Evergy Metro

Volume 4.5

Transmission And Distribution Analysis

Integrated Resource Plan

20 CSR 240-22.045

April 2024

Table of Contents

Table of Tables

Table of Appendices

Volume 4.5: Transmission and Distribution Analysis

Highlights

- SPP identified two economic and six reliability projects in the Evergy Metro footprint through its 2023 ITP process.

Section 1: Adequacy of The Transmission and Distribution Networks[1]

1.1 Opportunities To Reduce Transmission Power and Energy Losses[2]

Electrical losses in a transmission line are primarily dependent on the specific characteristics of the line (conductor type, line length, etc.) and the amount of power flowing (I^2R) on the transmission line. Evergy uses 161 kV transmission lines (approximately 1,000 miles) for the majority of its load serving substations in Missouri and many of Evergy's existing 161 kV transmission lines use a single 1192 ACSR conductor per phase on H-frame wood structures, which provides a normal line rating of 316 MVA and an emergency rating of 356 MVA for summer conditions. For increased transmission capability and lower line losses, Evergy has two different conductor types that are generally used: two 795 ACSR conductors per phase or a single 1192 ACSS/TW. The selection of either conductor type is based on the specific needs of the project and in both cases would be installed on steel structures. The bundled 795 ACSR design provides a normal line rating of 501 MVA and an emergency rating of 563 MVA for summer conditions and the single 1192 ACSS/TW provides a normal and emergency line rating of 591 MVA for summer conditions. The updated conductor reduces the line's electrical resistance and results in reduced transmission losses. High level cost estimates per voltage are shown in the table below, although actual costs may differ vastly due to specific details associated with each project.

Table 1: High-Level Transmission Line Costs per Mile

Line Voltage	Rural Cost / Mi	Urban Cost / Mi
69	$800k	$1M
115 / 138	$1.5-1.75M	$1.75 - 2M
161	$1.75-2M	$2 - 2.25M
230 / 345	$2 - 2.25M	$2.5M (rare)

In order to "analyze the feasibility and cost-effectiveness of transmission network loss reduction measures", Evergy analyzed the costs and loss reductions associated with rebuilding five of Evergy Metro's most heavily loaded 161kV transmission lines. This

[1] 20 CSR 4240-22.045 (1)
[2] 20 CSR 4240-22.045 (1)(A)

analysis involved calculating new impedance values for the five transmission lines converted to the preferred conductor based on location and performing a load flow analysis to determine the level of loss reduction for the rebuilt lines. Results of this analysis are in the table below.

Table 2: Cost Analysis for 161kV Transmission Line Loss Reduction

Existing Line Information							
161kV Transmission Line			Impedance			Estimated Summer Losses [MW]	Estimated Rebuild Cost
From Substation	To Substation	Line Length [mi]	R [pu]	X [pu]	B [pu]		
BNSF	West Gardner	2.6	0.000811	0.007088	0.00409	0.4	N/A
Norton	Salisbury	22.23	0.010223	0.065740	0.032390	2.6	N/A
Paola	South Ottawa	21.81	0.011026	0.064026	0.032000	0.1	N/A
Quarry	Mur-Len	5.5	0.001850	0.015240	0.009300	0.3	N/A
Southtown	Tomahawk	3.44	0.001220	0.009850	0.005200	0.1	N/A
					EM Totals	**3.5**	**$0**

Estimated Rebuild Line Information							
161kV Transmission Line			Impedance			Estimated Summer Losses [MW]	Estimated Rebuild Cost
From Substation	To Substation	Line Length [mi]	R [pu]	X [pu]	B [pu]		
BNSF	West Gardner	2.6	0.000591	0.005258	0.005435	0.3	$5,850,000
Norton	Salisbury	22.23	0.006642	0.063147	0.033374	1.7	$44,460,000
Paola	South Ottawa	21.81	0.006517	0.061954	0.032743	0.1	$43,620,000
Quarry	Mur-Len	5.5	0.001249	0.011122	0.011498	0.3	$12,375,000
Southtown	Tomahawk	3.44	0.000781	0.006956	0.007192	0	$7,740,000
					EM Totals	**2.4**	**$114,045,000**

Loss Reduction [MW]	1.1
Loss Reduction [kW]	1100
Cost per kW	$103,677

The average cost of loss reduction per kW for these five transmission lines is $103,677/kW. Clearly, transmission loss reduction is not cost effective for Evergy when compared to the cost of new supply side resources. This is mainly due to the fact that Evergy already has a relatively low loss transmission system.

1.1.1 Distribution System Overview

The various Evergy planning groups (Supply, Transmission, and Distribution) assimilate a broad set of engineering inputs to determine how the company will invest in improving the respective systems to meet ongoing load growth, system reliability, operational efficiency and asset optimization needs. The Distribution Engineering group analyzes data, identifies patterns, develops electrical models representative of the Evergy distribution system, and performs studies to understand and prioritize system improvement needs.

The Evergy Missouri service area consists of three general types of areas: a predominantly developed urban core, suburban areas in the territory fringes, and a rural area. The urban core can be characterized by high utilization of its distribution assets and its aging infrastructure. Reliability risk in this area is addressed by installing replacement or contingency infrastructure and infrastructure inspections as noted in Section 1.1.2.4 (Condition).

In contrast, the suburban areas of the Evergy system require the build-out of the distribution system due to the development of open land. The highest load growth is seen on the fringe, demanding investments to serve emerging electrical loads – largely a capacity issue. New circuits require expanding substation breaker positions and circuits must be effectively tied together to allow for contingency switching and to disperse the load across a larger number of circuits.

The rural areas have the most widespread infrastructure components and have the fewest or most limited contingency ties, where any load manipulation can cause large disturbances to customers' voltage. Distribution Engineering carefully examines these systems to ensure customer voltages are within tolerance, a process that demands high-quality mapping and device load data. With so many widespread components, acquiring data was one of the greatest challenges in these areas. However, load data acquisition is improving with the deployment of Communicating Fault Circuit Indicators (CFCI).

The Distribution Engineering group is tasked with elevating the highest priority and highest-risk projects to a point where investments are made earlier than those with lower priorities and risk profiles. Many years of constant review have provided the group with a robust set of criteria within which these problems are evaluated, and process improvements continue to be made to further analyze how to build out the distribution system to ensure cost-effectiveness.

