Project 13-7:
Conservation Voltage Reduction (CVR) Evaluation

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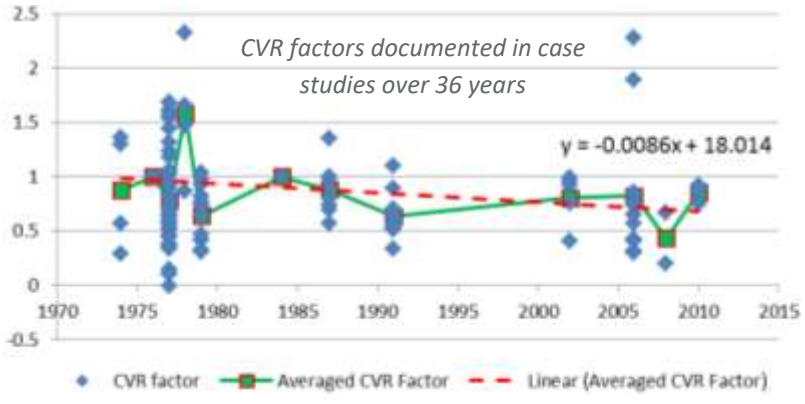
Project Summary:

Conservation Voltage Reduction (CVR) is a method of reducing power demand and energy consumption by lowering voltage within allowable limits. For years, distribution utilities have used CVR to temporarily reduce the MW loading during the peak load hours on individual feeders or stations, and in some cases, across the system. CVR was implemented typically in the event of equipment overload and/or system contingencies, giving system operators time to restore the system to a more secure configuration.

The first applications of CVR were seen in the 1970's precipitated by the oil crisis. Since then, there have been several successful implementations, as well as studies/evaluations of methodologies and outcomes. This study evaluated several relevant papers and reports that address Load Models, CVR Factor, Voltage Regulation, CVR Benefits, CVR Implementation Costs, and Challenges. The CVR factor is a widely adopted metric for power demand change versus voltage change. For real and reactive power, the CVR factor is:

$$CVRp = \frac{\Delta P / P_0}{\Delta V / V_0} \qquad CVRq = \frac{\Delta Q / Q_0}{\Delta V / V_0}$$

The CVR factor is different from substation to substation, feeder to feeder, and load to load. It is primarily determined by the end-user's load mix, and modified in the aggregate load by voltage control devices (e.g. regulators and switched capacitor banks) along the feeder. In the reviewed literature, 109 CVR factors were found in case studies on utility feeders and substations. Most of these cases involved feeders with residential loads or a mix of residential and light commercial loads. The chart below shows the CVR factors from case studies as a function of the year of publication. The plot shows that over the years there has been a slight decline in the average CVR factor reported. This trend is thought to be a result of changing load characteristics on distribution feeders. Research shows that loads are becoming more electronic and active in nature. The resulting changes in load voltage dependency impacts how aggregate load responds to changes in voltage.



With the emergence of advanced technologies, utilities have a greater ability to deploy effective CVR strategies to reduce peak demand, energy delivered during high-cost periods, overall energy demand, and generation emissions (where applicable). As the popularity of modern-day CVR implementations increase, utilities would like information to enable them to evaluate the effectiveness of CVR and maximize the potential benefits.

This report summarizes the results of a comprehensive study, including general discussion, literature review, practical guidelines, and findings from case studies. A detailed benefit/cost study of five representative feeders is documented in the report to quantify the cost-effectiveness of CVR implementation on the feeders, including load balancing, fixed and switched capacitor banks, voltage regulator application, and control strategies from basic local control to advanced centralized control.

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Who Should Use:

Distribution Operations, Planning, Standards Groups

For the complete report on Project 13-7: Conservation Voltage Reduction (CVR) Evaluation, visit www.dstar.org.

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