Model-Based Voltage Control vs Measurement-Anchored Optimization

A Technical Comparison of ADMS Voltage Control Capabilities and DVI Grid Solutions' EDGE® Platform for Advanced Voltage Optimization

EXECUTIVE SUMMARY

Utilities are leveraging voltage optimization to improve energy efficiency, reduce peak demand and capacity costs, and maintain system reliability while integrating demand-side resources. Traditional ADMS-based voltage control systems support these goals through centralized, model-driven approaches.

At the same time, newer approaches such as DVI's EDGE® Advanced Voltage Optimization (AVO) platform introduce a different paradigm: measurement-anchored control, leveraging AMI voltage data to inform operational decision making.

This paper examines how these approaches differ in planning, operations, and control, with a particular focus on how AMI data is utilized. While ADMS platforms have evolved to incorporate AMI in planning and validation workflows, EDGE® fundamentally changes how AMI participates in real-time decision making, enabling tighter control, more consistent Conservation Voltage Reduction (CVR) results, and effective Demand Response (DR) during peak times through its closed loop precision control.

DVI GRID SOLUTIONS

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Architectural Foundations

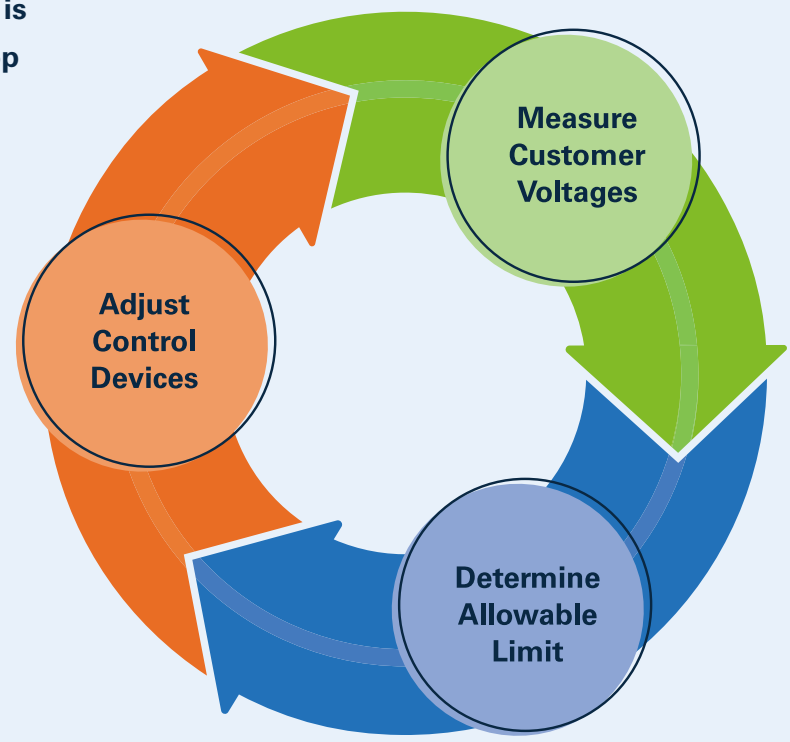
ADMS voltage control solutions from vendors such as Survalent, Schneider Electric, and AspenTech OSI primarily rely on centralized optimization engines that use distribution system models as the source of truth. SCADA (Supervisory Control and Data Acquisition) telemetry provides real-time inputs, while customer-level voltage is typically inferred. Because models are never perfect, safety margins are applied to ensure compliance.

In contrast, EDGE® uses AMI voltage measurements to understand actual customer conditions. These measurements help define the allowable operating envelope within which control actions are made. While EDGE® still relies on standard utility communications and SCADA systems, it shifts the source of truth from model assumptions to measured outcomes.

All models are wrong. Some models are useful.

Integrating AMI into ADMS solutions makes the models less wrong. EDGE® eliminates dependency on a model.

EDGE®'s architectural foundation is a measurement-based closed-loop precision control schema:



AMI Usage in Voltage Optimization Planning

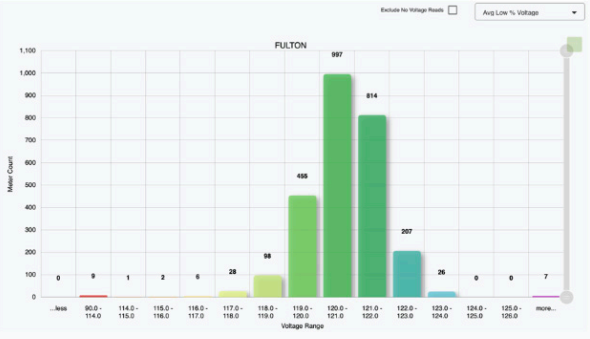
In ADMS deployments, AMI is most effectively used during planning. Utilities use AMI voltage profiles to inform the distribution system model, identify feeders with potential low-voltage issues, and determine where voltage reduction strategies such as CVR may be safely deployed.