It is the goal of Distribution Engineering to ensure that every investment optimizes capital spend and balances risk, meets current and future needs, and is built strategically when and where they are needed. Many tools are used and a great deal of information is processed and analyzed to develop these strategic plans.

1.1.2 Distribution Annual Scope of Work

Throughout each year, Distribution Engineering prepares several system studies to determine weaknesses or risks to reliability and to assess the overall adequacy of our distribution system. Much of the work focuses on increasing reliability and prioritizing work based upon cost, scope, impact, and effectiveness. This work is centered around five (5) specific areas: capacity, contingency, voltage, condition, and compliance. The table below illustrates the various deliverables associated with each focus area:

Table 3: Distribution Planning - Annual Scope of Work

Category	Study Name	Deliverable
Capacity	Load Preservation, 5-Year System Expansion-Load, Peak Load Study, 15-Year Forecast, Circuit Rating Study	Black Start Plan, Budgetary Recommendations, Distribution Load Book, Forecasted Substation Loads, Circuit Rating utilized for Operational Guidance
Contingency	5-Year System Expansion-Contingency, N-1 Contingency, N-1 Transformer Contingency, Fault Location Isolation Service Restoration (FLISR)	Budgetary Recommendations, Circuit Contingency Plan, Transformer Contingency Plan, Grid Modernization
Voltage & Losses	Phase Balancing, Voltage Drop, System Efficiency Studies, Capacitor, Voltage Regulation	Load-Swap Recommendations, Voltage Management Schemes, System Loss Studies, Capacitor Installations, Substation Tap Settings
Condition	Worst Performing Circuits, Circuit Review, Short Circuit, Other Reviews	Budgetary Recommendations, Grid Modernization, Customer-Required Special Studies
Compliance	MO/KS Load Split, EIA 861 Annual Circuit Count	Non-metered Power Flow Across State lines, Circuit Count for Voltages 35kV & below

To complete this identified scope of work, Distribution Engineers utilize a variety of tools that make use of the device loads and system schematics as inputs.

Capacity Planning

Device loads, such as substation transformer and distribution circuit loads are collected annually from several remote-sensing sources. This load data is compared to previous years' loads and device maximum loading to determine how the load is changing over time and if any component is overloaded and in need of an upgrade. These types of problems are given a higher priority than others to ensure continued reliability.

Circuit Rating Study

Using adjusted loads, Distribution Engineering will determine ratings for each circuit. This study is done in several different ways depending on the configuration and style of the distribution components under review. The most complex of these studies deals with underground feeder cables within duct banks, which de-rate each other by mutual heating. Distribution Engineering uses circuit loads to determine capacity 'choke-points' in order to rate the circuit. These ratings are provided to Operations to determine alarm setpoints and become an integral part of the N-1 Contingency Study. These ratings are also compared with native device loads to determine where normal-load capacity expansions are needed, leading to budget recommendations.

Electric Vehicle Load Forecast Study

In 2022, Evergy partnered with 1898 & Co. (1898) to conduct an electric vehicle (EV) impact and long-range load forecast study. The study details long-range circuit load growth due to estimated increases in the adoption of electric vehicles at different penetration levels for the entire Evergy service territory. The study intent was to help identify future capacity constrained areas due to EV load additions and to proactively plan for distribution expansion work before system loading became an issue. Estimates were provided for the entire Evergy service territory and will be utilized for all jurisdictions.

Electric vehicles present a potentially significant large end use load to the distribution system. To study the potential distribution impact of vehicle electrification, one must understand the customer key drivers of adoption. Therefore, 1898 leveraged data compiled by the Alliance for Automotive Innovation, Experian registration data paired with the diffusion of innovation theory, and demographic characteristics from the latest census to identify likely clusters of EV adoption. The potential for electrification of company or municipality fleets was also taken into account based on fleet size, vehicle replacement rate, and general electric vehicle sales percentages. This information was mapped geographically to locate potential electric vehicle clusters at different penetration levels in the Evergy service territory. The electric vehicle study provides Evergy a forecast for different electric vehicle penetration scenarios through 2040.

Evergy anticipates localized loading issues at the distribution line transformer level in the future when those transformers are providing service to a cluster of customers who all adopt EVs. Localized distribution line transformer loading can be resolved by upgrading the size of the transformer and/or the line size feeding the transformers. Based on the clustering of individuals who meet the profile for likely adoption, it is also anticipated that upgrades for additional capacity at the substation level will be required as penetration increases.

The scenario-based planning methodology has allowed Evergy to understand the anticipated impact of electric vehicles in the Evergy service territory at the circuit level. The study also highlighted the wide range of impacts that could result from various adoption rates and policies/rate structures related to EV charging.

Contingency Planning

Contingency Planning is similar to Capacity Planning in its view of loads compared to device capacity but deals in an N-1 contingency setting. Evergy designs its system to withstand a failure of any one component at a given time. It is the responsibility of Distribution Engineers to determine system weaknesses that do not comply with this and to make the necessary investment recommendations to allow emergency switching to restore power without overloading backup devices. These issues have a secondary priority in the budgetary process.

N-1 Contingency

The annual contingency study will provide the earliest indication of system improvement needs. It is more likely that conductor upgrades will be needed to address feeder or transformer loss, rather than there being simply too much native load on a single feeder or substation transformer. For Distribution Engineering, the N-1 Contingency Study is a systematic and complex process due to the magnitude of the individual distribution system circuit components. Synergi is the primary software tool in use to determine the load flow across a circuit. Distribution Engineers divide circuits into segments of load and establish switching orders for restoration in the case of a feeder or substation transformer loss. Using GIS models and load data, Synergi determines how that load is dispersed across the circuit by allocating the load based on the by-phase connected KVA on each circuit.

Three complex inputs into one N-1 Contingency Study using a highly technical software program yields effective results determining where system improvement is needed. By using the Synergi model to rearrange configuration of circuitry, Distribution Engineers can detect where mapping errors exist, where low voltage can be problematic, and where wire sizes can limit how the distribution system is operated. Contingency Planning is an intensely complex process taking significant time to determine system weaknesses for a given planning year. The study is completed every year for loss of every distribution feeder and substation transformer.

These weaknesses are identified and analyzed to determine the impact to system reliability and are ranked against each other correspondingly. This ranking, energy efficiency impacts, reliability and customer impact risks, and the project cost determine whether a system improvement is constructed or not. Distribution Engineering therefore must not only identify the weakness but provide some budgetary estimation and project description. It also becomes the responsibility of Distribution Engineering to thoroughly communicate why a project exists throughout the company, until it becomes part of the approved budget and is handed-off to design department for execution.

