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Value Assessment

Distribution Automation and Conservation Voltage Reduction Programs

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Executive Summary

Distribution Automation (DA) offers a broad range of benefits to electric utilities and its customers, regional power suppliers and society at large. Recognizing these benefits, Commonwealth Edison (ComEd) is proposing to automate several hundred distribution switches and deploy a pilot conservation voltage reduction (CVR) as outlined in a Funding Opportunity Application (FOA) 000058 Recovery Act - Smart Grid Investment Grant Program recently submitted to the Department of Energy (DOE).

Distribution automation provides tangible benefits to its customers via reduced outages and lower restoration costs. Using methods that quantify the value of enhanced reliability, the impact of DA to ComEd customers is expected to be substantial - up to 400,000 fewer customer interruptions with corresponding benefits of over $60 million achieved by avoided disruption of customer load and lost economic opportunity. Conservation Voltage Reduction also provides predictable benefits in the form of reduced customer energy consumption, enhanced grid efficiency, reduced equipment maintenance, lower PJM power supply, and reduced fossil emissions.

Because some of the value of these programs cited above accrue to beneficiaries other than ComEd and its customers, economic benefits are presented for other stakeholders, including Regional Power Supply (PJM) and Society at large for emissions benefits.

Figure 1 presents the annual benefits resulting from distribution automation. Results indicate annual DA benefits will range from over $40 million to over $100 million annually. These ranges are based on the variability in the number of outages that occur annually. All benefits are expected to accrue to ComEd and its customers.

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Figure 1: Distribution Automation Total Annual Benefits

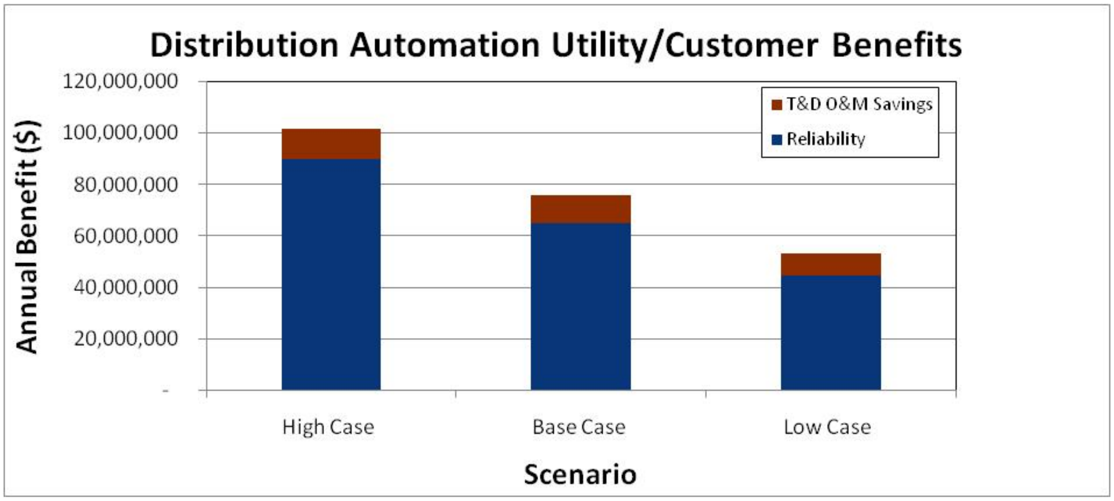
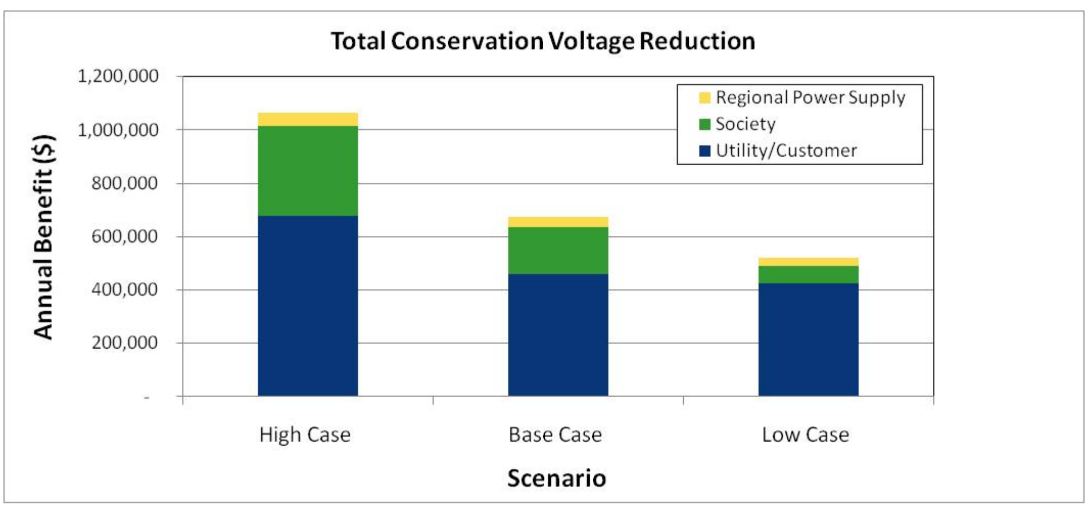


Figure 2 presents the annual savings for CVR, which is expected to range from over $400,000 to over $1 million annually, depending on the price of avoided energy and capacity, and the variability in energy usage reduction. These values translate to an annual benefit of between $71/MWh to $140/MWh. The majority of CVR benefits accrue to ComEd and its customers. However, approximately, 20 to 35 percent accrues to other stakeholders.

