automated Meter Reading (AMR) meters/modules. The existing AMR meters/modules use meter reading technology that was more than 20 years old and were installed between 1995 and 2000, thus exceeding their expected life (projected to have a 15 to 20-year life). These upgrades will have a number of associated benefits:

- Smart sensors, switches, and self-healing equipment work together to rapidly detect and isolate outages and more quickly restore power in the event of a service disruption.
- Smart meters enable Ameren Missouri to pinpoint outages in order to more quickly restore customers' service. Smart meter rate options (e.g., time-of-use rates) help customers manage their bills and shift load from peak to off-peak times to benefit the system.
- Improved mobile and web-based tools provide customers with greater visibility into their energy usage and greater control to manage their energy costs. Affordable customer rates are supported through a reduction in meter infrastructure operating costs by, for example, reduction in meter reading costs and enabling remote disconnect/reconnect capabilities.

Substations

Ameren Missouri has approximately 530 distribution substations and more than 100 bulk-supply substations on its system. As was previously discussed in Section 7.2.2 – The Aging Grid, there is a significant population of substations, which serve more than 48%

of our customers, that are approaching end-of-life and contribute significantly to reliability issues and increasing maintenance costs.

To combat this trend, Ameren Missouri's SEP has upgraded ~140 substations from 2019-2025. These new and upgraded substations will improve energy service reliability through a network that is more efficient.

Modernized substations feature automated sensors and smart technology equipment to create a self-healing system that more rapidly detects and informs us of outages and reroutes power to restore service. They also include other "smart" technology equipment (see Section 7.2.8.3 Smart Substation Technologies).

Distribution Automation

More than ten years ago, Ameren Missouri started to deploy distribution automation (DA) devices across the grid. This program was developed due to the significant improvement in reliability, up to 40%, when these devices were added to circuits. Ameren Missouri was able to greatly accelerate this process through the SEP and facilitate greater portions of the system equipped with smart, automated equipment that improves remote visibility and control. Because of this, the system can rapidly detect outages, reroute power, and restore service. From 2019 through 2025, we have installed ~2,150 DA devices. The result of broad DA deployment will be self-healing capabilities across much of the distribution system.

Grid Resiliency

The Grid Resiliency category supports reliability by adding capacity to serve localized growing loads and to improve the flexibility and switching ability of Ameren Missouri's substations and lines. Switching power flow around an outage through an alternate pathway is the fastest way to restore customers who are impacted by a grid outage. However, the ability to switch is often impaired by infrastructure that is already at or near capacity due to load growth. One impact of these constraints is the requirement to disable substation automatic transfer schemes during periods when loads are higher (e.g., during summer or winter peaks). There are currently ~20 devices operated in this manner during the summer season and ~40 during the winter season. Improvements in this category will address assets that have reached their capacity limits and those in growing areas with commercial and industrial customers and areas with expanding subdivisions.

Underground Revitalization

Our plan for Underground Revitalization is to increase reliability by upgrading aging and end-of-life infrastructure in downtown and surrounding metro St. Louis. By 2028 the total 140 miles in downtown St. Louis will be upgraded. Historically, our underground network 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 incorporating 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 the time required to locate and make repairs to underground assets.

Underground Cable

In Ameren Missouri's service territory, almost 8,000 miles of underground cable exist, with more than 30% having reached its expected life of 40 years. Our plan targets this end-of-life underground cable infrastructure. From 2019 through 2025, we upgraded ~570 miles of underground cable.

The two major types of upgrades are direct buried primary laterals that supply subdivisions and lead feeder exit cables coming from substations. In the direct bury upgrade program, Ameren's Missouri's historic strategy has been to reactively replace sections of cables upon failure. Our current strategy is to utilize a proactive, planned approach and identify problematic primary laterals and/or entire subdivisions that require full replacement. This approach will improve efficiencies, help balance resources, and improve reliability for customers. Since primary cables are the mainstay of the subdivisions, they will become the focus versus the ties to individual houses.

Private LTE

Initially, we deployed private Long-Term Evolution (PLTE) transmitters to 39 (of which 33 are fully operational) sites in the greater St. Louis metropolitan area to provide uniform PLTE coverage. This provides a consistent, private cellular network to operate additional smart devices and will provide better real-time system operational information. This is part of a larger effort further described in Section 7.2.8.4, Multi-Layered Network Architecture. As a part of Ameren Missouri's SEP, we completed the installation 12 PLTE towers in 2025.

7.2.5 Initiatives

7.2.5.1 System Inspection¹⁹

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 (2,400 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. Ameren Missouri also replaces a number of transformers each year with higher efficiency units when corrosion, oil leaks, or other visually detectable issues occur.

