Grid Modernization Case Study

Unlocking Demand Savings with Decentralized Volt/-VAR Optimization (VVO)

Electric utilities today are at the cusp of a new paradigm within the distribution grid landscape. From increasing Distributed Energy Resource (DER) penetration to more extreme weather events, the planning and operational challenges are becoming more complex. Yet, basic customer service expectations to continue safe, reliable, and affordable energy delivery remain of the utmost importance. As a result, many utilities are focused on programs under the context of "grid modernization" - evaluating and deploying a mix of solutions for the appropriate applications to meet their specific challenges.

One important application is Volt/VAR Optimization (VVO). Far from a new concept, VVO is a proven method of distribution management to reduce energy consumption, lower peak demand, and increase system efficiency. Over the last two decades, a number of utilities have evaluated and deployed Conservation Voltage Reduction (CVR). As a subset of VVO, the successful execution of CVR involves taking actions to first, flatten the distribution feeder voltage profile and second, lower the voltage at substation. As a result, utilities have the operational flexibility to obtain target

Conservation Voltage Reduction (CVR), focuses on flattening and then lowering the feeder voltage profile to reduce demand and energy consumption.

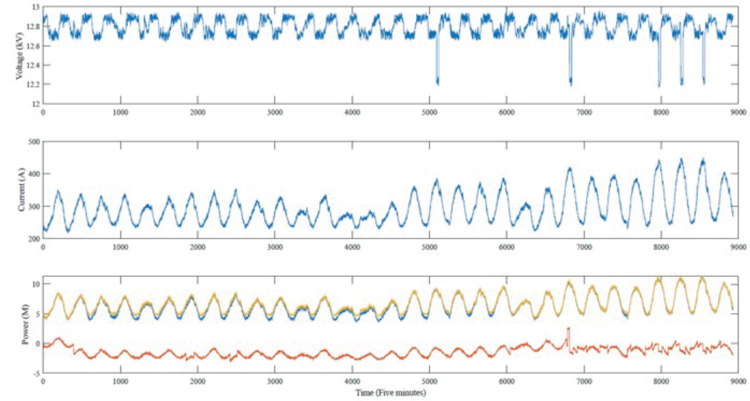
outcomes while supplying all customers with adequate voltage.

While there have been many successes, the full cost savings potential can at times become difficult to achieve because of voltage quality issues. These often occur at scattered locations where lowering the voltage on the primary side correlates to ANSI range violations. Moreover, the complexity of outages and system reconfigurations make these "limiting locations" a moving target depending on the as-operated network state.

Without addressing the limitations associated with additional voltage reduction, VVO/CVR projects have a lower chance of expanding system-wide. Achieving the target outcomes should focus on two key aspects. First, having the network visibility up front to validate the approach meets performance expectations and second, executing with the right tools necessary to realize the full cost savings potential of demand reduction through tighter voltage control.

Feeder Level CVR Analysis

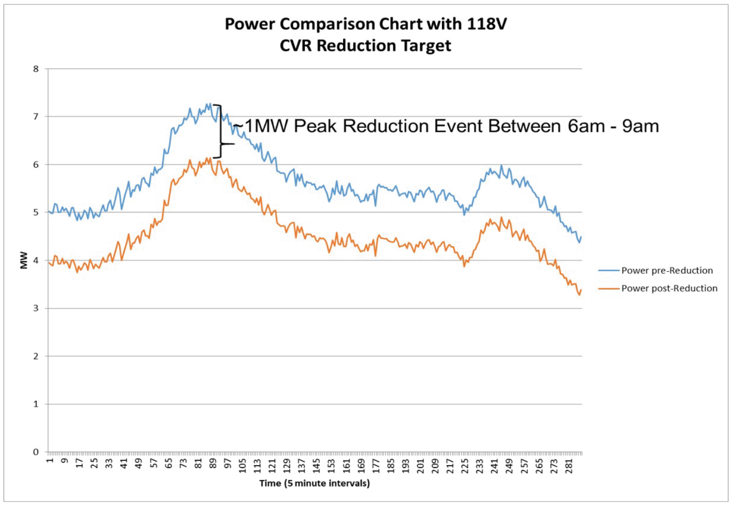
Managing voltage levels during peak demand periods in electric power distribution systems is the principal concern for planners and operators to maintain reliable and stable electrical systems. With this goal in mind, a utility in the southeast United States worked with GridBridge to evaluate the amount of demand reduction potential given a target feeder voltage reduction level. Baseline feeder voltage, current, real, reactive, apparent power, and power factor data measured for one month at the distribution substation were provided as shown in the chart below and loaded into a CVR analysis tool that was developed for the utility.



Voltage, current, and power profile supplied for the CVR analysis

With baselines obtained on the data, an impedance correlation was established to determine the CVR factor impact of the demand change relative to adjusting the voltage based on the actual load characteristics. Armed with this feeder data, the tool predicted demand and energy savings for this circuit after providing the new target voltage level and timeframe. An example of the peak demand reduction potential should an event take place on this given day is represented in the chart below.

After validating the benefit of demand reduction the next step was to put the approach in practice. For many distribution feeders, large voltage drops across a relatively small number of low voltage (LV)



CVR Analysis demonstrates 1MW of peak demand reduction savings potential with feeder voltage reduction to 7080V (118V on the secondary)

secondary services are what limit the overall voltage reduction opportunity.

The substation-based approach limits the ability to reduce voltage enough to maximize desired demand savings.

Existing approaches for CVR use centralized software to control substation-based equipment (load tap changers, voltage regulators, capacitor banks) to flatten and lower the primary voltage profile along the feeder. If nothing is done at the secondary, this approach is often not sufficient to lower voltages enough to meet desired savings goals without risking widescale under-voltage situations.

