Ameren Illinois
Voltage Optimization Plan

January 25, 2018

1. Executive Summary

Under 220 ILCS 5/8-103B(b-20) of the Future Energy Jobs Act ("FEJA," SB 2814, 2016), Ameren Illinois Company d/b/a Ameren Illinois is required to file "a plan with the Commission that identifies the cost-effective voltage optimization investment the electric utility plans to undertake through December 31, 2024." The statute requires that Ameren Illinois file its voltage optimization plan (the "VO Plan") within 270 days of the effective date of FEJA, or by February 26, 2018.

"Voltage optimization measures" are included in the overall "energy efficiency" definition in the IPA Act at 20 ILCS 3855/1-10, and described as "measures that optimize the voltage at points on the electric distribution voltage system and thereby reduce electricity consumption by electric customers' end-use devices." Ameren Illinois defines Voltage Optimization ("VO") as a combination of Volt/VAR Optimization ("VVO") and Conservation Voltage Reduction ("CVR"), which are implemented to first reduce the VAR flows on a circuit, and then lower the voltage to reduce end-use customer energy consumption and utility distribution system losses. VVO optimizes capacitor bank operations to improve power factor and reduce system losses. CVR utilizes voltage regulators, transformer load tap changers, and capacitors to control and reduce end-user voltages, which, in turn, lowers customers' energy consumption.

Ameren Illinois' VO team identified distribution circuits' average delivered energy[1] and categorized those circuits by operating voltage levels. The team then researched, studied, and analyzed industry accepted methodologies that could be used to quantify potential cost-effective VO energy savings of the entire Ameren Illinois distribution network. The result of these efforts is this VO Plan. The VO Plan incorporates a Total Resource Cost (TRC) analysis consistent with Ameren Illinois' energy efficiency plan to determine the cost-effectiveness of VO deployment on each individual circuit. At a very high level, a TRC analysis compares total resource costs (capital and O&M investments) to total resource benefits (primarily energy savings achieved by customers). When a project's total benefit exceeds total costs, the project is considered cost-effective, using the TRC methodology.

- **Key Findings**
  - A VO program deployment on Ameren Illinois' distribution network has the potential to cost-effectively achieve energy savings of an estimated 422 GWh per year by the end of 2025 and has a Plan TRC of 1.36.
  - These VO measures statutorily have a 15-year useful life for purposes of claiming energy savings; thus, AIC is committed to ensuring the VO program continues to produce savings through 2039 for those circuits deployed in 2024.

[1] Average delivered energy on a circuit is based on the customers currently served from the circuit using billing data for the years 2014-2016.

- The population of cost-effective candidate circuits for the VO program deployment is currently estimated at 1,047 circuits, which corresponds to approximately 64% of Ameren Illinois' customers.

- Ameren Illinois will annually refine the appropriateness and timing of deployment of each of these VO candidate circuits using detailed engineering studies and analysis, to achieve its yearly savings targets.

- The cost-effective VO program investment is estimated at approximately $122 million over the period of years 2017-2024. All reasonable and prudently incurred costs, fees, and charges, including, but not limited to, capital and associated O&M costs associated with this VO Plan shall be recovered under the provisions of Section 16-108.5.[2]

- **Approach**

  Ameren Illinois' approach for the VO Plan was designed using proven industry standards for estimating and quantifying cost-effective energy savings on Ameren Illinois' distribution network. Ameren Illinois relied on its previous VO pilot project experiences, recent industry VO activities, as well as recommendations from leading VO experts to create the VO Plan.

  Ameren Illinois' VO Plan has the following attributes:

  - Ameren Illinois, consistent with other EE programs, will use a TRC analysis as the main tool to determine the cost-effective VO circuits.

  - Ameren Illinois used voltage level as the primary criteria for establishing the initial pool of potential candidate circuits to analyze. Circuits served by voltage levels greater than 20 kV are not considered candidates for VO implementation. Based on this criteria, 2,474 distribution circuits were considered for further analysis.

  - Ameren Illinois used a CVR factor of 0.8 and an average voltage reduction of 3% to estimate the end-use customer energy savings per circuit. Ameren Illinois' CVR factor and percent voltage reduction are based on its VO pilot project results, recent VO industry findings, as well as VO industry expert recommendations. This approach of estimating the energy savings per circuit was used in the analysis.

  - This Ameren Illinois VO Plan is being designed and implemented as an energy efficiency measure, consistent with FEJA. The VO functionality is intended to operate 24 hours a day, 365 days a year. The analysis, CVR factor, and

[2] Costs associated with this plan will continue to be recovered until fully recovered under provisions of Article IX, in the event Section 16-108.5 no longer applies.

estimated average voltage reductions are all based on these operating parameters. There will naturally be some demand reduction on some circuits during the 8760 hours of operation of the system in a given year, but the timing and amount of any demand reduction during AIC system peak has not been determined. Since the program is not designed to reduce peak demand, Ameren Illinois has not estimated the amount of peak demand reduction that will result from this VO deployment; thus, peak demand reduction has not been included as a benefit in the TRC analysis.

- The energy savings associated with the VO Plan can be categorized into two forms: end-use load reductions and distribution line loss reductions. The majority of the savings come from end-use load reductions. Consistent with Ameren Illinois energy efficiency filings, Ameren Illinois has included the benefit of line loss reduction of the VO program in the TRC analysis.

- From the 2,474 distribution circuits that are candidates for the analysis, potential energy savings per circuit was estimated using the actual average 2014-2016 delivered energy on the circuit based on connected metered electric energy, the 0.8 CVR factor, and the 3% voltage reduction established above.

- The average cost to implement VO on each circuit, including the necessary infrastructure upgrades, control and communication devices, and appropriate circuit enhancements, was estimated.

- These costs and energy savings were analyzed using a model to evaluate the TRC or benefit-cost ratio of each circuit. The TRC analysis identified 1,047 distribution circuits that are estimated to be cost-effective (TRC score equal to or greater than 1.0) for VO deployment, and these circuits make up the final candidate circuit population for the VO program.

- Based on the estimated 422 GWh-yr total energy savings on 1,047 distribution circuits that the VO program would yield, Ameren Illinois established energy savings targets and investment required to achieve these targets, for every year of the program.

- The 422 GWh-yr target is a percent annual cumulative persisting savings of 1.5% in 2025. This exceeds the cumulative persisting savings of 1.0% established in section 8-103B (b-20) of FEJA.

- The 1,047 cost-effective circuits are spread across Ameren Illinois' service territory, and provide service to communities identified as the top 20 Tier One[3], and to communities with populations below the poverty level.

- Ameren Illinois will use an initial-year voltage reduction analysis to determine the amount of energy savings achieved per implemented circuit. This initial-year proven reduction amount will be considered to occur each of the remaining 14 years of operation of the given circuit after confirming continued VO operation each year.

- Consistent with Ameren Illinois' Energy Efficiency programs, Ameren Illinois will use an independent third-party evaluation, measurement and verification evaluator to review implementation of the plan and confirm estimated savings were achieved.

