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ComEd
An Exelon Company

Smart Grid Advanced Metering Annual Implementation Progress Report

Submitted by:
Commonwealth Edison Company

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EXCERPT
Appendix A,
VI. Voltage Optimization
A-10 to A-13

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APPENDIX A – REPORTS

and notified interested parties on August 15, 2013 of the posting of the map tool.[39] ComEd updated the map on October 1, 2014, plans to update the map once per year, and will continue to consider more frequent updates if there is a large increase in DG interconnection activities in the future. An update will also be necessary if and when there is a change to the rules that govern the review and approval of DG interconnection requests for DG facilities with a nameplate capacity of up to 10 MVA.[40]

VI. VOLTAGE OPTIMIZATION

A. Background

Voltage Optimization ("VO") is a combination of Conservation Voltage Reduction ("CVR") and Volt-VAR Optimization ("VVO"). These programs are intended to reduce end-use customer energy consumption and peak demand while also reducing utility distribution system energy losses. The ICC, in Docket No. 13-0495, stated that "A review of the record leads the Commission to believe that a VO feasibility study should be pursued and could in fact result in many direct and indirect benefits." The order also stated that "The record is also not clear whether there is already a budget earmarked for voltage optimization in ComEd's Smart Grid plan. If there is already, it should go forward; if not the Company is directed to include it with the next AMI plan filing." In accordance with ComEd's 2014 AIPR, a Voltage Optimization Feasibility study was completed by Applied Energy Group ("AEG") in December 2014.

B. Feasibility Study Approach

AEG was selected through a competitive bid process, based on the thoroughness of their proposed plan of work and the previous relevant experience to conduct a feasibility study of implementing Voltage Optimization on the ComEd distribution system. The study relied on industry standard modeling and engineering methods that have been used for electric utilities including:

- Use of power flow simulation feeder models derived from ComEd's Geographic Information System (CEGIS)
- Robust statistical techniques yielding representative system-level VO benefits and costs

The study methodology followed two major steps: 1) "total feeder prioritization" of potential candidates; and 2) "sample feeder detailed analysis" using load-flow simulations. Estimated VO

[39] https://www.comed.com/customer-service/rates-pricing/interconnection/Pages/distribution-under-10000kva.aspx.

[40] 83 Ill. Admin. Code Part 466 – Electric Interconnection of Distributed Generation Facilities.

factors were applied to both steps. Two VO scenarios labeled Plans A and B were evaluated to compare the benefits of alternative levels of energy efficiency.

The initial step of "total feeder prioritization" classified 3,757 feeders out of ComEd's total population of approximately 5,650 feeders using a simplified load flow analysis of feeder characteristics involving load type, load density, feeder lengths, existing voltage control settings, real and reactive loads, line voltage drops and losses, line regulators installed, and conductor loading. Feeders were categorized as viable or non-viable for VO implementation, and viable feeders were prioritized based on a potential voltage-reduction magnitude-sensitivity impact analysis, and subsequent energy savings potential.

For the "sample feeder detailed analysis", a sample of 70 feeders from 16 substations was selected using a stratified random sampling approach to fairly represent the total feeder population. Detailed analyses of planning and loadflow simulations were performed to determine expected annual energy savings (kWh) and peak power reductions (kW) for each of two VO scenarios. This sample feeder analysis included an assessment of system upgrades between the existing system and VO-modified plans, including benefits/costs for each VO scenario, which were then extrapolated back to the total ComEd system level using statistical ratio estimation techniques linking the sample group, study group, and system population. In addition, a recommended VO pilot project was outlined to demonstrate the proposed VO implementation strategies, verify estimated VO factors, and develop simplified VO M&V procedures for ComEd's distribution system.

It is important to note that the study is not an implementation plan for VO. In fact, the results are statistically valid, but represent an instant change from current operations to one where VO is implemented fully and effectively on each viable feeder.

C. Feasibility Study Results

The Commonwealth Edison Voltage Optimization (VO) Feasibility Study Final Report ("VO Feasibility Study Report"), dated January 6, 2015 and prepared by AEG, is attached hereto in Subsection F.