Distribution Voltage

At the customer-end of any given line, distribution voltage must be maintained within specific tolerances. It is the responsibility of Distribution Engineering to ensure system-level issues do not adversely affect the voltage received by customers. To do this, GIS models are used in a load-flow program called Synergi to simulate voltage levels in the field. In addition to supplying adequate voltage levels to our customers, we also strive to maintain an efficient low-loss distribution system. Several examples of this are the annual load balancing efforts and capacitor studies to optimize voltage levels and reduce system losses.

Loss Studies

Another method of analyzing overall system efficiency is through the performance of system loss studies. These are done periodically, and the information gathered is used by Distribution Engineering as well as in rate case filings. The most recent system loss study was completed by Management Applications Consulting, Inc. in December 2021. A complete copy of this study, “Evergy 2020 Analysis of System Losses”, can be found in Appendix 4.5.D.

Distribution Component Condition

Another important focus area for Distribution Engineering deals with component conditions and their effect on reliability as it relates to capacity, contingency, voltage and overall system efficiency. Ongoing strategic planning to maintain reliability must account for device degradation over time, and engineers look for cost-effective replacement or maintenance opportunities where they coincide with capacity expansion plans. By working with the Asset Management group to determine the best course of action, these replacements in some cases are combined into capacity expansion projects – an increase in project scope from the normal course of action. System expansion to proactively replace degraded system components can be a more cost-effective solution than the “run-to-failure” strategy.

Distribution Cable Assessment Program

In the Cable Assessment Program, the insulation properties of individual cable segments are evaluated using a partial discharge test which evaluates the cable’s integrity. Based on the results of these tests, a decision is made on which cable segments to replace.

Worst Performing Circuit Analysis

The High Outage Count Customer Program, also known as the “Worst Performing Circuits” Program, is a circuit-based program addressing service reliability issues associated with customers experiencing abnormally high outage counts. Evergy identifies high outage count customers, investigates their outage events, and develops solutions to improve their circuit reliability. The Company uses the definition found in the

MPSC reliability rule, 4 CSR 240-23.010 (6) to identify the top five percent (5%) worst performing circuits and to prioritize work needed to improve their reliability.

Pole Replacement and Reinforcement Program

The Distribution Pole Replacement/Reinforcement Program addresses reliability issues associated with the condition of distribution poles. Evergy annually conducts a ground-line inspection of the system to determine if there is a need to replace or reinforce distribution poles. The evaluation includes an examination for indications of decay and/or fungi at or below ground level, hollowness, and shell rot. When a pole is identified for replacement or reinforcement, the Company uses an independent contractor who is an expert in pole evaluation, maintenance, and repair, to prioritize and coordinate pole maintenance or replacement. The work is prioritized based on greatest risk to safety and impact to customer reliability.

Lateral Improvement Program

The Lateral Improvement Program addresses system-wide distribution reliability performance. Evergy conducts analysis to identify unfavorable reliability metrics. The systematic approach used determines root causes of irregular system component performances—such as pole or cross-arm failure, cutouts, arrester malfunction, grounding issues, undetected equipment vandalism and/or other undetected damage, among others. Detailed condition assessments and risk-modeling are used to formulate solutions concentrated on specific reliability issues. Projects are prioritized based on the magnitude and impact of customer outage.

Proactive Retirement of Substation Transformers

The Asset Management group has also proactively undertaken a study to assess Evergy's fleet of substation transformers, determine their risk of failure, and develop a retirement/replacement program. The condition of each transformer is primarily based upon dissolved gas analysis taken from annual transformer oil sampling. Evergy utilizes a transformer analysis package that categorizes each transformer as a category 1, 2, 3, or 4, with category 4 being the worst condition. This program reduces the overall operational risk associated with transformers that are identified as being at a higher risk for failure.

1.2 Assessment of Interconnecting New Facilities[3]

Evergy generation resource additions interconnecting at the transmission level (>60 kV) within the Southwest Power Pool (SPP) region are evaluated through the SPP Generation Interconnection process as detailed in their Federal Energy Regulatory Commission (FERC) approved open access transmission tariff. The interconnection process includes detailed transmission studies and interconnection estimates for connection to and use of the SPP transmission system. Resource additions would also have to go through the SPP Aggregate Facility Study process to obtain firm transmission service for delivery of generation to load.

1.3 Assessment of Transmission Upgrades for Power Purchases[4]

Evergy is a member of the Southwest Power Pool (SPP), a Regional Transmission Organization (RTO) mandated by the Federal Energy Regulatory Commission to ensure reliable supplies of power, adequate transmission infrastructure, and competitive wholesale prices of electricity. As a member of SPP, Evergy participates in the regional transmission expansion plan processes of the RTO, including requesting firm transmission service through the Aggregate Facility Study (AFS) process, which evaluates the transmission upgrades necessary for delivery of power purchases.

1.4 Assessment of Transmission or Distribution Improvements with Respect to Cost Effectiveness or DSM or Supply-Side Resources[5]

1.4.1 Capacitor Automation Efforts

Evergy is operating its MO Metro capacitor automation program over a 4G cellular system. Although Evergy has upgraded 77% of its capacitor control fleet, we are constantly reviewing additional controller and capacitor upgrades.

[3] 20 CSR 4240-22.045 (1)(B)
[4] 20 CSR 4240-22.045 (1)(C)
[5] 20 CSR 4240-22.045 (1)(D)

Control upgrades allow for:

- Remote engineering and control
- Enhanced data availability
- Better internal diagnostics

The business case for automated capacitors includes:

- Enhancements considered when upgrading legacy capacitor locations:
    - Voltage Override
    - Neutral Sensing
    - Limiting number of switching operations per day
    - Ability to change setpoints remotely
    - Ability to obtain power quality data for improved customer service
- Enhancement of safety for Evergy workers
    - Five-minute time delay in control for a close after an open
    - One-minute timer for close after faceplate control operation
- Reduction of O&M Costs
    - Limiting number of capacitor patrols due to near real time data
    - Limiting number of customer voltage complaints
    - Potentially extending life of existing capacitor switches
- Improved Distribution and Transmission Power Factor
    - Enhance System Stability
    - Enhance system volt/VAr response
    - Increase system efficiency

- Enabling component in advanced voltage management schemes

1.4.2 Voltage Management Program

Evergy is working on a territory wide voltage management program under our Grid Modernization initiative. The voltage management program will likely have consideration for the following voltage augmentation schemes:

- Peak Demand Management

- Conservation Voltage Reduction
- Volt-VAR Optimization
- Energy Efficiency

As the review process continues, main components of our evaluation will be as follows:

- Assessment of impact on intelligent grid assets e.g. capacitors, voltage regulators, Load Tap Changers (LTCs)
- Circuit, substation and system voltage management
- Improved process for adjusting intelligent grid asset set points
- Remote control of intelligent grid assets
- Functional and business impact of each voltage management scheme

This project will involve replacing electromechanical and non-communicating intelligent grid devices. These new devices will support standard industry specifications.