- Starting in 2018, Ameren Illinois will conduct detailed engineering analysis to determine which circuits to implement in a given year. The detailed engineering analysis could result in a different number of circuits, higher or lower, being deployed with VO than outlined in this Plan; however, the Company is committed to meeting the savings targets outlined in this VO Plan and will adjust circuit deployments as necessary. Ameren Illinois' cadence for implementing the VO Plan for a given program year ***N***, is as follows:

  - Year ***N-2***: Detailed engineering analysis to determine:
    - Select circuits to meet target for year ***N***.
    - Complete detailed engineering analysis and design on enhancements selected circuits and determine associated costs.
  - Year ***N-1***: Construct and install VO upgrades per engineering design. Turn VO on and place into service.
  - Year ***N***: 1st full year of VO operation on selected circuits. Measure and record average voltage reduction on circuits.
  - Year ***N+1***: Calculate energy savings and report on savings achieved in Year ***N***.

- **Results**

  The VO TRC benefit-cost analysis estimated the total potential cost-effective energy savings for the VO program to be 422 GWh-yr. These results are based on total investment cost of approximately $122 million, to implement VO on 1,047 distribution circuits. It is also estimated that the yearly O&M costs to operate and maintain the VO program is $7.4 million upon full deployment. A summary of the estimated VO plan results are presented in Tables 1 & 2, and Figure 1, below.

[3] As defined in the "Impact and Process Evaluation of the 2016 (PY9) Ameren Illinois Company Home Efficiency Income Qualified Program", dated December 28, 2017, by Opinion Dynamics.

	VO Plan Results
Estimated VO Savings Potential (Energy MWh/yr)	421,568
Estimated Number of Cost-Effective VO Circuits	1,047
Number of Customers Served by Estimated Cost-Effective VO Circuits	763,958
Average Energy Savings (MWh/yr) per Estimated Cost-Effective Circuit	403
Estimated VO Investment Cost	$122 M
Average VO Deployment Cost per Estimated Cost-Effective Circuits	$ 116,642

Table 1. Summary of VO Program

Year Ending	2018	2019	2020	2021	2022	2023	2024	2025
Estimated Cumulative Persisting Annual Savings (MWh)	0	7,650	59,994	128,433	201,725	275,006	348,287	421,568
% Cumulative Persisting Annual Savings	0%	0.03%	0.21%	0.46%	0.72%	0.98%	1.25%	1.50%
Estimated Incremental # of Circuits Deployed	19	130	170	182	182	182	182	0
Estimated Incremental Construction Cost (Capital Cost)	$2M	$14M	$18M	$19M	$19M	$19M	$19M	$0
Estimated Incremental Total Investment Cost (Construction Capital, Construction O&M, Upfront Capital)	$5M	$17M	$20M	$20M	$20M	$20M	$20M	$0

Table 2. Summary of Ameren Illinois' roll-out plan for the VO program

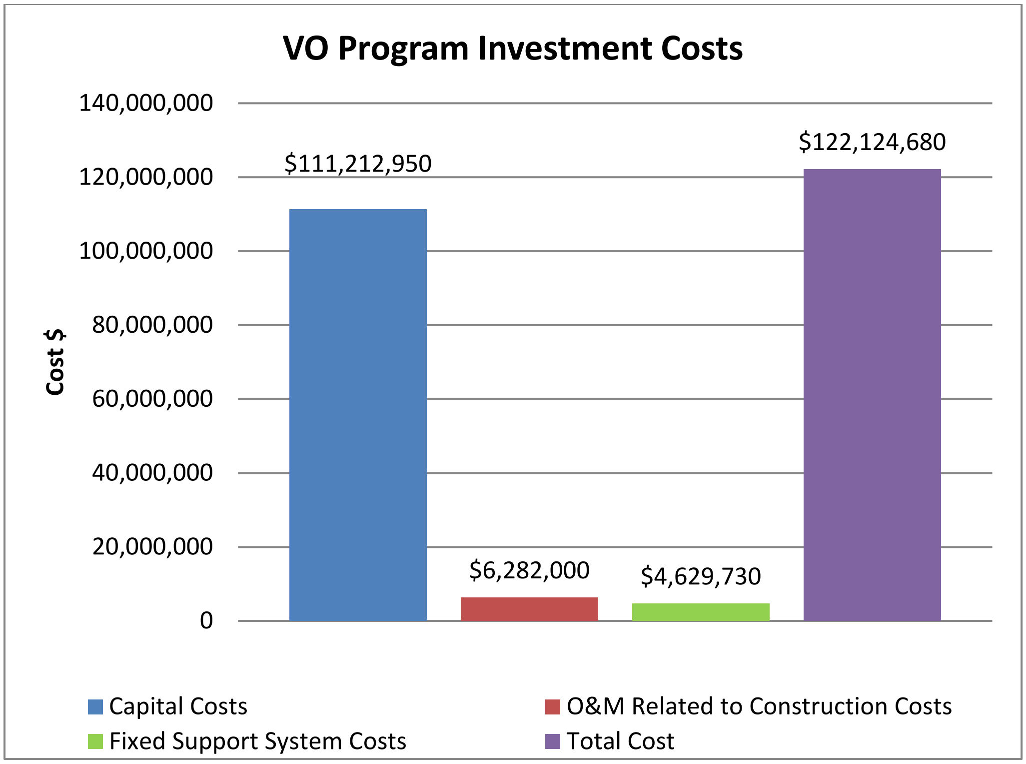

Figure 1. Ameren Illinois VO Investment Costs

Three considerations:

1. The estimated 1.5% of cumulative persisting annual savings after full deployment is based on the total normalized sales of electric power and energy during the calendar years 2014-2016 of 27,960 GWh, after excluding energy delivered to exempt customers identified as of September 1, 2017. If this baseline value is adjusted, the estimated persistent savings percentage will change as well.

2. As part of its EIMA Infrastructure Investment Plan, Ameren Illinois was already in the process of deploying VO on 19 circuits in 2017-2018. Ameren Illinois will incorporate these initial 19 circuits as its initial deployment of its FEJA VO Plan. Ameren Illinois will use these 19 circuits to gain experience designing, implementing, and operating a VO system, as well as determine which of three VO management software systems to use for the remainder of the deployment. Commensurate with an approved VO Plan, Ameren Illinois will begin engineering analysis in 2018 on the circuits it will deploy in 2019.

3. Table 2 shows the estimated number of circuits to be deployed and the estimated capital spend each year. Verification of achieved voltage reductions and realization of savings will occur in the year after deployment. For example, for the year 2020, Ameren Illinois plans to deploy an estimated 130 circuits at an estimated capital spend of approximately $14 Million in

2019, so that by the end of year 2020, an estimated 59,994 MWh are saved and the 0.21% persisting savings target is met.