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 7.2.8, 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 is installed as part of the upgrade, resulting in improved efficiency and reduction of losses.

7.2.5.2 System Planning²⁰

Ameren Missouri expects and plans for today's electric grid to evolve into a more integrated and complex system, one more capable of operating in the face of extreme weather and has developed a broad modernization strategy to that end. A key aspect of our SEP vision and this strategy is to increase operating efficiency and flexibility which allow for increasing levels of distributed energy resources and customer interfaces. While our approach is in its early stages, we are taking steps to build the necessary tools,

¹⁹ 20 CSR 4240-22.045(1)(A)

²⁰ 20 CSR 4240-22.045(1)(A)

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 sub-transmission 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. Additionally, positions for DER planning were added in 2022. These centralized groups provide subject matter expertise and streamlining efforts including load analysis and engineering methods/best practices. We also include the analysis of the impact of larger solar installations on the distribution system, electrification, and further innovation in the distribution system.

Annual Load Analysis and System Planning Process

Ameren Missouri records historical 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 from the distribution substations fed by the bulk substation. Engineers also enter adjustments for known or expected specific local load growth from factors including but not limited to planned residential subdivisions, apartments or condominium complexes, and commercial and industrial developments.

Engineers also calculate bulk-supply 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-supply substation loads. The substation loads are then compared to temperature-corrected values and used to evaluate what, if any, diversity factors apply at each bulk-supply 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-supply substations, 34,500 V and 69,000 V circuits. These studies pinpoint system limitations and enable engineers to identify upgrades required to maintain adequate system capacity.

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.

In all the load analysis and system planning described above, the impacts of energy efficiency are included as a consideration based on the historical summer and winter peak load baselines. Historical realized energy efficiency benefits are a reliable indicator, from a system planning perspective, of what system impacts and conditions we can expect to exist from energy efficiency in the future.

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, 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, thereby enabling better planning of future system development.

Capital Project Evaluation²¹

As part of SEP, Ameren Missouri routinely assesses the feasibility and cost effectiveness of potential system expansion and modernization projects. Both conventional and advanced technologies are regularly considered. Due to the age of our grid and recent trends in load growth, the majority of approved projects focus on system reliability support and modernization.

In 2022, Ameren Missouri developed project evaluation methodologies and frameworks to justify the six SEP categories of investments. Below is the breakdown of Ameren Missouri's frameworks and applicable evaluation criteria used in these justification methodologies:

²¹ 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

Figure 7.4 Project Evaluation Framework

Criteria	Grid Resiliency	Downtown Underground	Smart Grid	System Hardening	Underground Cable	Substation Condition Based
Age/Asset Vintage	✓	✓	✓	✓	✓	✓
Asset Condition	✓	✓		✓	✓	✓
Asset performance		✓		✓	✓	✓
Potential for Community Impact	✓	✓	✓	✓	✓	✓
Safety		✓			✓	✓
Capacity	✓					
Operating Flexibility	✓					
Circuit Topology/Grid Visibility			✓			

7.2.6 System Efficiency²²

7.2.6.1 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, load research activities, and as supporting information for rate reviews. Ameren Missouri is updating the Loss Study in 2026.

7.2.6.2 System Upgrade and Expansion Projects

By their nature, many types of energy delivery upgrade and expansion projects improve system efficiency by reducing load current, I²R losses, or both. Examples of such projects include:

- Constructing new circuits or rebuilding existing circuits with larger conductors
- Reconnecting single phase loads on three phase circuits to achieve balanced system phase currents
- Constructing new pad-mounted transformers with distribution automation devices to eliminate aged, rural (less than 2.5 MVA) substations

²² 20 CSR 4240-22.045(1)(A)

- Upgrading existing substations or strategically placing new substations to serve areas with increasing load density, using 38 kV switchgear
- 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 138 kV-fed distribution substations in specific and limited circumstances
- Reconfiguring distribution feeders as appropriate when connecting new customers

7.2.7 Distributed Generation

Ameren Missouri evaluates distributed generation (DG) and its impact on the distribution system for both Ameren Missouri and third-party installations. Currently, there are 11 Ameren Missouri-owned and four third-party owned renewable energy centers connected to the distribution system that range from 200 kW AC to 50 MW AC. One example is the Ameren Missouri owned and operated Vandalia Energy Center, near Vandalia, MO. This project includes the connection of 50 MW AC solar photovoltaic generation to the local 69 kV sub-transmission system.

Potential projects are analyzed on a case-by-case basis. At this time, Ameren Missouri is evaluating the potential installation of additional photovoltaic generating, fuel cells, and battery capacity at several locations. There are a multitude of factors that influence the evaluation of potential DG installations such as emissions ordinances, operational complexities of the DG associated with fuel and water availability, equipment maintenance, real estate to site the project, distribution system operational impacts, and the fact that traditional distribution system expansion projects can provide secondary benefits like improving reliability.