Section 2: Avoided Transmission and Distribution Cost[6]

The Evergy transmission projects included in the SPP regional planning processes for reliability improvement or economic benefits would not be impacted by the implementation of DSM (Demand Side Management) programs. Therefore, the only avoided cost for transmission facilities are the transmission equipment additions associated with distribution facility expansions.

2.1 Impact Of DSM on Distribution Expansion

Distribution Engineering's annual review of 15-year load projections indicate that loads for established urban areas of Evergy's service territory continue to flatten and more commonly, decline, which has reduced the need for load growth driven substation expansion projects in these areas. It is reasonable to assume that one of the drivers of decreasing load growth and peak demands in established areas are due to increasing energy efficient measures through (1) natural adoption by customers through replacement of older heating/cooling units, lighting, and other older appliances with newer energy efficient models and (2) wider customer adoption of DSM programs offered by Evergy, such as the residential smart thermostat program and other DSM programs targeted to residential and non-residential customers through the Missouri Energy Efficiency Investment Act (MEEIA), which began 10 years ago.

Another impact to consider is demand-side rates. Evergy received an order from the Missouri PSC to transition all residential customers to TOU rates in the fourth quarter of 2023. How those TOU rates may impact Evergy's transmission or distribution systems has not yet been evaluated.

In summary, while Distribution Engineering has not explicitly incorporated DSM programs as a resource to offset specific future distribution or substation capacity projects, it will continue to monitor opportunities to leverage targeted DSM as a cost-effective resource and review the impact of TOU rates.

[6] 20 CSR 4240-22.045 (2)

Section 3: Analysis of Transmission Network Pertinent to a Resource Acquisition Strategy[7]

3.1 Transmission Assessments[8]

3.1.1 Transmission Assessment for Congestion Upgrades[9]

SPP's Integrated Transmission Planning Process (ITP) is an annual planning cycle that assesses near- and long-term economic and reliability transmission needs. The ITP produces a ten-year transmission expansion plan each year, combining near-term, ten-year, and North American Electric Reliability Corporation transmission planning (TPL-001-4) compliance assessments into one study. A 20-year assessment is performed once every five years unless otherwise directed by the SPP Board of Directors. The ITP process seeks to target a reasonable balance between long-term transmission investments and congestion costs to customers.

The 2023 Integrated Transmission Plan looked ahead 10 years to ensure the SPP region could deliver energy reliably and economically, facilitate public policy objectives, and maximize benefits to end-use customers. Three distinct scenarios were considered to account for variations in system conditions over ten years. These scenarios considered requirements to support firm deliverability of capacity for reliability as well as exploring rapidly evolving technology that may influence the transmission system and energy industry. The scenarios included varied wind projections, utility-scale and distributed solar, energy storage resources, generation retirements and electric vehicles. Ultimately, the analysis resulted in the approval of a portfolio of 44 transmission projects across the SPP region at a cost of approximately $736 million. Eight projects were identified in the Evergy Metro area as part of the 2023 ITP.

3.1.2 Transmission Assessment for Advance Technologies[10]

Three distinct scenarios were considered to account for variations in system conditions over ten years. These scenarios considered requirements to support firm deliverability of

[7] 20 CSR 4240-22.045 (3)
[8] 20 CSR 4240-22.045 (3)(A)
[9] 20 CSR 4240-22.045 (3)(A)(1)
[10] 20 CSR 4240-22.045 (3)(A)(2)

capacity for reliability as well as exploring rapidly evolving technology that may influence the transmission system and energy industry. The scenarios included varied wind projections, utility-scale and distributed solar, energy storage resources, generation retirements and electric vehicles. Transmission upgrades were selected based on their ability to meet the varied needs identified in all scenarios.

3.1.3 Avoided Transmission Cost Estimate[11]

The Evergy transmission projects included in the SPP regional planning processes for reliability improvement or economic benefits would not be impacted by the implementation of DSM programs. Therefore, the only avoided cost for transmission facilities are the transmission equipment additions associated with distribution facility expansions.

3.1.4 Regional Transmission Upgrade Estimate[12]

Table 4 below shows the SPP projected annual transmission revenue requirement allocated to Evergy Metro for regional transmission upgrades.

[11] 20 CSR 4240-22.045 (3)(A)(3)
[12] 20 CSR 4240-22.045 (3)(A)(4)

Table 4: SPP Projected ATRR Allocated to Evergy Metro

Year	Projected Region-Wide Revenue Requirement	Allocated to the EMe Zone	Allocation to the EMe Native System Load
2024	$575,310,639	$43,395,232	$37,788,334
2025	$626,558,255	$46,973,772	$40,904,506
2026	$716,539,564	$53,316,077	$46,427,351
2027	$752,576,696	$55,809,302	$48,598,439
2028	$734,261,524	$54,424,327	$47,392,409
2029	$710,189,540	$52,628,585	$45,828,687
2030	$686,117,174	$50,832,817	$44,264,942
2031	$662,029,163	$49,035,932	$42,700,224
2032	$637,941,151	$47,239,047	$41,135,506

The region-wide revenue requirement includes amounts for projects owned by Transource Missouri. Transource Missouri is a wholly-owned subsidiary of Transource Energy, LLC, which is a joint venture between transmission holding company subsidiaries of Evergy and American Electric Power ("AEP"). Evergy owns 13.5 percent of Transource Energy and AEP owns the other 86.5 percent.

3.1.5 Revenue Credits Estimate[13]

The table below shows the region-wide 2024 revenue requirement for the SPP-directed projects owned by Evergy Metro.