2. Introduction

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"Voltage optimization measures" are included in the overall "energy efficiency" definition in the IPA Act at 20 ILCS 3855/1-10, and described as "measures that optimize the voltage at points on the electric distribution voltage system and thereby reduce electricity consumption by electric customers' end-use devices." Ameren Illinois defines Voltage Optimization ("VO") as a combination of Volt/VAR Optimization ("VVO") and Conservation Voltage Reduction ("CVR"), which are implemented to first reduce the VAR flows on a circuit, and then lower the voltage to reduce end-use customer energy consumption and utility distribution system losses. VVO optimizes capacitor bank operations to improve power factor and reduce system losses. CVR utilizes voltage regulators, transformer load tap changers and capacitors to control and reduce end-user voltages, which, in turn, lowers customers' energy consumption.

In subsequent sections, Ameren Illinois will provide information on pilot and initial projects that support its VO Plan, identify the goals Ameren Illinois seeks to accomplish with its VO investments, and then identify the VO investments selected to accomplish those goals. Each planned VO investment is then evaluated under the "total resource cost test" or "TRC test," and the results of those TRC tests are summarized. Ameren Illinois explains the estimated "cumulative persisting annual savings" for the VO measures, and how the measures will fit with the savings goals established pursuant to Section 8-103B. The overall schedule for VO measures, or overall VO Plan, is then established. Ameren Illinois concludes by describing the data collection process for the VO Plan, the evaluation, measurement, and verification (EM&V) process, and the process for Ameren Illinois to report results to the Illinois Commerce Commission ("ICC").

3. Background

Ameren Illinois has been piloting and investing in voltage control and management technologies for many years. More recently, since 2012, Ameren Illinois began testing and implementing specific VO approaches and technologies which will be explained further below.

3.1 Pilot VO Project

In Docket 10-0568, the ICC ordered Ameren Illinois to conduct a pilot VO project ("Pilot VO Project") to determine the benefits of wider adoption of an Ameren Illinois' VO program. Docket 10-0568, Dec. 21, 2010 Order, at 28. As part of that Docket, the ICC ordered Ameren Illinois to conduct a conservation voltage reduction pilot to test the feasibility of kWh and kW reduction from reduced voltage. The Pilot was conducted from 2012-2013.

Under Ameren Illinois' Pilot VO Project, Ameren Illinois employed CVR on four AIC circuits – the Mt. Zion substation circuit 173, and the Peoria University substation circuits 01, 03, 04. The results of the CVR Pilot Program resulted in determination of a CVR factor that relates percentage change in energy delivered to percentage change in voltage. The average CVR factor was 0.97 and 0.44 for the Mt. Zion test for the summer and fall, respectively. The average CVR factor for the University test was found to be 0.7 and 1.24 for summer and fall, respectively. These values are within the range of CVR factors reported in other industry CVR project results.

Substation	Summer CVRf	Fall CVRf	Average
Mt. Zion	0.97	0.44	0.71
University	0.78	1.24	1.01

Table 3. Ameren Illinois CVR Pilot Results

3.2 Primary Distribution Volt/VAR Control Infrastructure Investment Program

In addition to the CVR pilot discussed above, as part of its EIMA Infrastructure Investment Plan, AIC developed a primary distribution Volt/VAR program. The intent of this program is to provide for Dynamic Voltage Control and optimal Reactive Power flow (Volt/VAR Control or Volt/VAR Optimization) on select primary distribution circuits. Phase 1 (2013 engineering with 2014 construction) focused on ensuring all switched low voltage distribution capacitors in the Metro-East area that were controlled by an obsolete system would interact with the new ADMS (Advanced Distribution Management System). Phase 2 (2016/2017 engineering with 2017/2018 construction) is an initial implementation of the VO deployment across 19 AIC primary distribution level (<15kV) circuits by controlling switching capacitor banks, voltage regulators, and transformer load tap changers (LTCs) using a VO computerized control technology solution. This second phase will also focus on the evaluation of three voltage optimization vendor software control solutions for the further voltage optimization deployment. Since AIC plans to have these initial 19 circuits operable in 2018, these circuits will be incorporated as the initial circuits implemented as part of AIC's VO Plan.

Substation	Circuit	Software
Northwest Ckt 002	B00002	Vendor 1
Northwest Ckt 003	B00003	Vendor 1
Quincy 24th & Cherry Lane Ckt 556	V40533	Vendor 2
Quincy 28th & Adams Ckt 533	V42556	Vendor 2
Limit Ckt 015	D31015	Vendor 1
Ridge Ckt 002	C52002	Vendor 1
Ridge Ckt 001	C52001	Vendor 1
Shelbyville Ckt 500	Y79500	Vendor 2
Charleston S. EIU Ckt 501	K11376	Vendor 1
Bethalto Ckt 377	J34377	Vendor 2
Bethalto Ckt 357	J34357	Vendor 2
Caseyville Gardens Ckt 376	K11376	Vendor 1
E. Belleville Ckt 132	L93132	Vendor 2
Belleville 44th Ckt 140	J83140	Vendor 2
Mt. Zion Rt121	P69173	Vendor 3
Quincy 30th & Hampshire	V42572	Vendor 3
Tuscola East	Y98532	Vendor 3
Quincy 36th & College	V45574	Vendor 3
Mt. Vernon 27th St	P58155	Vendor 3

Table 4. Ameren Illinois Primary Distribution Volt/Var Control Infrastructure Program and Initial VO Deployment Circuits

3.3 Goals of VO Plan

A primary objective of this VO Plan is to identify and provide the roadmap to implement the cost-effective voltage optimization investment that AIC plans to undertake through December 31, 2024, as well as outline the reporting and evaluation, measurement, and verification methodology that will be used. Ameren Illinois' approach to identify viable, cost-effective circuits, estimate potential energy savings for the candidate population per viable VO feeder, TRC analysis for viable VO feeder, deployment and implementation schedule per year, and reporting and evaluation, measurement, and verification analysis, is detailed in the sections below.

4. The VO Plan

This plan provides a detailed description of the approach used to perform VO assessment of Ameren Illinois' distribution network to determine energy savings potential and associated costs. Prioritization methods, assumptions, related formulations and process steps are described.

Ameren Illinois' VO Plan was designed using:

1. Proven industry-standard engineering methods that have been used at other utilities similar to Ameren.

2. Reliable analysis and financial modeling techniques that provide representative and reasonable program level VO benefits and costs, consistent with other regulatory proceedings.

3. Reviewed and supported by the collective experience of Accenture consulting services.

4.1 Candidate Feeder Selection

Ameren Illinois operates a high-voltage distribution system (a.k.a. subtransmission system), with voltage levels 34.5kV and 69kV. The subtransmission system at Ameren Illinois includes networked lines, with multiple sources serving low-voltage distribution substations and some industrial customers. Ameren Illinois' distribution system directly serves most of Ameren Illinois' residential, commercial and small industrial customers. This system operates at voltages less than 34.5kV. The most common distribution voltage levels are 4.16kV and 12.47kV.

Ameren Illinois' bulk-supply subtransmission system was excluded from consideration for VO deployment, due to the following reasons:

1. Ameren Illinois' subtransmission system serves a small number of customers that are predominantly industrial customers.

2. Many portions of Ameren Illinois' subtransmission system are networked[4], making VO operation unviable.

3. A substantial number of subtransmission lines have no controllable voltage devices, such as a substation transformer with LTC.