Figure 2: Conservation Voltage Reduction Total Annual Benefits by Stakeholder



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Overview

Background

Distribution Automation (DA) offers a broad range of benefits to stakeholders, which include electric utilities and its customers, regional power suppliers and society at large. When DA is targeted to areas of the system most likely to benefit from DA, the value to these stakeholders can be substantial. Recognizing these benefits, Commonwealth Edison (ComEd) is proposing to automate several hundred distribution switches and deploy conservation voltage reduction (CVR) on segments of its system as part of a Smart Grid Investment project outlined in a Funding Opportunity Application (FOA) 000058 Recovery Act - Smart Grid Investment Grant Program recently submitted to the Department of Energy (DOE). The primary objective of the project is to …"stimulate the rapid deployment and integration of advanced digital technology that is needed to modernize the nation's electric delivery network for enhanced operational intelligence and connectivity" and to determine economic value to all beneficiaries.

Numerous prior studies have broadly addressed the benefits of DA and CVR. Some have sought to quantify these benefits, while others assessed benefits qualitatively. Historically, vertically integrated electric utilities were the key stakeholder as they were the recipient of most benefits to the power delivery system; particular, benefits that accrue to the electric distribution system. However, unbundling of power supply from energy delivery companies has blurred the line with regard to which entity actually realizes these benefits.

Navigant Consulting Inc. (NCI) was engaged to identify and quantify the long term benefits of its DA demonstration programs. The benefits analysis is limited to ComEd's automated feeder switching and conservation voltage reduction programs. Other benefits that may be derived from ComEd's Smart Grid program, including those associated with Advanced Metering Infrastructure (AMI), are outside of the scope of this analysis; but nonetheless, enhance the overall value of Smart Grid program implementation. The analysis is limited to evaluating program benefits. It excludes derivation of program costs or an economic comparison of program costs versus benefits.

Program Description

Commonwealth Edison (ComEd) in its application to DOE under FOA 000058 proposes to deploy approximately 600 hundred automated switches on 12.47kV distribution feeders and 90 automated switches on 34.5kV supply lines. For both the 12.47kV and 34.5kV systems, ComEd will deploy smart devices (Smart Grid) to monitor and control these devices to improve reliability to customers served by these lines. When combined with existing applications, the installation of automated controls on these switches will increase the amount of distribution automation on the ComEd System by about 30%.

ComEd also proposes to implement Conservation Voltage Reduction (CVR) on nineteen 12.47kV feeders served from two substations equipped with intelligent controls. The use of Smart Grid technology in the form of intelligent systems capable of real-time monitoring and control of distributed devices is expected to advance both the commercialization of these technologies and benefits derived.

A detailed description of each of these two programs is highlighted in the following section of this report.

Methodology

The study evaluates the benefits of distribution feeder automation and conservation voltage reduction for all affected stakeholders on an annual basis and estimates sensitivity based on the variability in fuel and pricing assumptions over the expected life of these assets. Program benefits are quantified using economic methods and assumptions for each benefit category, including those deemed to be difficult to quantify, such as enhanced reliability. In most instances, benefit calculations are based on the attributes of the energy delivery assets and customers served by facilities selected by ComEd's for its DA program. For example, expected reliability benefits are based on actual outage histories and the number of customers located on feeders selected for feeder automation. Notably, ComEd has targeted its automated switching program to feeders experiencing the greatest number of sustained interruptions.

The impact and value of the DA programs are derived based on the incremental impacts and savings achieved. For example, demand and energy savings are calculated using marginal prices. Further, economic benefits are derived for all affected stakeholders: (1) the electric utility delivery company and its customers; (2) regional power supply; and (3) society at large.[1]

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[1] Results presented in this study also align with the Energy Independence and Security Act of 2007[1] definition of Smart Grid as defined under Title 13. This title broadly describes the theoretical Smart Grid as maintaining a reliable and secure electricity infrastructure that can meet future demand growth and serve multiple functions including: increased use of digital information and controls; integration of

Results are presented for each stakeholder category, and in aggregate. Where benefits span multiple stakeholder categories, benefits are presented separately for each. For automated feeder switching, values are presented on total dollar. For CVR, economic benefits are presented on both a total dollar, and dollar per megawatt-hour basis.

The methodology and assumptions NCI employed to calculate these benefits are also consistent with several recent DA studies that it has conducted for the Department of Energy, California Energy Commission, and renewable resource/smart grid integration studies for multi-stakeholder groups – several are cited in Appendix A. Most noteworthy is the use of value of service metrics to quantify reliability, the primary benefit derived from automated switching and fault isolation.

Stakeholder Categories

The analysis considers a broad range of operational benefits that are each assigned to one of three stakeholders including Utility/Customers (UC), Regional Power Supply (RP) and Society (SC). Benefits assigned to Utility/Customers bring a direct benefit to ComEd customers such as improved reliability and through reductions in outage time and reductions in interrupted processes. Often, the Utility is defined as the owner and operator of the energy delivery system, but not the service provider of electricity.[2] Because customers ultimately receive the benefits of reduced energy usage and utility operating benefits in rates, the Utility and Customer categories are combined for purposes of this evaluation. Benefits assigned to Regional Power Supply bring a direct benefit to ComEd customers such as lower energy costs, but also benefit other PJM customers outside ComEd's territory. The societal benefits category includes only those benefits that reach beyond local and PJM customers to benefit society at large; for this study, emission reductions were assigned to the societal benefits category.

A distinction is made between Utility/Customer and Regional Power Supply to distinguish between benefits that directly accrue to energy delivery utilities and its customers, versus benefits that are passed through to customers in the form of reduced power supply costs.

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distributed generation, demand response capability, advanced energy storage; and deployment of "smart" meters and appliances with advanced communication and controls.

[2] Many utilities with unbundled service, including ComEd, also provide bundled default service to customers that do not elect to purchase power from third-party suppliers.

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Benefits Evaluation

The following describes ComEd's distribution automation program for automated feeder switching and conservation voltage reduction. It also describes each of the applicable benefits assigned to each of these programs by stakeholder, including the methods and rationale underlying the benefits calculation. The primary benefits associated with automated feeder switching is enhanced reliability and reduced operating costs; whereas, CVR will result in lower line losses, reduced power supply costs, and lower fossil emissions.