[13] 20 CSR 4240-22.045 (3)(A)(5)

Table 5: Region-Wide Revenue Requirements for SPP Projects Owned by Evergy Metro

Evergy Metro SPP-Directed Projects	2024 Region-Wide Revenue Requirement
Projects with NTCs issued prior to June 19,2010	
Tomahawk-Bendix Reconductor	$29,853
West Gardner Autotransformer	$145,480
Stilwell-Antioch Reconductor	$63,960
Antioch-Oxford Reconductor	$43,113
Antioch-Oxford Reconductor Switches	$0
Reconductor Craig-College -161kV Line	$13,361
Mayview -Line Terminal Equipment to 600amps	$0
South Waverly Capacity Bank	$19,444
Craig Sub 161 kV Capacitor Bank	$50,235
Westar Energy - Reservation `	$3,428
Total	**$368,874**
Projects with NTCs issued after June 19,2010	
Swissvale-Stilwell Tap at W. Gardner	$263,998
Loma Vista E.-Winchester Jct -161kV	$6,170
W. Gardner Line Terminals	$48,606
Total	**$318,774**
Projects with a Need Date after October 1, 2015	
Craig 161 kV Breaker	$10,716
Leeds 161 kV Breaker	$13,935
Midtown 161 kV Breakers	$12,794
Southtown 161 kV Breakers	$65,547
Wolf Creek 345kV Terminal Equipment	$110,284
Leeds 161 kV Breaker	$8,233
Shawnee Mission 161 kV Breaker	$12,257
Southtown 161 kV Breaker	$15,902
Platte City 161kV Terminal Upgrade	$0
Shawnee Mission 161 kV Breaker	$60,212
Craig 161kV Breaker#2 (R5-33)	$16,067
Iatan Stranger 345kV Voltage Conversion	$221,298

Northeast-Charlotte-Crosstown -161kV Reactor	$7,892
Stilwell Relaying	$3,352
Brookridge-Overland Park 161kV Term Upgrades	$23,148
Sub - Olathe - Switzer 161kV Ckt1 Terminal Upgrades	$28,022
Total	**$609,659**
Total Evergy Metro SPP-Directed Projects	**$1,297,307**

3.1.6 Timing of Needed Resources Estimate[14]

The SPP 2023 ITP portfolio contained two economic projects in the Evergy Metro service territory – terminal equipment upgrades at the Craig and Lenexa South 161kV substations. These projects have a need date of 1/1/2025.

3.2 Use of RTO Transmission Expansion Plan[15]

See response to Section 3.1.1 above for description of SPP RTO transmission expansion planning processes.

3.2.1 Utility Participation in RTO Transmission Plan[16]

Evergy actively participates in the development of SPP transmission expansion plans through a number of related activities. These include participation in the Model Development Advisory Group (MDAG), the Transmission Working Group (TWG) and regional transmission expansion workshops.

Participation in the MDAG involves reviewing and updating the transmission planning models used for regional transmission expansion analysis. This includes adding Evergy transmission projects into the planning models and providing a substation level load forecast for the seasonal and future years planning models. The expected generation dispatch required to meet Evergy load requirements is also included in these models. These models form the basis for the reliability analysis needed to identify future transmission projects to maintain reliable service and reduce transmission congestion.

[14] 20 CSR 4240-22.045 (3)(A)(6)
[15] 20 CSR 4240-22.045 (3)(B)
[16] 20 CSR 4240-22.045 (3)(B)(1)

The Transmission Working Group (TWG) is responsible for development and oversight of regional and interregional transmission planning processes, including generator interconnection and long-term transmission service study processes, review of proposed transmission interconnections, and coordination of transmission planning activities necessary for the development of the SPP Integrated Transmission Plan and SPP Transmission Expansion Plan.

SPP hosts ITP workshops annually to get stakeholder input to the transmission planning process and provide analysis results for stakeholder review. The workshops allow SPP stakeholders to provide input on assumptions for economic analysis and review identified needs and proposed solutions selected by SPP. Evergy proposes projects through SPP's FERC Order No. 1000 process, reviews selected transmission projects in its area and coordinates with SPP regarding details within its area that may affect proposed solutions. In other instances, Evergy offers an operating guide to mitigate a transmission problem and avoid new transmission construction.

3.2.2 Annual Review of RTO Expansion Plans[17]

Evergy reviews transmission projects in its area, coordinates with SPP regarding details within its area that may affect proposed solutions, or requests restudy for projects that it believes are not required. Evergy planning personnel participate throughout the year within the planning process providing insight and review of the transmission plans. In some instances, Evergy may be able to offer an operating guide to mitigate a transmission problem and avoid or delay new transmission construction. Also, Evergy personnel participate in the overall approval of RTO expansion plans through the SPP approval process within the Markets and Operation Policy Committee and Members Committee.

3.2.3 Annual Review of Service Territory Expansion Plan[18]

Evergy reviews transmission plans and projects within its service territory that develop through the SPP RTO transmission expansion plan. Many are zonal projects providing

[17] 20 CSR 4240-22.045 (3)(B)(2)
[18] 20 CSR 4240-22.045 (3)(B)(3)

additional obligations to serve or meet specific planning and bulk electric reliability criteria. For region-wide project sets identified through the SPP Integrated Transmission Planning process, projects meet a wide range of needs including reduced production costs, reduced congestion, reduced system losses and base reliability needs.

3.2.4 Documentation and Description of Annual Review of RTO Overall and Utility-Specific Expansion Plans[19]

Evergy reviews transmission projects in its area and coordinates with SPP regarding details within its area that may affect proposed solutions or requests restudy for projects that it believes are not required. Evergy planning personnel participate throughout the year within the planning process providing insight and review of the transmission plans. In some instances, Evergy may be able to offer an operating guide to mitigate a transmission problem and avoid or delay new transmission construction. Also, Evergy personnel participate in the overall approval of RTO expansion plans through the SPP approval process within the Markets and Operation Policy Committee and Members Committee.

3.2.5 Affiliate Build Transmission Project Discussion[20]

Transource Energy, LLC ("Transource"), a joint venture between Evergy and American Electric Power ("AEP"), was created to build and invest in transmission infrastructure. Transource will pursue competitive transmission projects in the SPP region, the MISO and PJM regions, and potentially other regions in the future. Evergy owns 13.5 percent of Transource and AEP owns the other 86.5 percent of Transource.