Based on the information above, Ameren Illinois' population of candidate circuits for VO deployment is based on the evaluation of 2,474 distribution circuits through a total resource cost (TRC) analysis, which uses estimated per feeder deployment costs and estimated feeder benefits/savings. This will be explained in more detail under the "TRC Methodology" section.

[4] "Ameren Illinois Utilities Electric Subtransmission System Planning Criteria and Guidelines", Electric Planning Standard No.1, Transmission & Distribution Design Department, Energy Delivery Technical Services 2015.

4.2 Estimation of Energy Reduction

Consistent with FEJA, Ameren Illinois' VO Plan is being designed and implemented as an energy efficiency measure, and has not considered peak demand reduction as a benefit of the program. Therefore, for the purposes of this plan, Ameren Illinois considers the term "load" to be consistent with the term "energy".

The energy savings from CVR is the product of three key parameters:

$$Energy\ Savings\ (kWh) = Load \cdot CVR_f\ \cdot\ \Delta V$$

Where:

- $Load$: is the load expressed as energy (kWh) prior to VO implementation
- CVR_f: is the factor which represents the percent change in load for each percent change in voltage
- ΔV: is the percent change in average voltage on a circuit as a result of VO implementation

Determination of these three values drives the estimated energy savings calculations. These items are addressed for the Ameren Illinois' VO program in the sections below.

Load

Baseline loads used to estimate energy savings per circuit for the VO Plan are defined below:

- *Ameren Illinois Program Baseline Load:* Ameren Illinois' average delivery of energy during the calendar years 2014-2016 was 36,900 GWh. This value was then reduced to exclude energy delivered during the same time period to exempt customers, resulting in the baseline of 27,960 GWh. The baseline is the basis for AIC's EE savings goals, including savings achieved through this VVO Plan. The % of cumulative persisting annual savings targets within this VO Plan are based on this 27,960 GWh value. The percentage target values will change if this baseline is adjusted.
- *Candidate VO Circuit Baseline Load:* The total energy delivered for candidate VO circuits was based on the 2014-2016 average MWh.

CVR Factor (CVR_f)

Based on AIC's 2012 – 2013 Pilot VO Project, and other industry studies, a CVR factor of 0.8 was selected for use across all feeders and aligns with CVR factors reported in industry literature and regulatory filings. The tables below summarize CVR factors from a variety of industry projects as well as extracted from regulatory filings in other jurisdictions.

Utility	CVR Factor
California IOUs	0.75
New York State Electric & Gas	0.6
Central Florida Electric Cooperative	0.5-0.75
Clay Electric Cooperative (Florida)	1.0
Progress Energy – Florida	1.0
Georgia Power	0.8-1.7
Cobb EMC	0.75
Progress Energy – Carolinas	0.4
NRECA[5]	0.80
OG&E[6]	0.70
KCP&L[7]	0.80
Avista Utilities	1.09
Clatskanie PUD	1.4
Inland Power & Light	0.93
Snohomish PUD	0.65
Seattle City Light	0.13
Average	0.8

Table 5[8]. CVR Factors from a Variety of Industry Projects

The data in the above table combined with the results of the Ameren Illinois Pilot VO Project support use of a CVR factor of 0.8 for the evaluation, measurement, and verification of the VO Plan.

[5] National Rural Electric Cooperative Association, Costs and Benefits of Conservation Voltage Reduction – CVR Warrants Careful Examination, Final Report (Technical Report) (Arlington, VA: May 2014).

[6] Oklahoma Gas & Electric, 2015 Oklahoma Demand Programs Annual Report, Attachment H IVVC Impact and Capability Report, http://www.occeweb.com/pu/EnergyEfficiency/2015OGE_DemandProgramsAnnualReport.pdf

[7] "Voltage and Power Optimization Saves Energy and Reduces Peak Power", https://www.smartgrid.gov/files/Voltage-Power-Optimization-Saves-Energy-Reduces-Peak-Power.pdf

[8] "Distribution Efficiency Initiative, Market Progress Evaluation report, No.1", NEEA 1207, Northwest Energy Efficiency Alliance 2007, http://neea.org/docs/reports/distribution-efficiency-initiative-e05-139.pdf?sfvrsn=7

Voltage Change (ΔV)

Ameren Illinois utilized a 3.0% voltage reduction for the assessment of candidate feeder energy savings resulting from VO deployment. The 3.0% voltage reduction was selected based on Ameren Illinois' Pilot VO Project, evaluation of results from VO implementations reported by other utilities, and Ameren Illinois' design and operating practices.

4.3 Loss Reduction

VO-related energy savings consists of two principal items: end-use load reduction and loss reduction. In general, loss reductions are small relative to end use load reductions.

Loss reductions arise as a "side effect" of the VO implementation. Distribution line losses are reduced through two principal mechanisms: 1) reduced customer load reduces the magnitude of the load on lines and transformers, resulting in a corresponding reduction of losses across these elements, and; 2) improved distribution primary power factor from reactive power (capacitor bank) dispatch can further reduce the magnitude of load on lines.

Ameren Illinois captured the benefits associated with loss improvements through use of loss factors in the TRC analysis. However, reporting energy reductions due to VO will be based on metered energy without loss gross up. Reporting will be explained in a later section.

4.4 Peak Demand Reduction

Determination of peak demand savings presents challenges that are not encountered in forecasting and reporting energy savings. Specifically, peak demand is subject to far greater variation from year to year than annual energy, due to variations in weather characteristics. Additionally, due to system electrical characteristics in combination with variable peak loading (due to aforementioned weather characteristics) the voltage reduction effected at peak is subject to greater variation and does not offer the balance of the year offset variation as provided in energy reductions. Finally, peak CVR factors can demonstrate variation due to the unique load mix at the time of peak (and depending on the peak load level in a given year). These factors make projections of peak demand savings difficult and subject to significant variation.

Ameren Illinois' VO Plan is being designed and implemented as an energy reduction measure, consistent with the FEJA. The VO functionality is intended to operate 24 hours a day, 365 days a year. The analysis, CVR factor, and estimated average voltage reductions are all based on these operating parameters.

4.5 *VO Technology*

Ameren Illinois identified multiple technology upgrades required for the successful deployment of a VO program. These technology upgrades have hardware, software and communication components. Each component is described below.

Hardware: Hardware upgrades are necessary to enable the execution of VO strategies on the distribution circuit. Upgrades include the installation of new controllers, monitors and metering packages.

- LTC (Load Tap Changer) Controls
- Voltage Regulator Controls
- Capacitor Controls
- Substation Metering
- Voltage Monitors (AMI, Substation SCADA, Field Devices, etc.)