<u>Key AEG Feasibility Study Findings</u>

- ✓ VO is likely to be cost-effective for viable feeders
  - The high level estimated potential Total Resource Cost (TRC) benefit cost ratio for viable feeders ranges from 2.2 to 2.3
- ✓ Deployment costs are primarily to increase feeder efficiency, minimize voltage drop and monitor last customer and system voltages
- ✓ ComEd has a relatively efficient feeder design
- ✓ Existing voltage regulation practices provide an opportunity for voltage reduction
- ✓ Approximately 50% of all ComEd feeders are believed to be viable for VO (2,890 of 5,655 feeders)

- Viable feeder criteria - 12kV feeders that supply residential and small C&I customers
- Non-viable feeders continue using traditional voltage regulation

Summary of Feasibility Study Analysis

	Plan A (Reduced Cost)	Plan B (Greater Savings)
Potential VO Savings • **Energy (GWh/year)** • **Peak Load (MW)**	1350 260	1900 360
Total VO Estimated Costs	$425 M	$575 M
VO Program TRC	2.20	2.30
Levelized Cost of Energy Saved ($/kWh)	$0.0193	$0.0185
Number of Viable Feeders	2890	2890
Average Energy Savings per Viable Feeder (MWh/yr)	470	660
Average VO cost per feeder	$150 K	$200 K
Average Voltage Reduction	3.0%	3.8%

Key AEG Feasibility Study Recommendations

✓ Design/Implement VO verification project(s) to validate:
- Method used to estimate energy savings
- Residential and commercial VO factor assumptions
- Test voltage optimization strategies
- Validate Line Drop Compensation (LDC) voltage control schemes
- Test End of Line (EOL) voltage feedback for overriding LDC controls
- Switched capacitor VAR control schemes
- Measurement and Verification protocol
- Effectiveness of Integrated Volt VAR Control (IVVC) applications

✓ Develop and implement VO analysis training, operations, and maintenance materials

✓ Improve VAR management with small capacitor banks using controls with VAR sensing

✓ Install EOL voltmeters on every VO feeder and voltage control device at the lowest voltage location

- ✓ Examine AMI voltage/loading data to determine actual feeder voltage drop and load profiles to determine the need to upgrade distribution transformers.

D. Planned ComEd Validation Project

Based on the VO Feasibility Study Report and the AEG Recommendations, ComEd plans to conduct a VO Validation Project as follows:

- ✓ Conduct a validation project to confirm annual estimated energy savings, deployment costs and implementation technologies for at least 2 substations with 4-to-6 feeders each
  - Selected feeders will represent urban, suburban and rural areas and will contain those evaluated by AEG with both higher and lower benefit-cost ratios
- ✓ Evaluate and select appropriate VO technologies at the validation substations
  - Validate both LDC and IVVC control technologies
- ✓ Begin VO operations of the validation project in 2016. It is anticipated that data collected over a 12-month operating period will be sufficient to validate the assumptions and conclusions reached in the feasibility study. Additional data collection and evaluation for a period of up to 12 months may be necessary if unanticipated operational issues arise during the validation project.
- ✓ Assess and report learnings from the results of the validation project

E. Budget and Cost Recovery

A preliminary estimate of the cost of the validation project is $2,000,000. As indicated above, the estimated cost to fully implement VO is expected to be in the range of $425-575 million. This amount may exceed what is available in the AMI budget. Therefore, at some point prior to full implementation, an appropriate cost recovery mechanism will need to be considered and addressed. ComEd notes that proposed legislation was introduced on March 19, 2015 (currently, Amendment 1 to Senate Bill 1879; Amendment 1 to House Bill 3328) that revises the Public Utilities Act to expressly address voltage optimization as an energy efficiency measure. The proposed Bills would find that "Voltage optimization is an energy efficiency measure that can deliver cost-effective energy savings for all retail customers, including low-income customers." (220 ILCS 5/16-108.11(a) new) They would also authorize utilities to file plans with the Commission for the implementation of "cost-effective voltage optimization on identified elements of its electric delivery system," subject to Commission review, and make clear that the costs of implementing voltage optimization, as well as validation of VO, shall be recovered through Article IX rates or under Section 16-108.5 of the Public Utilities Act. (220 ILCS 5/16-108.11(b) new). Going forward, the continued implementation of voltage optimization would be addressed in ComEd's energy efficiency assessments. (220 ILCS 5/8-103 (b-5); 220 ILCS 5/16-108.11(d) new). ComEd supports these Bills, as proposed.

F. VO Feasibility Study Final Report

The VO Feasibility Study Final Report is attached below.