Ameren Missouri generally cannot dispatch DG at this time, 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.

7.2.8 Advanced Distribution System Technologies²³

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.

²³ 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

7.2.8.1 *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 through advanced equipment via high-speed two-way digital communications technology. 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.

<u>Conventional Equipment</u>	<u>Advanced Technology Equipment</u>
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	Pad-mounted Switch with SCADA communication and current/voltage monitors and fault location capability
Network Protector	Advanced Network Protectors with SCADA communication and current/voltage/load and equipment condition monitoring capability
Electromechanical Relays	Microprocessor Based Relays with SCADA communication 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
Circuit Breaker Timing Tests	Online Breaker Timing and Contact Wear Monitoring

7.2.8.2 *Automated Switching Applications*

Ameren Missouri's design strategy for the sub-transmission (34.5 & 69 kV portion of our distribution system) system includes providing redundant service in a preferred-reserve fashion to distribution substations. In densely populated areas, redundant sub-transmission 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 sub-transmission 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 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 the device does not allow for automatic or remote operation. 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 7.2.4.3 Smart Energy Plan Highlights, Ameren Missouri's strategy for automating 12 kV 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 capacity and topology supports the restoration of un-faulted line sections to a different feeder. Where appropriate, Ameren Missouri prioritizes projects based on reliability metrics. Our long-term goal is to have one smart switch (DA device) per approximately 400 customers to provide more reliable service throughout our territory.

7.2.8.3 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, going forward, mobile substation transformer and switchgear purchases 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. Ameren Missouri plans to continue installing sensor technology on substation transformers over time as an integral part of its capital substation projects, including those undertaken for reasons of load growth, reliability upgrade, or condition-based maintenance.

7.2.8.4 Multi-Layered Network Architecture

Currently, several isolated and overlapping networks are operating in support of AMI 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. We anticipate that more capacity will be required for ultimate end device populations in the tens of thousands. We also expect 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. Over time, WAN infrastructure additions 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 LAN 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 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.

7.2.8.5 Advanced Distribution Management System (ADMS)

Since 2014, Ameren Missouri has used 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.

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 was not feasible on legacy platforms and provides the flexibility to add and integrate future applications.

7.2.8.6 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 a strategic 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 quickly identify unforeseen overloads, release capacity by allowing for daily operation closer to margin and greatly enhance 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 enhances operations by allowing for real-time outage notification and immediate intervention by dispatchers in restoration scenarios.

There are approximately 80 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.

7.2.8.7 Capacitor Control

Smart line capacitor operation has helped Ameren Missouri maintain a 98% substation transformer power factor over the last thirty 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 effectively controls customer end use voltages, and 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.

7.3 Compliance References

20 CSR 4240-22.040(3)	7
20 CSR 4240-22.040(3)(A)	7
20 CSR 4240-22.045(1)	2, 16
20 CSR 4240-22.045(1)(A)	24, 27, 28
20 CSR 4240-22.045(1)(B)	7
20 CSR 4240-22.045(1)(C)	7
20 CSR 4240-22.045(1)(D)	11, 28
20 CSR 4240-22.045(2)	15
20 CSR 4240-22.045(3)	2
20 CSR 4240-22.045(3)(A)2	11
20 CSR 4240-22.045(3)(A)3	15
20 CSR 4240-22.045(3)(A)4	5, 11
20 CSR 4240-22.045(3)(A)5	6
20 CSR 4240-22.045(3)(B)	11
20 CSR 4240-22.045(3)(B)1	2, 3, 6
20 CSR 4240-22.045(3)(B)2	3, 6
20 CSR 4240-22.045(3)(B)3	3, 6
20 CSR 4240-22.045(3)(B)4	6
20 CSR 4240-22.045(3)(B)5	14
20 CSR 4240-22.045(3)(C)	5
20 CSR 4240-22.045(3)(D)	7
20 CSR 4240-22.045(4)(A)	11
20 CSR 4240-22.045(4)(B)	28
20 CSR 4240-22.045(4)(C)	11, 26
20 CSR 4240-22.045(4)(D)	11, 26
20 CSR 4240-22.045(4)(D)1	26
20 CSR 4240-22.045(4)(D)2	26
20 CSR 4240-22.045(4)(E)	26
20 CSR 4240-22.045(4)(E)1	11, 26
20 CSR 4240-22.045(5)	14
20 CSR 4240-22.045(6)	5
20 CSR 4240-22.070(1)(B)	11, 28