Software: Software is a fundamental piece to the enablement of VO. It is responsible for taking inputs from field devices, circuit models and other sources of information for a given distribution circuit, and then using advanced algorithms to make decisions that optimally operate the circuit so maximum safe voltage reduction can be achieved. Ameren Illinois will deploy software that can:

- Dynamically monitor, optimize and control devices on the distribution circuit to achieve circuit specific maximum safe voltage reduction.
- Use real-time measurements from distribution circuit field devices and AMI meters, so all customer voltages remain in compliance while achieving energy savings.
- Use real-time electrical connectivity circuit models that would reflect the real-time configuration of the distribution circuit, identifying outages, abnormal switching and back-feed scenarios, and adjusting controls and commands according to the system's real-time configuration.

Communications: The reliable communication between the optimization software and field devices is key to achieving maximum attainable savings per distribution circuit. Each controller (voltage regulator controller, capacitor bank controller, LTC controller) as well as each metering package and line voltage monitor, will require a communication device that will connect them to the optimization software.

Circuit Enhancements: To enhance the voltage reduction capability of a distribution circuit, a number of additional enhancements will be done as appropriate. These enhancements may include:

- Phase Balancing

- Power Factor Correction
- Upgrading Distribution Transformers
- Moving Secondary Services
- Adding Line Voltage Regulators

AMI: Ameren Illinois sees significant advantages in using AMI voltage reads that can be fed as inputs to the optimization software and can be used by the software to determine the maximum amount of savings that can be achieved on the circuit, as well as limit the potential for voltage violations on a circuit. AMI voltage data will also be used in the engineering design process.

4.6 TRC Methodology

This evaluation identifies the cost and benefit components using the Total Resource Cost (TRC) analysis. The Act states that an overall portfolio of energy efficiency and demand-response measures is determined cost-effective using the TRC test. The TRC test is a benefit-cost ratio of the net present value of total benefits of the program to the net present value of the total costs, as calculated over the lifetime of the measures. A program is considered cost-effective if this ratio is greater than one. The also Act states that the TRC shall have the meaning set forth in the Illinois Power Agency Act.

“Total Resource Cost test” or “TRC test” means a standard that is met if, for an investment in energy efficiency or demand-response measures, the benefit-cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures. A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, as well as other quantifiable societal benefits, including avoided natural gas utility costs, to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, to quantify the net savings obtained by substituting the demand-side program for supply resources. In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.”

The TRC test compares benefits (energy costs times energy savings, plus the value of resulting carbon reduction) to costs (incremental capital, installation and O&M costs of measures + utility implementation and administration costs). The formal expression of the Illinois TRC test is as follows:

TRC = Benefits/Costs

$$BTRC = \sum_{t=1}^{N} \frac{UAC_t}{(1+d)^{t-1}}$$

$$CTRC = \sum_{t=1}^{N} \frac{PRC_t + PCN_t + UIC_t}{(1+d)^{t-1}}$$

Where:

BTRC = Benefits of the program/measure

CTRC = Costs of the program/measure

UAC_t = Utility avoided supply costs plus avoided O&M costs in year t

UIC_t = Utility increased supply costs in year t

PRC_t = Program Administrator (Utility) program costs in year t

PCN = Net Participant Costs

BenCost Modeling Tool: The TRC analysis utilized a modeling tool called BenCost. The BenCost modeling tool is a powerful modeling tool that is used to evaluate the costs, benefits, and risks of DSM programs and services. It is a Microsoft Excel-based tool built by Applied Energy Group (AEG) to conduct robust cost-effectiveness evaluations consistent with industry best practices and individual client needs. The model utilizes information obtained directly from Ameren Illinois to ensure that results are accurate and reliable. AEG's approach to cost-effectiveness analysis has been honed over decades of experience with program planning, design, and evaluation. BenCost is used by more than 25 utilities and state agencies, including Ameren Illinois, for DSM program planning.

4.7 TRC Analysis Results

Ameren utilized the BenCost tool to conduct the TRC analysis on each viable circuit, based on the estimated incremental cost of implementing the circuit, and the estimated energy reduction that could be realized from the circuit. Program fixed costs not directly dependent on the number of circuits implemented (such as the initial and ongoing software costs, and overall administration, measurement, and evaluation, etc.) were not included in the individual circuit TRC analysis. The results of this analysis yielded 1,047 cost-effective circuits, with an estimated total energy savings after full deployment of 422 GWh. The overall TRC of the VO Plan assuming implementation of all circuits with an individual TRC greater than 1.0 is 1.36.

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Table 6. Summary of VO Plan Results.

4.8 Distribution of Cost-Effective Circuits

The population of cost-effective candidate circuits for the VO program deployment is currently estimated at 1,047 circuits, which corresponds to approximately 64% of Ameren Illinois' customers. Unlike other energy efficiency programs, all customers served from one of these circuits, will directly benefit from VO, as they do not have to decide to opt-in. These customers are spread across the full territory of Ameren Illinois.

Locations	Circuits / Division	Customers in Division	Estimated # of Customers on Cost Effective Circuits
Division 1	260	267,824	213,988
Division 2	103	123,978	53,684
Division 3	132	152,003	112,636
Division 4	231	250,323	151,181
Division 5	107	147,170	83,572
Division 6	214	263,078	148,897
Totals	1047	1,204,376	763,958

Table 7. Cost effective circuits by Division.

Based on zip codes of customers served by the proposed feeders, these circuits also serve portions of the top 20 Tier One communities (defined below), with the exception of Springfield and Peru which are not totally within AIC electric service territory. The below table provides the names of 20 Tier One communities, ranked in terms of the number of estimated eligible households. Tier One communities are defined as communities where over 50% of households are low-income, less than 10% of households are multifamily, and less than 10% of households participated in previous residential energy efficiency programs.

Ranking (Top 10)	Name*	Estimated Eligible Households	Estimated Population Below Poverty Level	Estimated # of Customers on Cost-Effective Circuits	Ranking (11-20)	Name*	Estimated Eligible Households	Estimated Population Below Poverty Level	Estimated # of Customers on Cost-Effective Circuits
1	Springfield[1]	13,897	8,807	6,600	11	Belleville	2,675	4,542	37,490
2	Decatur	4,888	7,773	29,202	12	Jacksonville	2,294	3,702	9,798
3	Bloomington	4,370	7,416	19,264	13	Ottawa	1,954	3,426	9,584
4	Centralia	4,100	4,399	4,874	14	Alton	1,917	6,702	4,958
5	East Saint Louis	3,519	5,790	1,457	15	Salem	1,623	1,652	1,222
6	Danville	3,439	10,286	11,316	16	Marseilles	1,470	1,310	3,719
7	Galesburg	2,980	6,788	13,674	17	Olney	1,442	1,960	3,105
8	Carbondale	2,956	10,688	7,590	18	Quincy	1,338	6,522	12,022
9	Mount Vernon	2,897	4,471	5,381	19	Peru[1]	1,283	1,034	330
10	Granite City	2,887	7,612	6,777	20	Monmouth	1,233	1,911	3,340

[1] Ameren Illinois Only Serves a small portion of the Springfield & Peru Zip Codes
* Communities named based on the city to which they belong.[9]

Table 8. EE Top 20 Tier One Communities

4.9 VO Plan Implementation Costs

The Ameren Illinois VO team has conducted a detailed cost assessment of the VO program to determine the capital and operations and maintenance (O&M) costs associated with the VO deployment. Table 9 shows the total estimated project costs broken down by category.