At this point, it is Evergy's intent to pursue, develop, construct, and own through its interest in Transource – rather than through Evergy Metro and/or Evergy Missouri West – any future competitive regional and inter-regional transmission projects subject to regional cost allocation. While it is premature to determine the specific impact on the regionally allocated costs resulting from constructing projects within Transource, it is anticipated that the partnership between Evergy and AEP will provide for a financially

[19] 20 CSR 4240-22.045 (3)(B)(4)
[20] 20 CSR 4240-22.045 (3)(B)(5)

strong, cost-competitive, and technically-proficient transmission development entity. The scale, execution experience, and engineering expertise that Transource expects to be able to bring to the projects should provide benefits to customers through lower construction costs, better access to capital, and operational efficiencies.

3.3 RTO Expansion Plan Information[21]

The following SPP regional transmission planning reports are provided as attachments to this report:

- 2023 SPP Integrated Transmission Planning Assessment Report
- 2024 SPP Transmission Expansion Plan Report
- 2024 SPP Transmission Expansion Plan Report Appendix 1

The 2023 SPP Integrated Transmission Planning Assessment is described in Section 3.1.1 above. The 2024 SPP Transmission Expansion Plan (STEP) Report and Project List summarize 2023 activities that impact future development of the SPP transmission grid. Eight distinct areas of transmission planning are discussed in this report, although studies were not completed in all areas in 2023: Transmission Services, Generation Interconnection, Transmission Planning, Balanced Portfolio, High Priority Studies, Sponsored Upgrades, Interregional Coordination, and the 20-Year Assessment.

3.4 Transmission Upgrades Report[22]

3.4.1 Physical Interconnection Within RTO[23]

It is not possible to provide a specific list of transmission upgrades needed to physically interconnect a generation resource within the SPP footprint. Any generation interconnection request within the SPP must proceed through the generation interconnection process as defined by the SPP transmission tariff. That process will examine the specific location proposed for generator interconnection and develop the necessary transmission upgrades needed at that location.

[21] 20 CSR 4240-22.045 (3)(C)
[22] 20 CSR 4240-22.045 (3)(D)
[23] 20 CSR 4240-22.045 (3)(D)(1)

3.4.2 Deliverability Enhancement Within RTO[24]

In the SPP, requests for firm transmission service are processed through the Aggregate Facility Study (AFS) process. The AFS process is performed two times per year by collectively analyzing specific transmission service requests, including those associated with generation interconnection requests, across the entire SPP footprint. These service reservations are modeled based on control area to control area transfers. The transmission system is assessed with these potential service requests and, where needed, transmission improvements are identified that would enable the service to occur without standard or criteria violations. All transmission customers are allocated cost responsibility for portions of the various upgrades needed to deliver all of the transmission service requests. Transmission customers may adjust their conditions following the posting of the preliminary results if their initial conditions were not met; otherwise, the request will be considered withdrawn. This is an iterative process until all conditions are met. The remaining transmission customers with service requests in the process agree to the projects needed to deliver the remaining transmission service and share the resulting upgrade costs. Those remaining upgrade projects are included in the next SPP transmission expansion planning process.

Because of the iterative nature of the Aggregate Facility Study process, it is not possible to identify specific transmission upgrades needed to deliver energy from a resource in the RTO footprint to Evergy until the process for a specific transmission service request has been completed.

3.4.3 Physical Interconnection Outside RTO[25]

It is not possible to develop a list of specific upgrades needed to interconnect a generation resource located outside the SPP without making a generation interconnection request at a specific location.

3.4.4 Deliverability Enhancement Outside RTO[26]

It is not possible to develop a list of specific upgrades needed to deliver capacity and energy from a generation resource located outside the SPP without making a generation

[24] 20 CSR 4240-22.045 (3)(D)(2)
[25] 20 CSR 4240-22.045 (3)(D)(3)
[26] 20 CSR 4240-22.045 (3)(D)(4)

interconnection request and an associated transmission service request at a specific location.

3.4.5 Estimate of Total Cost[27]

A list of Evergy Metro transmission projects included in the 2024 SPP Transmission Expansion Plan (STEP) as a result of the 2023 ITP assessment is shown in the table below.

Table 6: Evergy Metro Transmission Upgrades 2023 SPP ITP

Transmission Project	Cost Estimate	Project Type	Need Date
Craig 161 kV Ckt 2 Terminal Upgrade	$1,329,162	Economic	1/1/2025
Lenexa South 161 kV Ckt 2 Terminal Upgrade	$1,329,161	Economic	1/1/2025
Blue Valley 161 kV Breaker #1	$310,000	Regional Reliability	6/1/2024
Craig 161 kV Breaker #1	$609,491	Regional Reliability	6/1/2024
Craig 161 kV Breaker #3	$609,490	Regional Reliability	6/1/2024
Craig 161 kV Breaker #4	$609,491	Regional Reliability	6/1/2024
Craig 161 kV Breaker #5	$609,491	Regional Reliability	6/1/2024
Craig 161 kV Breaker #6	$609,492	Regional Reliability	6/1/2024

Total estimated construction cost for these transmission upgrades is $6,015,778.

[27] 20 CSR 4240-22.045 (3)(D)(5)

3.4.6 Cost Estimates[28]

A list of Evergy transmission projects included in the 2024 SPP STEP as a result of the 2023 ITP Assessment and the portion of their estimated cost allocated to Evergy Metro is shown in the table below.

Table 7: Transmission Upgrade Cost Allocated to Evergy

Transmission Project	Cost Estimate	Approx. % Allocation to Evergy Metro	Evergy Metro $
Craig 161 kV Ckt 2 Terminal Upgrade	$1,329,162	68.8%	$914,463
Lenexa South 161 kV Ckt 2 Terminal Upgrade	$1,329,161	68.8%	$45,658
Blue Valley 161 kV Breaker #1	$310,000	68.8%	$45,444
Craig 161 kV Breaker #1	$609,491	68.8%	$45,444
Craig 161 kV Breaker #3	$609,490	68.8%	$45,444
Craig 161 kV Breaker #4	$609,491	68.8%	$45,444
Craig 161 kV Breaker #5	$609,491	68.8%	$45,444
Craig 161 kV Breaker #6	$609,492	68.8%	$45,444

[28] 20 CSR 4240-22.045 (3)(D)(6)

Section 4: Advanced Technology Analysis[29]

4.1 Transmission Upgrades for Advanced Transmission Technologies[30]

Evergy will use advanced technologies such as Hybrid Structure Design, Solid Dielectric Cables, and Fiber Optic Shield Wire where applicable in transmission upgrades included in the SPP regional transmission expansion plan.