According to our research among the various ADMS solutions, Schneider Electric's architecture is heavily model-centric and includes advanced metering integration and analytics capabilities that support the planning stage for voltage optimization.

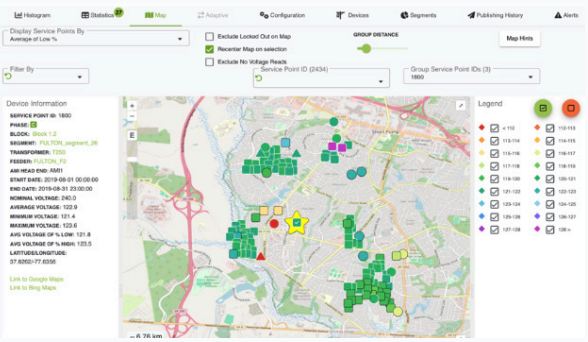
AspenTech OSI environments emphasize analytical validation and study-based refinement of the model used for planning purposes. Survalent deployments seem to make limited use of AMI data and often rely almost exclusively on the distribution system model for planning purposes.

DVI's EDGE® platform ingests historical AMI voltage data (typically 30 days) for all meters on a feeder and runs advanced analytics to identify chronic customer voltage issues that will limit voltage optimization efforts. Voltage readings for the feeder are displayed on a histogram as well as on a map so that analysis of potential issues can be accomplished in the backoffice before sending out a crew to investigate or remediate.

HISTOGRAM



MAP



Additionally, during the planning process, EDGE® guides the user through the process of selecting "bellwether" meters – a small subset of meters on the feeder that will be watched in real time during operations. Bellwether meters are typically the lowest voltage meters on the feeder, but EDGE® allows planners to "lock in" or "lock out" certain meters based on local knowledge. The use of a bellwether meter set for real-time monitoring significantly reduces the data payload on the AMI system, yet enables precision control during operations. Once a feeder's bellwether meter set is established, EDGE® then analyzes all voltage data on the feeder on a daily/overnight basis to determine if different meters need to be included or excluded from the set based on changes in the field – allowing for load growth, seasonal differences, and field issues to be detected in the future.

ADMS voltage control solutions look at AMI meters during the planning phase.

DVI's EDGE® platform listens to AMI meters throughout the planning, operations, and control phases.

AMI Usage in Voltage Optimization Operations and Control

In real-world ADMS deployments, AMI has begun to move into operational workflows, but typically in a supervisory role. AMI readings are often collected at some interval and used to validate voltage conditions and determine whether control actions should continue.

For example, deployments using Survalent have demonstrated voltage optimization programs using "near" and "far" meters as reference points during operations. AMI readings act as gating conditions; if readings are missing, the voltage reduction process is halted. AMI data is relied on for periodic validation, but not continuous control.

This approach is reasonable — and in many cases necessary — because **no distribution system model is complete.** Secondary conductors and connections, phase errors, unknown loading, and topology drift introduce uncertainty that cannot be eliminated, even with strong data governance.

EDGE® flips the script when it comes to AMI data and extends AMI use into continuous operational awareness and control. Rather than acting as periodic checkpoints, AMI data is evaluated continuously to understand available voltage headroom and guide control decisions within utility configured limits. Now the paradigm is "how low does the utility want to allow customer voltages to go on this particular feeder?" EDGE® figures out the rest. Control decisions are informed by the worst-case observed customers on the feeder, which are adapted (daily) as load and topology shift. EDGE®'s patented algorithms determine setpoints for grid voltage control devices in order to move customer voltages to the utility's preferred limit. Rather than relying on buffered, static margins, the system adjusts control actions based on observed customer voltage, enabling tighter and more responsive operation while maintaining compliance.

ADMS solutions do not work this way and rely heavily on the system model. What other utility grid control system relies on something other than measured output or response?

ADMS voltage control thinks in terms of target regulator setpoints, global feeder voltage profiles, mode-based control (normal, CVR, conservative). EDGE® thinks in terms of a continuously monitored voltage envelope, dynamic slack that is harvested whenever it exists, control outputs that adapt because customer voltage allows it. Voltage becomes an opportunity variable instead of purely a risk constraint.

With EDGE®:

- *Utilities define the minimum acceptable customer voltage.*
- *AMI voltage data reveals actual customer conditions.*
- *Control logic adapts based on measured response, not inferred profiles.*
- *The lowest voltage customers define the permissible operating envelope.*

ADMS voltage control solutions control the grid you think you have.

DVI's EDGE® platform controls the grid you actually have.