Results of Deploying Grid Energy Routers (GER) for Peak Demand Reduction

Understanding the limitations of substation-based control equipment, meeting the savings goal meant both actively managing the primary and simultaneously mitigating the distributed limiting loads in the secondary. By considering secondary construction standards, GIS and loading information (AMI voltage data is an option in as well, if available) from the feeder used in the CVR analysis, several sites were identified on the secondary as limiting low voltage points requiring correction in order to further reduce the overall distribution feeder voltage.

"Business as Usual" practices such as upgrading the distribution transformer or reconductoring the secondary may be an option for some utilities, but have constraints that include limited voltage impact, higher expense, and longer time to implement. These upgrades lack precision, do not respond to dynamic events, nor do they simplify planning for future DER penetration. All of these shortcomings will further challenge the long-term goals of a CVR program. Considering this, it was decided utilizing GERs was the best option for providing a pathway to increased visibility and control to maximize long-term savings.

Traditional upgrades have less precision, do not respond to dynamic events, and risk becoming short-term fixes as the grid rapidly evolves.

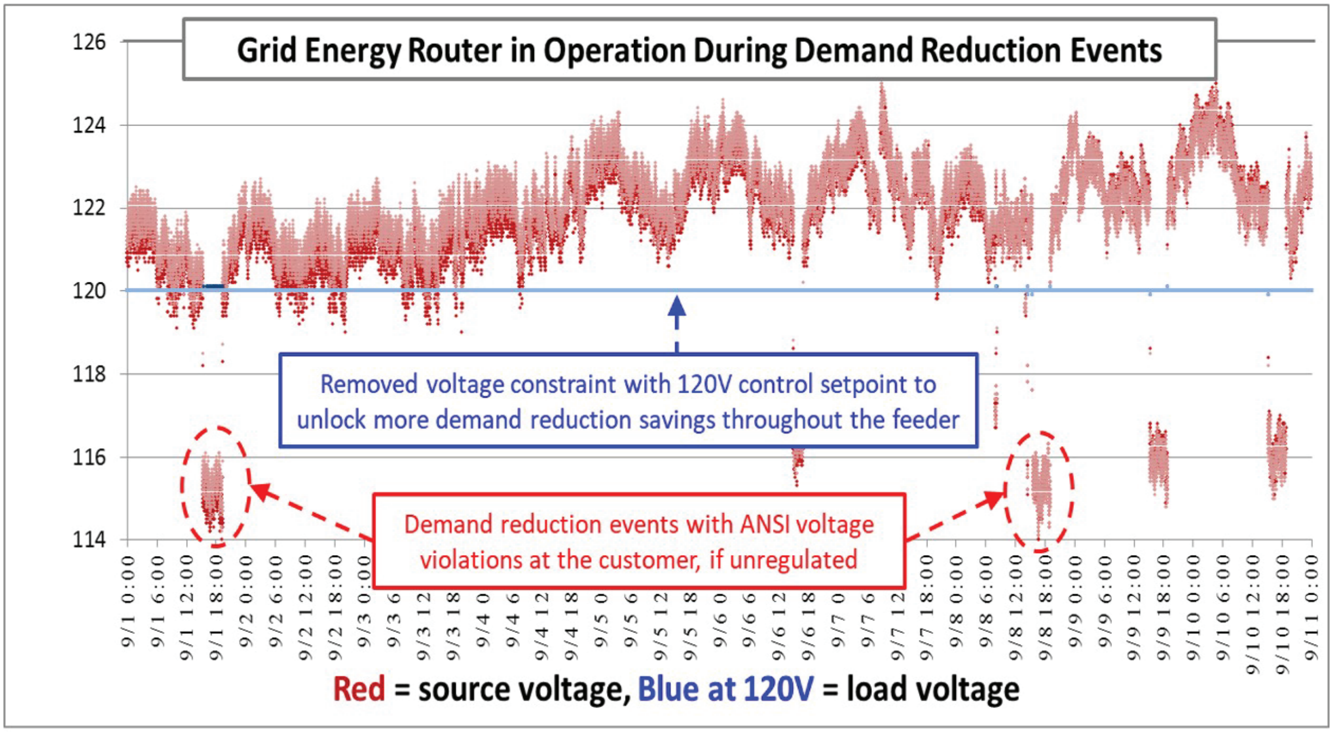
GridBridge GER installed to maintain customer voltage quality during peak demand reduction events.

ERMCO-GridBridge's GER is a power electronics-based device that is located at the transformer and controls power flow by adjusting voltage levels at secondary locations along a distribution feeder.

Operational performance at one particular location was monitored in greater detail as shown in the chart below. After commissioning this poletop unit downstream of the distribution transformer with a 120V setpoint, the unit instantly measured the source voltage and corrected the load voltage being delivered to the customer. During most of the operation, voltage was set at a constant 120V.

Given demand reduction events drove the source voltage down as low as 114V, the GER quickly and smoothly transitioned from bucking to boosting voltage up to the 120V setpoint. These fast and precise actions assured the customer would not experience low voltage violations.

With additional installations at the few remaining voltage constrained secondaries, GERs unlock the flexibility necessary to achieve the target voltage reduction and realize the predicted demand/cost savings. Through precise, continuous distributed voltage regulation, the visibility and control of LV secondary load voltages provide new capabilities to distribution engineers address both the technical challenges and business case requirements today and in the future.



GridBridge GER maintains precise 120V setpoint during normal and demand reduction event operation.