Detailed Program Description

ComEd's DA and CVR programs, as filed under FOA 000058 are summarized below:

Distribution Automation (Automated Feeder Switching)

The Project will deploy approximately 700 automated devices on 12kV and 34kV distribution lines that will improve overall reliability and operation of the ComEd distribution system. It includes approximately 400 automated feeder loop schemes and 200 in-line reclosers. The auto-loop schemes and line reclosers will enable ComEd to continuously monitor the distribution system to automatically detect a fault or troubled line section and isolate this section, thereby preventing disruption of electric service to customers on the unfaulted line segment.

- **Cooper NOVA reclosers**: Three-phase, vacuum-interrupting devices for use on the 12kV distribution system
- **S&C Intelli-rupter, utilizing Pulse Closing technology**: ***(next generation technology)*** Used as a mid-circuit and/or tie reclosing device in the 12kV system. Pulse closing devices apply a very fast, low energy pulse to the line to reduce damaging fault currents and voltage sags on the faulted line as well as on adjacent feeders. Intelli-rupter utilizes the Intelli-TEAM II automatic restoration system and provides the ability to track system conditions on overhead and underground distribution systems and provide fast, fully automatic fault isolation and customer service restoration
- **S&C SCADA-Mate Automatic Line Restoration Switches (ALRS**): ComEd will install 90 ALRS on 34kV lines. ALRS switches provide remote feeder monitoring capability and automatic reconfiguration, and employ S&C Intelli-TEAM technology. ComEd will also perform an upgrade of all existing ALRS controllers to Intelli-TEAM 2 technology allowing enhanced sectionalizing and communication ability of teams.

- **Communication Network:** A highly secure and interoperable Silver Spring Networks mesh radio technology, including point-to-point capability to adhere to the interoperability and cyber security principals established by the National Institute of Standards.

These auto-sectionalizing devices will communicate with the Silver Spring AMI network and serve as collection points for facilitating data storage and outage analysis. They will also utilize the Silver Spring network as part of an overall migration to a cyber secure communications system at ComEd.

ComEd studies indicate automated feeder switching will reduce the number of sustained[3] customer interruptions (CI) between 300,000 to 400,000 annually, resulting in a composite SAIFI reduction of 0.1, almost 8 percent of ComEd's total system SAIFI.

Conservation Voltage Reduction (CVR)

ComEd will deploy CVR on nineteen 12.47kV feeders serving 23,000 customers out of two distribution substations: Oak Park and Berwyn. The composite peak demand projected for these substations in 2010 is about 106 MW. Using smart control algorithms designed for this application, CVR will regulate voltages over a narrower band and at a lower average voltage, but within the ICC limits.[4] For the CVR pilot, ComEd will reduce the substation voltage by 2.5 percent, resulting in a voltage reduction to most customers – voltages for some customers located at the end of the feeder may be at the 113 volt minimum under peak conditions.

To prevent violations of the voltage regulation standard, ComEd will utilize voltage measurements from AMI voltage sensors located near customers at the lowest voltage points, which will initiate switching of feeder capacitors to increase feeder voltages via centralized

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[3] The Institute of Electric and Electronic Engineers (IEEE) Working Group on Reliability defines a sustained outage as a continuous interruption of service of greater than 5 minutes. The automated switching schemes employed in the demonstration will restore service within the 5-minute threshold.
[4] Illinois Commerce Commission Administrative rules require that energy be delivered between 113 and 127 volts, inclusive, for customers taking service at a 120 volt standard; or plus or minus 10 percent for customers taking service at a voltage other than 120 volts. ComEd currently regulates substation bus voltage between 124 to 126V for all load levels.

controls as voltages reach 113 volts. Data from the voltage sensors will be analyzed to validate assumptions presented in ComEd's FOA application and the results presented herein.

CVR also provides monitoring functions for implementation of a condition-based maintenance program for distribution capacitor switch inspection. This deployment seeks to identify other additional benefits and requirements that could result from a broader implementation.

Specific attributes and characteristics of ComEd's CVR program include:

- Micro-processor feeder relays to monitor real and reactive power
- Digital substation transformer tap changer controls
- Digital controls for pole-top capacitor banks
- A central controller that minimizes feeder reactive power flow while maintaining minimum voltage delivered to customers by feeders
- Digital communications between sensors, capacitor controls and the central controller
- Use of highly secure and interoperable mesh radio technology (Silver Spring Networks)

In order to confirm the limits of voltage reduction – a key objective of the project – ComEd will continuously test these algorithms and monitor performance, and make adjustments or changes when needed. AMI voltage sensors will be used to collect data and monitor performance.

ComEd studies indicate CVR will reduce annual energy consumption by 7,205 MWh. In addition, lower distribution losses achieved by reducing feeder and substation reactive loads via optimized capacitor switching will further reduce energy savings by about 180 MWh annually. The combined energy savings results will reduce annual energy consumption by approximately 1.6 percent for the 19 feeders selected for CVR. The reduction in energy consumption also reduces power plant emissions – up to 5000 MT annually of CO_2.

In addition to the above, automated condition monitoring is expected to reduce or eliminate the need to conduct annual field inspection of capacitors.

Assignment of Benefits to Stakeholder Categories

Benefits provided by DA technologies can be assigned to one or more of the three stakeholder groups. A total of 13 discrete benefits were identified as having sufficient economic value to warrant quantification for this study. These 13 benefits were then mapped and grouped into six primary benefit categories.

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Table 1 presents the benefits calculation hierarchy in matrix form. It also highlights which benefit applies, by program, and how these are assigned to the three stakeholder groups. The subsections that follow describe the methodology and rationale applied to quantify each of these benefits.