[9] "Impact and Process Evaluation of the 2016 (PY9) Ameren Illinois Company Home Efficiency Income Qualified Program", dated December 28, 2017, by Opinion Dynamics

Project Costs	Total (M)
Capital Construction-Automation, Communications	$48
Capital Construction- Circuit Enhancements	$63
O&M Related to Construction Costs	$6
Fixed Support System Capital Costs	$5

Table 9. Total VO Program Costs

4.9.1 Capital & O&M Related to Construction

Based on the candidate cost-effective VO circuit population of 1,047, the number of devices necessary to implement the VO program was assessed. For each circuit, Ameren Illinois' VO team identified the following items for the enablement of the VO implementation:

- Number of LTC Controllers
- Number of Voltage Regulator Controllers
- Number of Voltage Regulators
- Number of Capacitor Banks
- Number of Capacitor Controllers
- Number of Communication Devices
- Number of Substation Metering Installations

The Ameren Illinois VO team also identified circuit enhancement work that is necessary to enable the successful operations of VO, and to achieve the estimated 3% voltage reduction outlined in the plan. The potential circuit enhancement work was assessed by the Ameren Illinois team as follows:

- Phase Balancing
- Power Factor Correction
- Upgrading Distribution Transformers
- Moving Secondary Services
- Adding Line Voltage Regulators

Circuit Enhancement Work	Cost per Circuit
Phase Balancing – for 20% or more phase unbalance	$10,000
Power Factor Correction – for circuits with Power Factor worse than 98% lagging/leading. Estimated adding a capacitor bank and relocating another.	$20,000
Upgrading Distribution Transformer – estimated for replacing one distribution transformer.	$2,500
Moving Secondary Services – for low voltage conditions. Estimated moving three secondary services.	$2,500
Adding Line Voltage Regulators – for low voltage zones within circuits. Estimated adding one set of three-phase voltage regulators.	$25,000
Total	$60,000

Table 10. Estimated Circuit Enhancement Costs

Ameren Illinois' VO team also identified the following items necessary for the implementation of the VO program and are independent of the number of circuits implemented. This includes the implementation of a VO software system that is integrated with our Advanced Distribution Management System (ADMS) and AMI system. It also includes the enhancement of the existing AMI system to retrieve voltage values from the meters and store in a data warehouse. These total fixed costs are estimated to be $4.6M.

Material and labor costs were estimated through the use of equipment quantities known for each of the 1,047 circuits, as well as labor estimates from internal work management systems, or directly from vendors.

The figure below further summarizes the VO Plan investment costs.

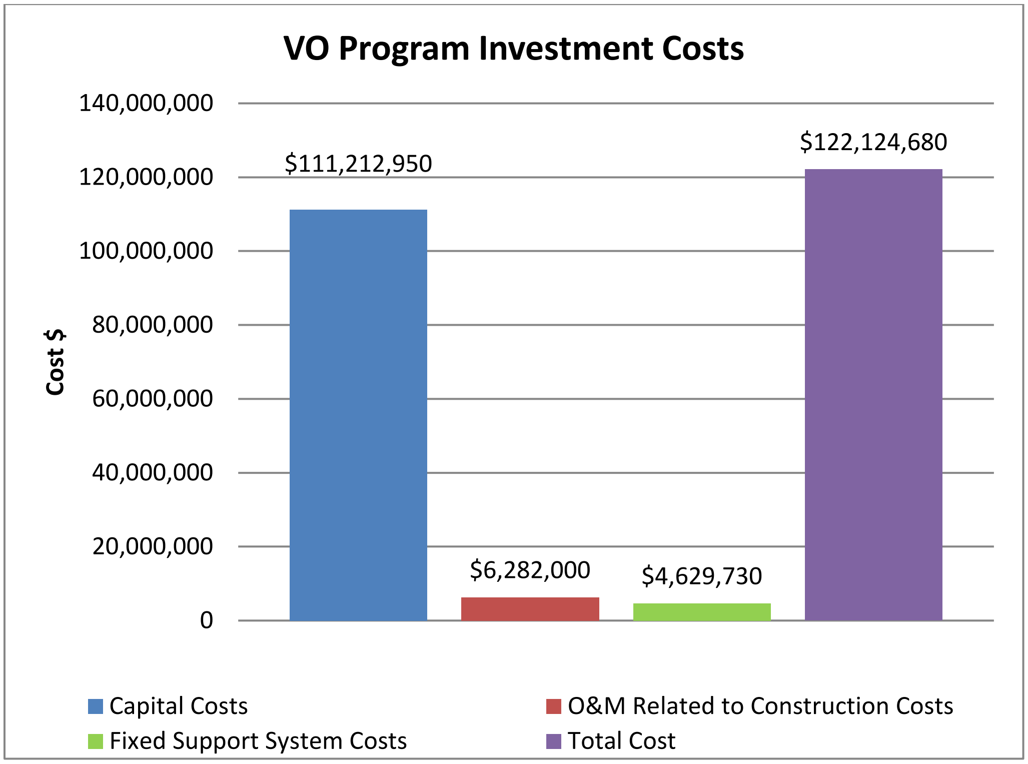

Figure 2. Ameren Illinois VO investment Cost.

4.9.2 Ongoing O&M

The ongoing operating and maintenance cost of the VO Plan is estimated at $7.4M (these estimates include engineering, operating, engineering technician and substation/lineman support to maintain the VO systems and equipment).

5. Timeframe and Implementation Plan

Based on the estimated 422 GWh-yr total energy savings on 1,047 distribution circuits that the VO program would yield, Ameren Illinois established energy savings targets, as well as the estimated investment required to achieve these targets, for every year of the program. Starting in 2018, Ameren Illinois will conduct further detailed engineering analysis and determine which circuits to implement in a given year. The detailed engineering analysis could result in some of the 1,047 circuits falling out of the cost effective candidate list, while other circuits might be determined cost-effective and are added as candidates. Therefore, the number of circuits deployed in any given year may differ from those outlined in the Plan to meet savings goals.

Ameren Illinois' cadence for implementing the VO plan for a given program year ***N***, is as follows:

- Year ***N-2***: Detailed engineering analysis to determine:
  - Select circuits to meet or exceed energy savings target for year ***N***
  - Complete detailed engineering analysis and design on selected circuits and determine associated costs
- Year ***N-1***: Construct and install VO upgrades per engineering design. Turn VO on and place in service.
- Year ***N***: 1st full year of VO operation on selected circuits. Monitor voltage reduction.
- Year ***N+1***: Calculate energy savings and report on savings captured in Year ***N***

The summary of Ameren Illinois' roll-out for the VO Plan is shown in Table 11 below. All investments and amounts shown are subject to revision as AIC refines and adapts the VO Plan in light of future analysis, findings and circumstances. The work may evolve from that originally planned; and planned schedules may be either accelerated or delayed. Implementation of the VO Plan may also involve the increase or reduction in the number of cost-effective circuits deployed, at lower or higher cost than originally estimated. Such occurrences shall not imply the imprudence or unreasonableness of the VO Plan, including, but not limited to, its programs, cost or schedule.