Voltage margins no longer exist as static buffers. They become dynamic, observed headroom.

This does not eliminate the role of SCADA, communications, or engineering judgment — but it fundamentally changes where certainty comes from.

CVR Implementation for Energy Efficiency

ADMS platforms are capable of delivering measurable CVR benefits. However, due to reliance on models and associated uncertainty, CVR operations are often conservative or conditional. CVR may be enabled during certain grid conditions and relaxed during others.

EDGE® improves CVR implementation in two ways.

Aggressiveness: due to EDGE®'s continuous awareness of worst-case customer voltages, utilities can elect more aggressive voltage reductions during CVR operations, providing additional energy efficiency savings to their customers.

Consistency: since control decisions are based on measured customer voltages and not model estimates, the utility can operate in CVR mode nearly all of the time regardless of grid conditions. This does not guarantee continuous CVR under all scenarios, but it improves reliability and operator confidence.

Because EDGE® knows exactly how low it can go and when it must back off, it can sit closer to the utility's lower voltage bound, stay there longer, return there faster after disturbances. This is why EDGE® delivers persistent CVR, not conditional CVR.

For electric utilities, this can mean big savings for their customers. For a typical electric utility with one million meters, 24,000 GWh annual sales, and 6,000 MW peak demand, a 1% additional voltage reduction could mean $34 million annual savings for customers.[1]

Additionally, during periods of communications latency, EDGE® uses recent historical AMI and SCADA data and predictive algorithms to "ride through" gaps in real-time data. The Predictive Ride Through capabilities enable AVO operations to continue for a period of time rather than reverting to default settings and compromising energy savings and demand reduction while communications are recovered.

CVR in ADMS is conditional.

In EDGE®, it becomes more consistently achievable.

[1] **Assumptions:** CVRf 0.8; $0.151/kWh electricity cost; savings at full deployment of EDGE®

Demand Voltage Reduction (DVR) for Demand Response

Demand Response represents an important extension of voltage optimization that is not typically implemented within the voltage control module of an ADMS system. In ADMS deployments, DR is typically event-driven and executed in discrete steps, often involving load curtailment rather than voltage reduction. When a DR strategy does involve voltage reduction, operator input is often required. Adjustments are stepwise and sometimes dependent on AMI checkpoints. In these situations, timing delays between measurement and action can limit effectiveness.

EDGE® enables a more integrated approach to Demand Response using Advanced Voltage Optimization. Because customer voltage is continuously monitored, the system can drive voltage toward the absolute lowest allowable limit during peak demand periods. Demand Voltage Reduction (DVR) can be implemented on a daily schedule (e.g. hot summer afternoons) without operator involvement or invoked on demand. With EDGE®, voltage is a demand lever. EDGE®'s customer voltage awareness provides continuous insight into available demand flexibility. Using that lever strategically allows peaks to be softened before they occur.

Taking things one step further into true grid emergency situations, EDGE®'s Emergency Voltage Reduction (EVR) mode enables even greater Demand Response when the grid is in extreme stress. During emergencies or certain operating conditions, EDGE®'s constant monitoring of worst-case customer voltages allows utilities to temporarily drop voltages down into the ANSI C84.1-B range (110 V on a 120 V nominal), unlocking even more capacity – often enough to avoid blackouts or other curtailment activities. The level of safety and confidence that EDGE®'s closed-loop precision control provides is not typically practical with traditional model-centric ADMS voltage control approaches.

For our typical electric utility, a 3% voltage reduction means 180 MW peak reduction on those hot afternoons, and up to 360 MW peak reduction (at 6% voltage reduction) during extreme circumstances. That's potentially a peaker plant that doesn't have to start up (or be built). It's most assuredly electricity that doesn't have to be purchased at peak pricing.

CVR defines the baseline efficiency posture.

DVR / EVR emerges when demand pressure rises.

CONCLUSION

ADMS voltage control platforms continue to evolve and make increasing use of AMI data, particularly in planning and validation workflows. However, they remain fundamentally model-driven systems. EDGE® does not replace traditional ADMS capabilities. Those systems remain essential for switching, outage management, and system-wide operational awareness and control. EDGE® operates where centralized models struggle most: at the customer edge, during volatility, and near the true lower voltage boundary.

EDGE® introduces a complementary approach by leveraging AMI as an operational constraint rather than solely a planning input. This enables tighter voltage control, improved consistency in CVR performance, and a more effective pathway to demand response through DVR and EVR modes.

So the difference is not about better algorithms or faster control loops. It is about truth. And when affordability, peak demand, and system constraints all matter — optimizing the grid customers actually experience is no longer optional.

It's essential.

The difference is the source of truth; what the system believes, versus what customers actually experience.

What's your voltage worth?

Let's Talk.

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