Table 1: Stakeholders and Benefit Categories

Benefit Category	Stakeholder UC	Stakeholder RP	Stakeholder SC	Benefits Achieved	
1. Reliability	✓			1	Reduction in Sustained Outages (DA)
	✓			2	Reduced Equipment Failure (CVR)
2. Energy Savings	✓	✓		3	Reduced Energy Cost (CVR)
3. Line Losses		✓		4	Lower Peak Demand Losses (CVR)
		✓		5	Lower Energy Losses (CVR)
4. PJM Capacity/Delivery Charges		✓		6	Lower Reserve Margin Requirements (CVR)
	✓			7	Reduced Capacity Costs (CVR)
5. T&D Operation & Maintenance	✓			8	Reduced Outage Restoration Cost (DA)
	✓			9	Reduction in LTC Maintenance (CVR)
	✓			10	Lower O&M Cost for Capacitors (CVR)
6. Emissions			✓	11	Lower CO2 Emissions (CVR)
			✓	12	Lower SOx Emissions (CVR)
			✓	13	Lower NOx Emissions (CVR)

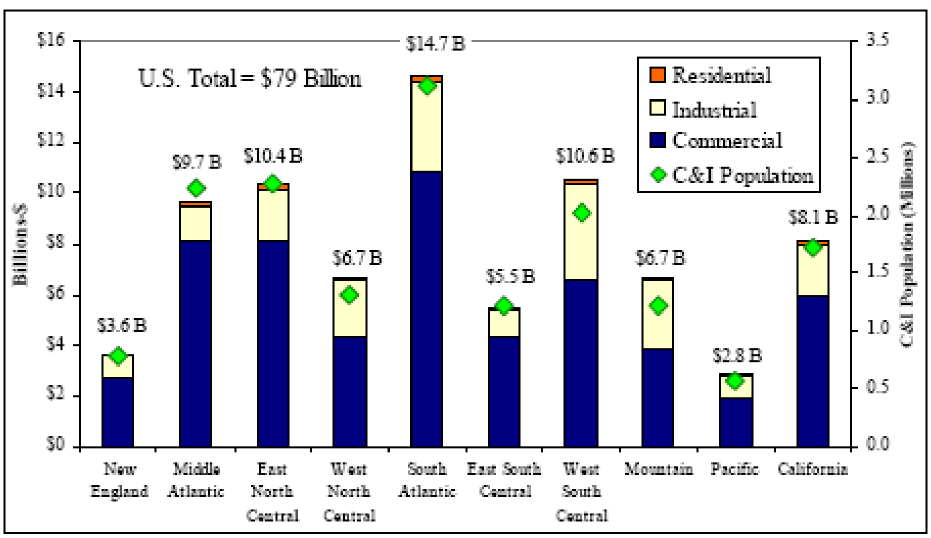
Each benefit category is described in the following subsections, including key assumptions and methods employed to derive economic savings. Benefits include operational expenses and capital savings. All savings are projected to recur annually, but should be escalated to account for real cost escalation.

Reliability

Improved reliability accounts for the majority of benefits for automated feeder switching. There is no reliability benefit assigned to CVR, although there may be benefits from reduced equipment failures achieved via voltage stabilization and tighter bandwidth; however, these would likely be small and not materially impact system reliability on such a small scale (19 feeders). Feeder switching does not eliminate line outages. It improves reliability by significantly reducing the length of time – from hours to minutes or seconds – to restore power to customers located on unfaulted line sections. This reduction is achieved via automated switching using control logic and algorithms designed to locate and isolate line faults, and transfer customers on unfaulted line sections to adjacent feeders. It reduces sustained outages as measured by the System Average Interruption Frequency Index (SAIFI). For example, a feeder loop scheme with two mid-point switches and a single feeder tie serving 4000 customers (2000 on each of the 2 feeders) would see a reduction of 2000 customer interruptions if the main line section of each feeder experiences one outage per year.

Reliability benefits are quantified by multiplying the reduction in customer interruptions, by the weighted customer class value of service (VOS) for sustained outages. Values for VOS vary significantly by customer class, as the impact of customer interruptions is far greater for commercial and industrial customers. Derivation of VOS has been studied extensively over the past several years, as the impact of reliability on utility customers is substantial. Recent studies by the Lawrence Berkeley National Laboratory (LNBL), New York State Energy Research Agency (NYSERDA) and private firms, including NCI, have estimated the cost of reliability to consumers and electric utilities. A recent study conducted by LBNL estimates the impact of outages at over $100 billion annually. The cost of reliability is presented in Figure 3 for regions in the U.S. The estimated annual cost of outages in the region that includes ComEd is over $10 billion.

Figure 3: High Case Estimate of the Cost of Power Interruptions by Region and Customer



[1]Costs shown in U.S. 2002 CPI-weighted dollars

Source: Cost of Power Interruptions to Electricity Consumers in the United States (U.S.); Feb 2006; K. Lawrence Berkeley National Lab, Contract No. DE-AC02-05CH11231; Kristina Hamachi LaCommare and Joseph H. Eto.

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For this study, base case values are based on a 2009 study completed by LBNL. Table 2 summarizes weighted value of service costs for a given average Customer Average Interruption Duration Index (CAIDI) value. The 2.5 hour estimate was provided by ComEd based on the outage duration over the past five years. The value of $174 was used for the base case scenario, while $225 and $148 were used for the high and low case scenario respectively.

Table 2: Value of Service for a 2.5 hour outage

Sector	Weighted VOS Rate ($/interruption)
Residential ($)	$4.6
Commercial ($)	$169.4
Total Weighed	**$174.0**

Note that the impact of outages to industrial customers does not apply for automated switching of distribution feeders, as large industrial customers typically are served by dedicated facilities or directly from the transmission system. The percentage split between residential and commercial customers associated with the feeders selected for the demonstration project is approximately 90/10. Based on this percentage split, the weighted VOS applied to each customer interruption is $174. Using an average restoration time of 2.5 hours (CAIDI) and average customer demand of 3.5 kW yields a VOS of approximately $20,000/MWh, a value commonly cited in industry studies.