Year Ending	2018	2019	2020	2021	2022	2023	2024	2025
Estimated Cumulative Persisting Annual Savings (MWh)	0	7,650	59,994	128,433	201,725	275,006	348,287	421,568
% Cumulative Persisting Annual Savings	0%	0.03%	0.21%	0.46%	0.72%	0.98%	1.25%	1.50%
Estimated Incremental # of Circuits Deployed	19	130	170	182	182	182	182	0
Estimated Incremental Construction Cost (Capital Cost)	$2M	$14M	$18M	$19M	$19M	$19M	$19M	$0
Estimated Incremental Total Investment Cost (Construction Capital, Construction O&M, Upfront Capital)	$5M	$17M	$20M	$20M	$20M	$20M	$20M	$0

Table 11. Summary of Ameren Illinois' roll-out plan for the VO program.

Ameren Illinois' VO Plan, as proposed, is estimated to yield a percent annual cumulative persisting savings of 1.5% in 2025. This exceeds the cumulative persisting savings of 1.0% established in section 8-103B (b-20) of FEJA, as outlined in the table below. The estimated 1.5% of persisting annual savings after full deployment is based on the total normalized sales of electric power and energy during the calendar years 2014-2016 of

27,960 GWh, after excluding energy delivered to exempt customers identified as of September 1, 2017. If this baseline value is adjusted, the estimated persistent savings percentage will change as well.

Year Ending	2018	2019	2020	2021	2022	2023	2024	2025
Estimated Cumulative Persisting Annual Savings (MWh)	0	7,650	59,994	128,433	201,725	275,006	348,287	421,568
% Cumulative Persisting Annual Savings	0.00%	0.03%	0.21%	0.46%	0.72%	0.98%	1.25%	1.50%
% Cumulative Persisting Annual Savings from Section 8-103B (b-20) of FEJA	0.00%	0.17%	0.17%	0.33%	0.50%	0.67%	0.83%	1.00%

Table 12. VO Plan cumulative savings target percentages compared to FEJA.

6. Voltage Data Collection

For purposes of evaluation, measurement and verification of the VO program, Ameren Illinois will collect voltage data from multiple sources that will be utilized to verify the execution of VO and measure the savings that result from its execution.

As discussed in the EM&V section below, Ameren Illinois will rely on voltage values pre-VO execution and post-VO execution to evaluate the energy savings. The general approach to collecting voltage data will be as follows:

- **Pre-VO Deployment Voltage**
  For pre-VO deployment voltage values, data will be collected based on one of the options listed below in order of priority:

  - AMI Measurement Values: Hourly Averages for each meter on the circuit for the pre-VO deployment.
  - SCADA Measurement Values: Hourly Averages for all SCADA-enabled devices for the pre-VO deployment year.

  Ameren Illinois plans to complete AMI deployment by the end of 2019. Therefore, it is expected that the AMI Measurement Values option for pre-VO deployment voltage data will be the option used after 2020.

  Substations at Ameren Illinois differ in design, configuration and available metering. The sections below provide detail and guidance to the data collection process for the different substation and feeder types.

Substation LTC

Some of Ameren Illinois Distribution substations are fed by an LTC (Load Tap Changer) Transformer. An LTC Transformer has built-in voltage regulators that are used to ensure that distribution feeders provide proper voltage levels to customers. For substations that have LTCs, there are no individual feeder regulators, and the LTC is responsible for providing regulation to downstream feeders.

There are three main types of available data at LTC locations:

1. LTC-Controlled Circuits with AMI deployed
   Data to be collected is the average hourly voltage value for each meter.

2. LTC SCADA – Three-phase Voltage
   Data to be collected from this location is the average hourly voltage value for each phase; then average the three phases into one average reading.

3. LTC SCADA – Bus Voltage
   Data to be collected from this location is the average hourly voltage value.

Voltage Regulators

Unlike substations with LTC Transformers, the majority of Ameren Illinois distribution substations have independent phase voltage regulation for each individual circuit. This is done by having a set of three single-phase voltage regulators that ensure that each circuit phase from the substation provides proper voltage. Unlike substation LTC transformers, Ameren Illinois does not have metering for all circuit voltage regulators. Ameren Illinois will rely on the following methods to collect voltage values:

1. Voltage Regulator Controlled Circuits with AMI deployed
   Data to be collected is the average hourly voltage value for each meter.

2. Voltage Regulator SCADA – Three-phase Voltage
   Data to be collected from this location is the average hourly voltage value for each phase; then average the three phases into one average reading.

- **Post-VO Deployment Voltage**
  For post-VO deployment voltage values, data will be collected based on one of the options listed below in order of priority:
  - AMI Measurement Values: Hourly Averages for each meter on the circuit for the post-VO deployment.
  - SCADA Measurement Values: Hourly Averages for all SCADA-enabled devices on the circuit the post-VO deployment year.

Part of the VO implementation plan is to allow for circuit voltage metering to be captured and collected. It is also part of the VO implementation plan to allow for AMI metering to make interval voltage data available to be collected. These two methods will be used to collect voltage data post-VO deployment.

7. EM&V

Ameren Illinois proposes evaluation, measurement and validation of the VO program benefits, utilizing a continuous operation approach to ensure achievement of the greatest customer benefits. Ameren Illinois considered use of an “on/off” testing approach for every deployed circuit; however, such approaches sacrifice up to half of the customer energy savings that might otherwise be achieved during the testing period. On/off testing subjects voltage regulating equipment to increased number of operations, which reduces the life of these devices. Also, on/off testing requires increased labor resources, due to manipulation and monitoring of the VO control solution, as well as data analysis efforts to assess the operational performance data.

7.1 Savings Evaluation

Energy savings are computed in a manner similar to that outlined above, and is based on the average annual energy use in the 2014-2016 timeframe less energy use by exempt customers. The energy savings from conservation voltage reduction is the product of three key parameters:

$$Energy\ Savings = Annual\ Energy\ Use\ 2014 - 2016 \cdot CVR_f \cdot \Delta V$$

Where:

- *Annual Energy Use 2014-2016* is the average annual customer energy use over the 2014-2016 timeframe, less energy use by exempt customers.
- CVR_f is the factor which represents the percent change in load for each percent change in voltage
- ΔV is the percent change in voltage as a result of VO implementation

These three items are discussed further below:

Annual Energy Use

Annual energy use is taken as the 2014-2016 annual energy use for each feeder as outlined above and consistent with the direction provided in FEJA that energy reduction is to be measured based on a 2014-2016 baseline.

CVR Factor

A CVR factor of 0.8 was selected based on the pilot results and survey of industry reported CVR factors.

Voltage Change (∆V)

The voltage change is the average hourly voltage reduction achieved throughout the initial full year of deployment compared to pre-deployment (i.e., average annual voltage change). Importantly, the average annual voltage change shall be from voltages measured from the same system level (i.e., either customer level (meter) voltages shall be used for both pre- and post-VO voltage measurements or primary SCADA based voltages shall be used for both pre- and post-VO voltage measurements).