4.2 Distribution Upgrades for Advanced Distribution Technologies[31]

Evergy's ongoing grid modernization efforts are focused on the need to ensure the grid is reliable and flexible to meet our customers' needs. Out of that initiative, Evergy is focusing on the advanced distribution technologies below to support those needs.

- Advanced Distribution Management Systems (ADMS)
- Communicating Fault Circuit Indicators (CFCIs)
- Reclosers with communication

4.2.1 Advanced Distribution Management Systems

Evergy has started the process of implementing ADMS functionality beginning with Fault Location, Isolation and Service Restoration (FLISR). When fully deployed, ADMS can provide the following functions for system operators to manage the grid in a safe, intelligent, and efficient manner.

- Fault Location Isolation and Service Restoration (FLISR)
- Advanced Fault Location functionality utilization (FLA)
- Distribution Supervisory Control and Data Acquisition (D-SCADA)
- Power Flow Optimization
- Volt/Var Optimization (VVO)
- State Estimation

[29] 20 CSR 4240-22.045 (4)
[30] 20 CSR 4240-22.045 (4)(A)
[31] 20 CSR 4240-22.045 (4)(B)

Fault Location Isolation and Service Restoration

Evergy is actively deploying FLISR that uses a central application to communicate with and control smart switching with reclosers and communicating fault indicators.

A centralized FLISR engine will be used to drive the primary functions of our Intelligent End Devices (IEDs). These functions include Supervisory Control and Data Acquisition (SCADA) commands, automated FLISR actions, circuit / substation parameters and safety needs such as hold cards. In order to enable a hybrid (partially centralized, partially decentralized) approach, the IED will consume remote data while taking on some of the responsibility to adjust circuit protection settings, trip cycles and switching functions. This allows IEDs to have a subset of safe operational capabilities should communications be interrupted.

Centralized systems require little operator interaction during FLISR events. This allows the FLISR system to run quickly and effectively based on engineered algorithms. Operators will have ultimate authority over the system and will be able to disable and enable FLISR as needed.

Fault Location Analysis Functionality (FLA)

To enable automated fault location prediction, an advanced application is needed which requires accurate and persistently maintained circuit source impedance profiles, primary conductor impedance profiles, and communicating field equipment sensor data. This sensor data allows the application to model and calculate sections of a feeder where a fault is likely or unlikely to be physically located. Further improved fault location accuracy is attainable by installing additional fault sensors (such as communicating fault circuit indicators or communicating switches) on the circuit to compliment the model with more physical and logical sensor data points in coordination with smart meter integration.

The Company's current fault location solution is an internally engineered application for circuit and data modeling that exists alongside the Company's Outage Management System (OMS), granting capability to leverage system integrations and data which do not necessarily exist or need to exist within the OMS platform itself. This independent application models and calculates fault location using similar methods and equations to an advanced vendor supplied engineering distribution system modeling platform which is leveraged by several engineering departments for various routine system load flow analyses and ad-hoc system studies such as arc-flash. The internally created FLA application has been validated in producing actionable solutions for actual outage events to aid crew and operators in reduction of outage duration.

Benefits anticipated from Fault Location prediction are mainly reduced patrol time for field crews in event location identification during outage events, and the ability to identify and trend momentary faulting events enabling the Company to remedy emergent issues prior to their severity producing a sustained outage event. With a near real-time FLA solution produced for an outage event, dispatchers can immediately direct field crews to focus on specific predicted sections of circuit as opposed to crews needing to patrol an entire circuit to identify the specific location of a system fault.

No specific timeline has been established, but the Company intends to further expand FLA solutions beyond the current state by fully configuring the system impedance model within the OMS application and aggregating in the required field data as a parallel FLA effort, which will enable further validation and model calibration of the two FLA systems in contrast to one another. Success of this planned effort is dependent on OMS system capability plus successful integration and testing of model comparisons and prescribed event solutions.

Communicating Fault Circuit Indicators (CFCI)

Evergy is perpetually evaluating emerging CFCI technologies and installing where enhancements benefit grid resiliency and reliability.

Dispatchers now have the ability to receive CFCI alarms and activity in OMS. Using the OMS One-line diagram, Operators use CFCIs while troubleshooting an outage. This greatly enhances the “visibility” and usefulness of CFCIs to dispatchers.

CFCIs are also anticipated to be a cost-effective way to enhance the Fault Location functionality discussed previously. Although CFCIs cannot perform switching operations, they can enhance the effectiveness of dispatching and manual switching. To date, over 7,000 CFCIs have been installed in the Evergy service territory.

Reclosers with Communication

Evergy is currently deploying reclosers configured to support FLISR. These devices function like a traditional reclosers with the benefit of being able to communicate with a centralized FLISR application for coordination and action. Additionally, these devices can be used by an operator in our dispatch center.

Regulators and Capacitors with Communication

Evergy is working to upgrade as needed our Regulators and Capacitors with communication to support our VVO planned work. Evergy currently has these assets deployed, however they currently can only react to pre-planned events at the time the asset is deployed. This change will allow us to use automation and intelligence to manage the system to a greater degree.

Load Tap Changers with Communication

Similar to Regulators and Capacitors Evergy is upgrading Load Tap Changers (LTCs) as needed to add communications and controls for these devices. They will support VVO by enabling control of system voltage. Evergy currently has these assets deployed however they currently can only react to pre-planned events at the time the asset is deployed. This change will allow us to use automation and intelligence to manage the system to a greater degree.

4.3 Optimization of Investment in Advanced Transmission and Distribution Technologies[32]

4.3.1 Optimization of Investment – Total Costs and Benefits[33]

Distribution Analysis

Evergy's advanced distribution technologies program outlines a substantial commitment to upgrading both hardware and software components. This program is poised to deliver considerable savings across various operational facets, encapsulated in three main categories:

Truck Roll Savings: The adoption of advanced distribution technologies such as FLISR and communicating devices like faulted circuit indicators and reclosers is anticipated to significantly reduce the necessity for dispatching field crews for fault location and service restoration. This reduction is expected to lower operational costs associated with vehicle deployment, fuel, labor, and the associated time.