The second area of potential reliability savings is reduced equipment failure for voltage regulating devices used for CVR; mostly load tap changing (LTC) devices on substation power transformers and voltage regulators. Benefits are derived from the reduction in equipment failures due to fewer LTC operations and stabilized voltages, and from condition monitoring of capacitors. Although tangible, the savings are likely to be very small compared to other benefits. However, if the pilot program for CVR expands to include a greater number of feeders, additional reliability benefits may apply. This could include expanding the condition monitoring program to include devices other than line capacitors. Proactive monitoring of other equipment, particularly those with high failure rates, would enable ComEd to proactively monitor equipment to detect incipient equipment failures, and take corrective action prior to failure.

Energy Savings

The Conservation Voltage Reduction (CVR) reduces energy consumption at the customer level is achieved by lowering feeder distribution voltages, yet remain within ICC allowable ranges; particularly line-end customers where the drop typically is greatest. Voltage reduction is

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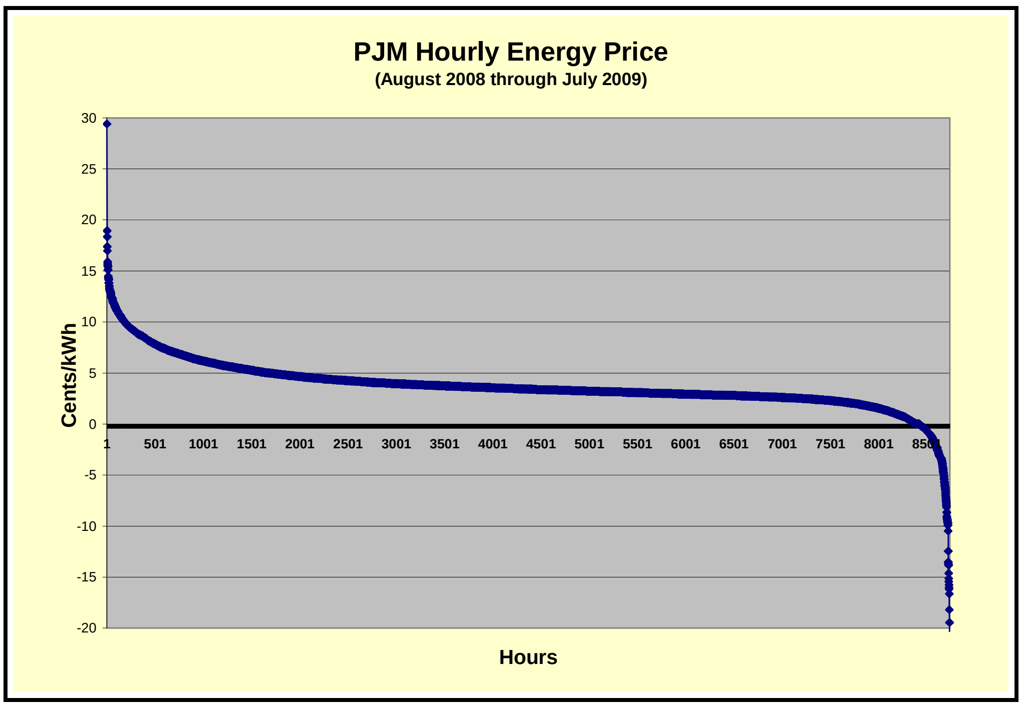
achieved by decreasing voltage at the substation low-side bus; usually via the transformer LTC. For each of the 19 feeders, ComEd proposes to reduce voltages by 2.5 percent for all hours of the year. Customer energy consumption is reduced in an amount proportional to the amount of voltage decrease.

CVR reduces energy deliveries that otherwise would be supplied by ComEd or third-party suppliers. Benefits are assigned to the Utility/Customer stakeholder category, as all energy cost savings are assumed to flow through to the customer, either via third-party suppliers or by ComEd via provision of bundled service. The value of reduced energy consumption is calculated based on the PJM avoided costs for August 2008 through July 2009. Figure 4 presents PJM's avoided cost profile during this time frame. Notably, for most hours of the year – over 7500 hours - the PJM price is below five cents per kilowatt-hour. It increases to over ten cents during peak hours, which is less than 200 hours.

Figure 4: PJM Avoided Cost Profile



Energy savings were allocated over seven time periods based on the avoided PJM energy charges for the time interval. Table 3 presents the analysis, which results in annual energy savings of approximately $272,000 for CVR.

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Table 3: Allocated Energy Savings

Hours	Percent of Hours	PJM Energy Price ($/MWh)	Load Reduction ()kW)	Energy Savings (MWh)	Interval Savings ($)
183	2.1%	119	1,789	150,938	$18,027
280	3.2%	89	1,761	230,943	$20,569
620	7.1%	68	1,718	511,374	$35,025
1819	20.8%	48	1,624	1,500,304	$71,575
4856	55.6%	31	1,348	4,005,210	$125,096
661	7.6%	12	612	545,190	$6,439
317	3.6%	-32	511	261,460	($5,186)
8736	**100%**			**7,205,419**	**$271,545**

Line Losses

Reduced line loss savings are achieved on feeders with CVR controls by optimizing capacitor switching and substation LTC to reduce reactive loads on distribution feeders (i.e., higher power factor). Because losses are greatest when loads are highest, the cost of energy usually is highest during these hours as well. Hence, the average avoided cost of energy production was weighted to the highest load hours. In addition, NCI estimated the loss reduction at peak, which is typically twice the value of average line losses. Because the feeder peak is nearly coincident with the system peak, it is appropriate to apply avoided production capacity credits as well. ComEd feeder simulation studies produced energy loss data for CVR, estimated at 180 MWh annually.

The value of DER loss benefit improvements is estimated by applying avoided generation demand and energy costs to the derived loss savings. These savings are allocated to the Utility/Customer stakeholder category as these benefits ultimately will reduce loss factors used to adjust PJM capacity and energy charges.