Pre Deployment Voltage

Hourly pre-deployment voltages will be captured as described in the section above for one year prior to the enablement of VO on the subject circuits. (Note: the availability of pre-deployment AMI voltages will determine whether AMI voltages can be used to support M&V.)

Missing or zero data points will be removed from the dataset, as such points are not representative of normal system operation (i.e., missing voltages may be due to loss of remote terminal unit communications, resulting in missing periods of data across all measurement types for a particular feeder).

Post Deployment Voltage

Hourly post-deployment voltages will be captured as described in the section above for the initial full year of the enablement of VO on the subject circuits. Note: The post- deployment voltages collected shall align with the locations for the pre-deployment voltages (i.e., if customer meter voltages are used for pre-deployment annual average voltages, customer meter should also be used for post-deployment annual average voltage determination).

Missing, zero and outlying data points will be removed from the dataset, as such points are not representative of normal system operation (i.e., missing voltages may be due to loss of remote terminal unit communications, resulting in missing periods of data across all measurement types for a particular feeder). An overall average annual post deployment voltage will be computed, based on the dataset with missing or zero data points excluded.

Average Annual Voltage Change

The average annual voltage change shall be computed from the difference between the average annual pre-deployment voltage and the average annual post-deployment voltage.

7.2 Ongoing Evaluation, Measurement & Verification Methodology

Consistent with Ameren Illinois' Energy Efficiency programs, Ameren Illinois will use an independent third-party evaluation, measurement, and verification evaluator to review Ameren Illinois' implementation of this plan and confirm estimated savings were achieved. The evaluator will review and confirm the following:

1. The new circuits were deployed with VO in the year reported.
2. The new circuits were appropriately operating for the initial evaluation, measurement, and verification year.
3. The resulting % voltage reduction pre- vs. post-deployment of the newly deployed circuits.
4. The resulting energy savings calculation realized from the newly deployed circuits using the plan approved CVR factor and savings calculation methodology.
5. Circuits deployed and verified in previous years are still in operation.
6. The new cumulative persisting annual savings of all deployed circuits.

Once the voltage reduction is verified for a circuit in its initial-year of operation, and thereby the energy savings is calculated using the plan approved CVR factor, this initial-year proven energy savings is considered to occur the full 15-year life of the VO operation, provided VO continues to be operated on the circuit throughout the entire 15-year life of the program. No subsequent voltage reduction calculations, CVR factor adjustment, or delivered energy verification, will be made on a deployed circuit, once the savings on a circuit has been calculated and verified in its initial year of operation.

As a confirmation that the proven CVR factor of 0.8 is still valid for the VO deployment outlined in this plan, and to further confirm the relationship among typical circuit delivered energy, voltage, and other appropriate parameters, in 2020 Ameren Illinois plans to conduct a test of the CVR factor and other appropriate parameters using appropriate analysis methods on a representative sample of the estimated 130 circuits deployed in 2019. If the resultant CVR factor materially differs from the proven 0.8 factor used in the plan development and implementation to that point, then Ameren Illinois will use the new CVR factor in all engineering and economic analysis related to the plan in all subsequent years beginning in 2021, and resulting energy savings verification in all subsequent years beginning in 2023. Changes to the CVR factor will not change the 15-year deemed savings of circuits already deployed.

8. Reporting

As outlined in the legislation, Ameren Illinois will provide the utility data to its independent evaluator 30 days after the calendar year. The independent evaluator will have draft evaluations completed by March 15 and circulated to the Stakeholders Advisory Group for comment. These draft evaluations will provide the annual incremental and cumulative persisting savings related to the VO program. Interested stakeholders will be provided a comment period, after which evaluators will review and address. Final evaluations will be delivered no later than April 30. The VO program results will be incorporated into an annual integrated report detailing all Ameren Illinois Efficiency program annual persisting, and annual incremental savings.

9. 2017 / 2018 Detailed Plan

As mentioned above, Ameren Illinois will use the 19 circuits already planned for VO implementation as part of its EIMA Infrastructure Investment Plan as the initial implementation of this VO plan.

In 2017, Ameren Illinois began deployment of VO technologies on 14 of the 19 circuits. Seven of these circuits will be deployed with a Vendor 1 VO control software package. The other seven will be deployed with a second Vendor VO control software package. Table 13 below shows the 14 circuits that are being deployed.

Substation	Circuit	Software
Northwest Ckt 002	B00002	Vendor 1
Northwest Ckt 003	B00003	Vendor 1
Quincy 24th & Cherry Lane Ckt 556	V40533	Vendor 2
Quincy 28th & Adams Ckt 533	V42556	Vendor 2
Limit Ckt 015	D31015	Vendor 1
Ridge Ckt 002	C52002	Vendor 1
Ridge Ckt 001	C52001	Vendor 1
Shelbyville Ckt 500	Y79500	Vendor 2
Charleston S. EIU Ckt 501	K11376	Vendor 1
Bethalto Ckt 377	J34377	Vendor 2
Bethalto Ckt 357	J34357	Vendor 2
Caseyville Gardens Ckt 376	K11376	Vendor 1

Substation	Circuit	Software
E. Belleville Ckt 132	L93132	Vendor 2
Belleville 44th Ckt 140	J83140	Vendor 2

Table 13. Ameren Illinois' 2017 Primary Distribution Volt/VAR Control Infrastructure Investment Program Circuits

An additional 5 circuits will be deployed in 2018 for a total of 19 circuits. The additional 5 circuits will be deployed with a third Vendor VO control software package. These circuits are listed in Table 14.

Substation	Circuit	Software
Quincy 36th & College	V45574	Vendor 3
Quincy 30th & Hampshire	V42572	Vendor 3
Tuscola East	Y98532	Vendor 3
Mt. Zion Rt121	P69173	Vendor 3
Mt. Vernon 27th St	P58155	Vendor 3

Table 14. Ameren Illinois' 2018 Primary Distribution Volt/VAR Control Infrastructure Investment Program Circuits

In 2018, Ameren Illinois will also perform a more detailed engineering assessment of the 19 VO circuits consistent with this proposed VO Plan. The assessment will be used to further determine the circuit enhancement requirements of each circuit. The assessment will include the following:

- Voltage High/Low Study
- Power Factor Correction
- Load Imbalance

The circuit enhancement work that will result from these studies will be done in 2018. Once the circuit enhancement work is complete for each circuit, VO will start operations and verification of voltage reduction capabilities of each circuit. The three software packages will also be tested to determine which provides the most appropriate solution for full VO deployment. Ameren Illinois will use the chosen software solution for the subsequent circuits deployed as part of this plan.

Based on the Plan, Ameren Illinois is estimating energy savings for the 19 circuits to be 7,650 MWh-yr. This savings is expected to begin during the first full year of operation of these circuits in 2019.

Ameren Illinois will use the learnings from the implementation and initial operation of these 19 circuits to inform the design, deployment, and operation of subsequent circuits deployed as part of the plan.