VVO Energy Efficiency Benefits: The program's investment in Volt/Var Optimization (VVO) through enhanced regulators, capacitors, and load tap changers with communication capabilities is expected to result in notable energy efficiency benefits. VVO aims to optimize voltage and reactive power flow in the distribution network, leading to decreased energy consumption, minimized losses, and improved power quality, which collectively contribute to considerable operational savings.

Reliability Benefits: The comprehensive enhancement of grid reliability through these advanced technologies is projected to yield significant benefits. Improved reliability can lead to fewer outages, shorter outage durations, and better service

[32] 20 CSR 4240-22.045 (4)(C)

[33] 20 CSR 4240-22.045 (4)(C)(1); 20 CSR 4240-22.045 (4)(C)(1)(A); 20 CSR 4240-22.045 (4)(C)(1)(A); 20 CSR 4240-22.045 (4)(C)(1)(B); 20 CSR 4240-22.045 (4)(C)(1)(C); 20 CSR 4240-22.045 (4)(C)(1)(D); 20 CSR 4240-22.045 (4)(C)(2); 20 CSR 4240-22.045 (4)(C)(2)(A); 20 CSR 4240-22.045 (4)(C)(2)(B); 20 CSR 4240-22.045 (4)(C)(2)(C); 20 CSR 4240-22.045 (4)(C)(3); 20 CSR 4240-22.045 (4)(C)(3)(A); 20 CSR 4240-22.045 (4)(C)(3)(B); 20 CSR 4240-22.045 (4)(C)(3)(C); 20 CSR 4240-22.045 (4)(C)(3)(D); 20 CSR 4240-22.045 (4)(C)(4); 20 CSR 4240-22.045 (4)(C)(5); 20 CSR 4240-22.045 (4)(D)(2); 20 CSR 4240-22.045 (4)(E)

quality, which may result in reduced compensations, penalties, and enhanced customer satisfaction.

4.4 Non-Advanced Transmission and Distribution Inclusion[34]

4.4.1 Non-Advanced Transmission and Distribution Required Analysis[35]

Distribution

Evergy is not proposing any new non-advanced distribution grid technologies or programs in this triennial IRP compliance filing.

Evergy understands that prior to including new non-advanced distribution grid technologies in future IRP filings, Evergy will conduct, describe, and document an analysis which demonstrates that investment in each non-advanced distribution upgrade is more beneficial to consumers than an investment in the equivalent upgrade incorporating advanced grid technologies. Evergy further understands that we may present a generic analysis as long as we verify its applicability.

4.5 Advanced Transmission and Distribution Required Cost-Benefit Analysis[36]

4.5.1 Historical Advanced Grid Technology Deployments in Distribution[37]

The distribution grid in place at Evergy today is substantially "smart" having benefited from decades of power engineering expertise and adoption of relevant technology enhancements. The existing systems already execute a variety of sophisticated system operations and protection functions. Much of the automation has been accomplished through embedding incremental technological advancements into Evergy's asset and construction standards. The following sections describe many of the advanced distribution technologies that have and are currently being implemented at Evergy.

[34] 20 CSR 4240-22.045 (4)(D)
[35] 20 CSR 4240-22.045 (4)(D)(1); 20 CSR 4240-22.045 (4)(D)(2)
[36] 20 CSR 4240-22.045 (4)(E)
[37] 20 CSR 4240-22.045 (4)(E)(1)

Evergy SmartGrid Demonstration Project

Evergy's SmartGrid Demonstration Project deployed an end-to-end SmartGrid (within Kansas City, MO) that provided a wide array of technologies and components. These were grouped into five (5) major sectors: Smart Distribution, Smart Metering, Interoperability and Security, Smart End-Use and Smart Generation. The DOE portion of the project was completed in 2015, with decommissioning of immature technologies through mid-2016. The final report was filed with the DOE in 2016. Please reference Evergy Smart Grid Project [i] for additional details.

4.5.1 Distribution Advanced Grid Technologies Impact Description[38]

Evergy will be taking steps under its Grid Modernization Initiative to implement various modules under our ADMS plan. The main near-term focuses are on automated switching and voltage management schemes. These schemes will execute automation engines like Fault Location Isolation and Service Restoration (FLISR) and peak demand management. In addition to these automation engines, upgraded SCADA applications will be implemented to coincide with the automation schemes enabling components of advanced grid technologies.

4.5.2 Transmission Advanced Grid Technologies Impact Description[39]

Evergy generation resource additions interconnecting at the transmission level (>60 kV) within the Southwest Power Pool (SPP) region would be evaluated through the SPP Generation Interconnection process as detailed in their Federal Energy Regulatory Commission (FERC) approved open access transmission tariff. The interconnection process includes detailed transmission studies and interconnection estimates for connecting to and using the SPP transmission system. Resource additions would also have to go through the SPP Aggregate Facility Study process to obtain firm transmission service for delivery of generation to load. Advanced grid technologies necessary to enable resource acquisitions would be evaluated and identified through that process.

[38] 20 CSR 4240-22.045 (4)(E)(2)
[39] 20 CSR 4240-22.045 (4)(E)(3)
[i] https://www.smartgrid.gov/recovery_act/program_impacts/regional_demonstration_technology_performance_reports

Section 5: Utility Affiliation[40]

Transource Energy, LLC ("Transource"), a joint venture between Evergy and American Electric Power ("AEP"), was created to build and invest in transmission infrastructure. Transource will pursue competitive transmission projects in the SPP region, the MISO and PJM regions, and potentially other regions in the future. Evergy owns 13.5 percent of Transource and AEP owns the other 86.5 percent of Transource.

At this point, it is Evergy's intent to pursue, develop, construct, and own through its interest in Transource – rather than through Evergy Metro and/or Evergy Missouri West – any future competitive regional and inter-regional transmission projects subject to regional cost allocation. While it is premature to determine the specific impact on the regionally allocated costs resulting from constructing projects within Transource, it is anticipated that the partnership between Evergy and AEP will provide for a financially strong, cost-competitive, and technically-proficient transmission development entity. The scale, execution experience, and engineering expertise that Transource expects to be able to bring to the projects should provide benefits to customers through lower construction costs, better access to capital, and operational efficiencies.

[40] 20 CSR 4240-22.045 (5)

Section 6: Future Transmission Projects[41]

SPP is scheduled to complete another ITP assessment in 2024, but projects are not yet under consideration.

[41] 20 CSR 4240-22.045 (6)