PJM Capacity and Delivery Charges

The reduction in energy usage reduction (and line losses) achieved by CVR also decreases costs via reduced PJM generation capacity and delivery charges. Although small (due to the limited size of the CVR demonstration project), system demand on the PJM system is reduced, with the maximum reduction occurring during peak hours. In addition, the lower overall demand also results in a smaller amount of generation capacity needed to meet PJM reserve margins.

The total reduction in peak demand achieved by CVR at peak is about 1800 kW. Combining PJM's $3.21/kW capacity and ComEd's $5/kW delivery charges yields annual savings of about $160,000. These savings are assigned to the Utility/Customer stakeholder group as these charges ultimately are reflected in a reduction in the customer's bill.

As a result of the load reduction achieved by CVR, the amount of capacity needed to meet PJM reserve margin requirements also declines. Assuming a 15 to 20 percent PJM reserve margin requirement, the total demand reduction is about 2500 kW. Using an avoided gas-fired peaking unit as a proxy, the annual value of deferred capacity is estimated at $75/kW-Year. Total annual savings for the reserve margin component is approximately $30,000.

Transmission and Distribution Operations and Maintenance Savings

Discussions with ComEd operations staff revealed several areas where DA could provide operations and maintenance (O&M) benefits. One benefit results from reduced travel time for crew dispatch in response to line outages for automated feeder switching. In general, this benefit provides operational benefits via the crew dispatch time saved by using automated switching to isolate faults and transfer load to unfaulted line sections.

The other primary benefit is the elimination of annual capacitor inspections by utility crews. ComEd's condition-based equipment monitoring program will be used to monitor capacitor switching operations, described above. Maintenance benefits are derived from the reduction in the range of steady-state voltage swings that regularly occur on distribution feeders. In addition, CVR will reduce preventive maintenance (PM) for voltage regulating devices; mostly load tap changing (LTC) devices on substation power transformers and voltage regulators.

Voltage regulation benefits were derived based on estimates of fewer maintenance intervals achieved by reducing the number of tap changing operations resulting from CVR voltage stabilization. Average LTC maintenance costs are estimated at $2200 annually for the Berwyn and Oak Park. Net PM benefits were estimated by assuming the average annual maintenance costs would be reduced by 15 to 25 percent.

Other potential operational expense savings, excluding energy cost reductions captured in other benefit categories, include feeder line maintenance and patrol, supervisory and administrative overhead expense, routine trouble calls including outage events, and customer service. However, these, too, were deemed to be small compared to other benefit categories, and omitted from the study. However, if the pilot program for CVR expands to include a greater number of feeders or to monitor additional equipment such as LTC's and regulators, additional benefits may apply.

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Emissions

This benefit category monetizes emission reductions achieved by energy from reduced energy usage and loss savings. The emissions offset achieved by CVR assumes the emissions offset from generation operating at the margin. For this study, we use ComEd's 2008 environmental disclosure data to estimate the emission rates of ComEd's resource mix. We assumed that nuclear does not operate at the margin and took the emission rate (lbs/kWh) weighted averages of the remaining fuel resources which consist mainly of coal and natural gas. The deployment of CVR, often coincides with peak demand intervals in the PJM system and reduces the need for fossil fueled peaking facilities such as NGCC or other gas-fired generation; for example simple cycle combustion turbines.[5] The value of emission offsets is based on NCI's 2009 fuel and emission price estimates which builds on data from EIA.[6]

Table 4 outlines the emission assumptions made for the four types of gases included in the study.

Table 4: Emission Estimates

Emission Type	Marginal Emission Rate (lbs/MWh)	Value of Emissions ($/ton)	Reference
CO2 Emissions	1,893	10-60	ComEd, EIA, NCI Estimate
SOx Emissions	3.23	300-700	ComEd, EIA, NCI Estimate
NOx Emissions	10.08	400-1,100	ComEd, EIA, NCI Estimate

Project Parameters and Key Assumptions

The assumptions used to derive savings and economic value follows. Wherever possible, DA and CVR data is from ComEd sources or operational experience, supplemented with information from credible sources such as the Energy Information Administration (EIA) and National Laboratory Studies. Study parameters not cited in the individual benefit categories are presented in Table 5.

[5] Senate Bill 1368 also supports this assumption as it requires emissions from new base load generation in California to be less than or equal to the emissions Natural Gas Combined Cycle plants.

[6] EIA Price of CO2 Forecast--Energy Market and Economic Impacts of H.R. 2454--Figure 5 Projection to 2030

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Table 5: Study Parameters

Parameter Type	Unit	Low	Base	High	Source
Avoided Customer Interruptions	Interruptions	300,000	373,000	400,000	ComEd FOA 58
Utility Restoration Costs	$/interruption	29	29	29	Data from ComEd
Avoided Generation Energy Costs to Customer	$ per kWh	0.038	0.038	0.053	Data from ComEd
Annual Energy Loss Reduction due to CVR	MWh/yr.	180	180	180	ComEd FOA 58
Weighted Average Marginal Energy Value	$ per kWh	0.0451	0.0451	0.0631	Data from ComEd
2010 Forecast Feeder Average Peak (KVA)	KVA	5,046	5,046	5,046	Data from ComEd
Voltage reduction	%	2.5%	2.5%	2.5%	Data from ComEd
% power reduction per % voltage reduction	%	75%	75%	75%	Data from ComEd
Marginal Distribution Losses	%	10%	10%	10%	NCI Estimate
Number of Feeders	Feeders	19	19	19	Data from ComEd
Monthly Value of PJM Capacity	$/kW	1.61	3.21	4.82	Data from ComEd
Monthly Value of ComEd Delivery Charges	$/kW	5.00	5.00	5.00	Data from ComEd
Reserve Margin Requirement	%	15%	18%	20%	NCI Estimate
CVR Effective Capacity	kWh/yr	1,789	1,789	1,789	Data from ComEd
ComEd Carbon Dioxide weighted w/o nuclear	lbs/MWh	1,893	1,893	1,893	ComEd 2008 EDI
ComEd NOx weighted w/o nuclear	lbs/MWh	3.23	3.23	3.23	ComEd 2008 EDI
ComEd SO2 weighted w/o nuclear	lbs/MWh	10.08	10.08	10.08	ComEd 2008 EDI
FOA Annual CO2 Emissions	MT	5,000	5,000	5,000	ComEd FOA 58
Annual Energy Reduction—CVR	MWh/yr.	7,205	7,205	7,205	Data from ComEd
Annual O&M cost for capacitors	$ per location	85	100	115	Data from ComEd
Pilot capacitor locations	locations	26	26	26	Data from ComEd
Annual Maintenance Costs	$	2,200	2,200	2,200	NCI Estimate
Percent reduction in Maintenance	%	15%	20%	25%	NCI Estimate

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Study Results

This section highlights the results of the benefits analysis for a base case with sensitivity applied to value of service, fuel costs, and emissions cost. The charts and tables that follow illustrate the extent to which each benefit contributes to the total, and how these benefits align with DA and CVR. Finally, the value of CVR is presented on a per megawatt-hour basis. Unless otherwise specified, assume all numbers in the results below are in 2009 dollars.

Distribution Automation (DA) Results

The greatest benefit from DA is derived from enhanced reliability; whereas, for CVR, the greatest benefits are from energy savings, emissions, and capacity benefits. Figure 5 provides an overview of the DA benefit categories and corresponding benefit estimate.

Figure 5: Distribution Automation Total Annual Benefits

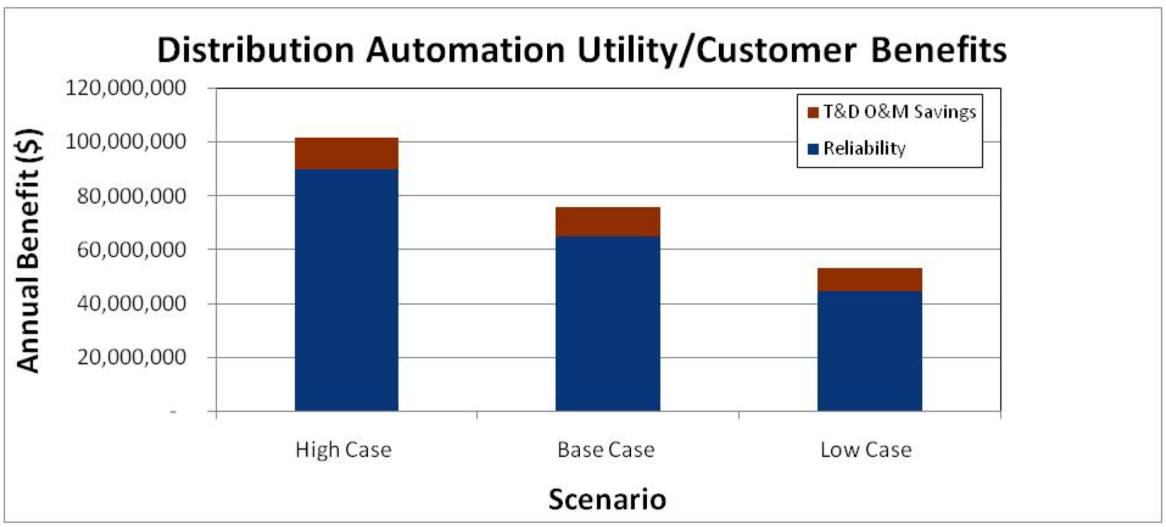

Table 6 summarizes the results for the DA benefits for each scenario. The only relevant benefit categories include reliability, and T&D operations and maintenance savings. All benefits accrue to the Utility/Customer stakeholder group.

Table 6: Distribution Automation Annual Benefits ($)

Benefit Category	Scenario	Utility/Customer
Reliability	High	90,000,000
	Base	64,900,000
	Low	44,400,000
T&D O&M Savings	High	11,600,000
	Base	10,800,000
	Low	8,700,000

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Conservation Voltage Results

Figure 6 summarize the CVR range of benefits by stakeholder. The utility/customer category receives most of the benefit.

Figure 6: Conservation Voltage Reduction Total Annual Benefits by Stakeholder

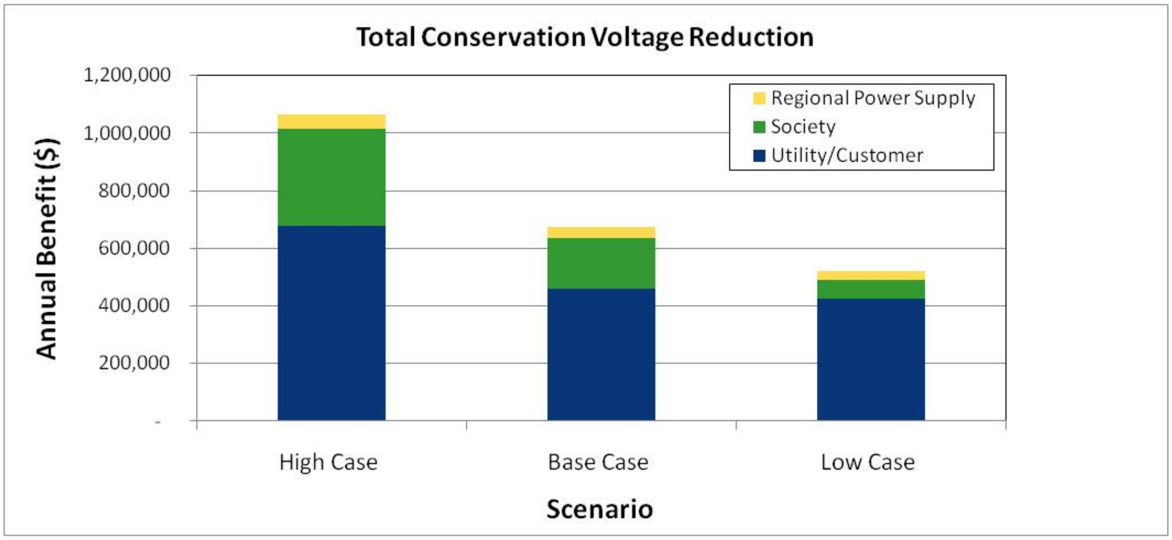

Table 7 estimates the dollar per MWh benefit of CVR for the base case scenario using 180 MWh/yr in line losses and 7,205 MWh/yr in reduced energy consumption.

Table 7: CVR Benefits

Benefit Category	Base Case Totals	$/MWh
Energy Savings	$286,000	$39
Emissions	$175,000	$24
Deferred Generation	$187,000	$25
Losses	$26,000	$3.5
T&D O&M Savings	$3,000	$0.41
Total	**$677,000**	**$92**

Figure 7 provides more detail on the breakdown of each relevant CVR benefit category for the high and low scenarios. Energy savings provides the largest benefit followed by emissions reductions which has a wide range resulting from the current uncertainty of federal regulations (e.g. H.R. 2454) on emissions.

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Figure 7: Conservation Voltage Reduction Annual Benefits by Benefit Category

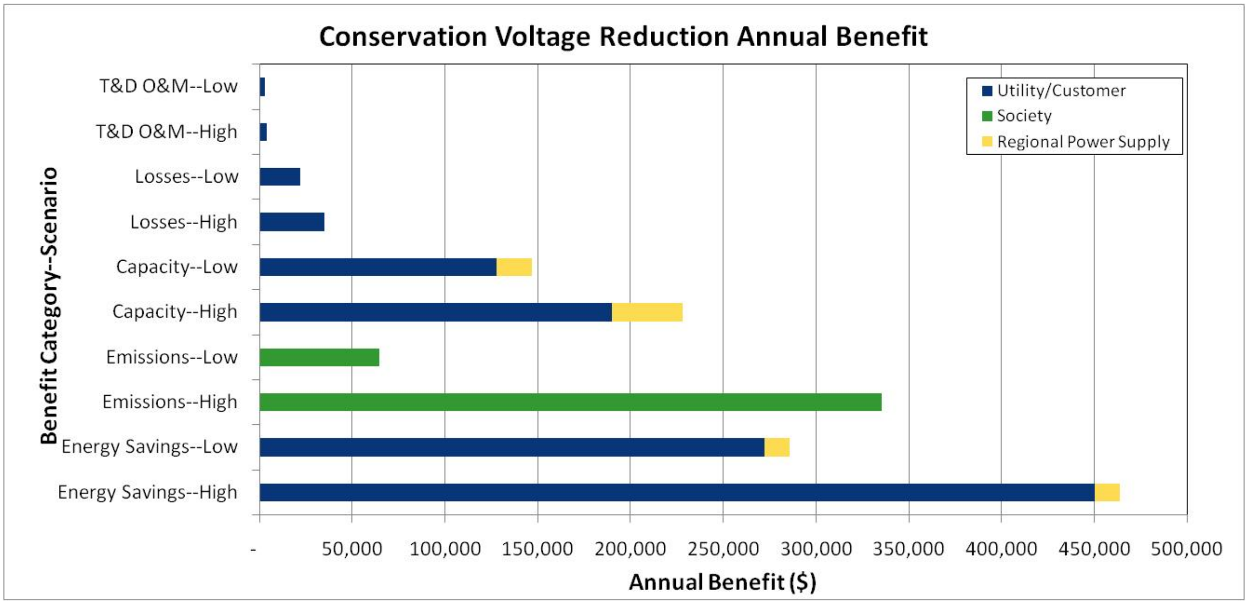

Table 8 lists each CVR benefit category, scenario, stakeholder, and corresponding dollar benefit.

Table 8: CVR Benefits Summary

Benefit Category	Scenario	Utility/Customer ($)	Society ($)	Regional Power Supply ($)	Total ($)
Energy Savings	High	450,000	-	14,000	464,000
	Base	272,000	-	14,000	286,000
	Low	272,000	-	14,000	286,000
Emissions	High	-	335,600	-	335,600
	Base	-	175,000	-	175,000
	Low	-	64,500	-	64,500
Capacity	High	190,000	-	38,000	228,000
	Base	159,000	-	28,000	187,000
	Low	128,000	-	19,000	147,000
Line Losses	High	35,000	-	-	35,000
	Base	26,000	-	-	26,000
	Low	22,000	-	-	22,000
T&D O&M	High	4,000	-	-	4,000
	Base	3,000	-	-	3,000
	Low	3,000	-	-	3,000

Summary Assessment and Conclusions

The results of ComEd's DA and CVR program assessment, described herein, indicates substantial benefits may be achieved via automation, particularly when stakeholders other than the energy delivery service provider are included in the evaluation. The monetary value of these applications is underscored by the significant reliability benefits associated with reducing the number of sustained customer interruptions

For CVR, the greatest benefits to Utility/Customers derive from reduced energy consumption, followed by avoided regional capacity costs. Although measurable, operating benefits are lower than the displacement of energy and capacity.

Key results and findings include:

1. The composite annual value of ComEd's DA and CVR ranges from $54 to 103 million or roughly $76 million for the base case scenario.

2. Automated feeder switching provides substantial benefits via the reduction of sustained interruptions. When fully implemented, the program has the potential to reduce SAIFI by approximately 0.1 or 8 percent of total SAIFI. The value of avoided interruption to ComEd customers accounts for most of the dollar benefit—approximately $53 to 102 million annually, which includes reduced T&D restoration costs of $9 to 12 million.

3. The collective avoided demand and energy costs associated with CVR produces annual benefits of approximately $680,000 for the base case scenario. On a per unit basis, this value is $92/MWh.

4. The uncertainty of federal emissions regulations results in high variability of CVR societal benefits in the sensitivity analysis.

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