ADMS: The Substratum of Modern Age Power Distribution

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***Abstract*- High perforation of distributed energy resources and the progressively dynamic nature of distribution systems brings up many new challenges for the distribution system operators today. To handle and manage these remarkably huge changes, they need to take an active role in managing their systems and adapt to varying conditions in real time. Only a all-inclusive set of dedicated software tools combined into a robust solution can handle these challenges and guarantee a smooth transition from conventional, paper-driven processes to a digital and adaptive way of managing grids in real-time. These abilities are now offered by an Advanced Distribution Management System (ADMS).**

INTRODUCTION

From a conventional electric distribution system to renewables and electric vehicles, the conventional way of generating electricity and supplying it to end-customers was straightforward. The electricity was produced in bulk in large power plants, transmitted through HV lines to the supply stations, and then through distribution lines, distributed to consumers. Power-flow at the distribution system level was in a top-down, one-way direction with voltage dropping along the feeders as a result of natural energy losses. Old-style voltage regulating devices (voltage regulators, capacitor banks, etc.) were advantageously located at predefined positions and helped maintain voltage inside regulatory limits. Protection equipment was conventionally located at predefined critical locations and set to react on unidirectional fault currents (from the supply station to the fault location). Distribution protection, control, and metering were controlled by electromechanical devices, and almost zero automation existed at the conventional distribution system level. Subsequently, Distribution Network Operators (DNOs) at that time could control their grids manually, applying conventional paper-driven processes.

PRESENT SCENARIO

Nowadays, a massive paradigm shift is shaking conventional distribution systems operations: rapidly escalating utilization of Distributed Energy Resources (DER). The proliferation of DER use is being propelled by low-carbon initiatives announced around the world, greenhouse gas emissions from coal power plants & gas-fueled vehicles, the plummeting cost of DER such as solar photovoltaic (PV), wind energy storage (WES) and electric vehicles (EV). As the output from renewable DER are variable by nature, and time & location of electric vehicle charging is challenging to predict, these new resources present a high level of uncertainty and variability into the operation of distribution networks. Optimal coordination of these novel resources ensuring dependable grid integration and operation is still in its early stages. But the modern initiatives in grid automation and modernization applied by the combination of remotely controlled regulation, protection and metering devices, provide better situational awareness with the capability to monitor and control an increasing number of interconnected distribution grid assets. However, to defer the cost of retrofitting distribution circuits, they are being loaded more severely, nearer to their limits. This additionally complicates conventional switching procedures, as operators can no longer rely on having unused capacity on adjacent circuits for carrying out load transfers that help satisfy various operating objectives. Finally, outages triggered by some of the

most serious storms observed in recent history have left disastrous consequences to electric infrastructures that are not prepared enough and unequipped for such threats. To reduce the gap between conventional practices for managing distribution networks and modern practices necessary to address these challenges, and to have greater visibility and control and ultimately optimize grid-connected assets for reliability and financial objectives, conventional DNOs are heading towards a role involving more complex operations, called Distribution System Operators (DSOs).

DSOs' ACCOUNTABILITIES

DSOs must offer:

Dependable and affordable grid operations:-

- Ensure that the grid operates within the technical and operational boundaries providing reliable and consistent flow of electricity to customers.
- Empower the grid to be more resilient under circuit trips and generation loss.
- Coordinate with Transmission System Operators (TSOs) to support overall system optimization
- Support a rising list of customer demands.

Network investment planning:

Identify system-wide options for capacity provisioning including flexible energy services that help reduce traditional network investment and enable greater market participation. A more sophisticated, intelligent, and digital way of managing the emerging distribution system is crucial for DSOs. The implementation of an Advanced Distribution Management System (ADMS) platform becomes an essential ingredient to an efficacious future.

FEATURES OF ADMS

ADMS is an all-inclusive set of tools consisting of:

- Supervisory Control and Data Acquisition (SCADA) solution for remote control and monitoring of field devices.
- Outage Management System (OMS) solution for managing planned and unplanned outage events
- Distribution Management System (DMS) solution with a wide-ranging collection of advanced power applications for visualization, planning, monitoring, control, and overall management of the distribution system. In-short, ADMS provides the intelligence behind the optimal management of ever-changing distribution grids.

ADMS applications optimally coordinate the operations of various dispersed resources in real time to:

- Offer optimal voltage level across the distribution grid with bidirectional power flows.
- Set and coordinate properly protection equipment for feeders with high penetration of DER
- Avoid high expenditures in new grid assets by coordinating DER such as PV, EV and energy storage
- Predict future production of variable DER based on weather data output and usage trends and other important factors.
- Identify ways of transferring load during peak energy usage.

ADMS BENEFITS

There are many use cases that clearly demonstrate the value ADMS can deliver.

1. Manage voltage fluctuations and reverse power flows:-

Growing penetration of DER causes voltage rise, reverse power flow when the local load is low and generation is high. Traditional operations are not designed to handle such issues. These challenges cannot be solved without the harmonized and active control of DER output. ADMS can help identify issues and manage the active control of DERs in a coordinated fashion, and address and avoid the overvoltage and re-verse power flow conditions.

2. Coordinate irregular and discontinuous inputs to the grid:-

As the vast majority of DER are fueled by variable energy sources such as sun and wind, sudden loss of significant amounts of generation (e.g., when clouds pass over-head) can occur. Consequently, this can cause sudden and substantial voltage drops at their points of interconnection. Conversely, when the weather conditions clear, sudden restoration of high

amounts of power can produce high voltage rises. These effects can produce highly undesirable voltage fluctuations, and these effects cannot be solved with traditional voltage correction techniques. ADMS can simultaneously use a mix of traditional resources with actively managing smart inverters to absorb or generate reactive power, and in that way successfully mitigate adverse voltage conditions.

3. Assist EV integration to the grid at scale:-
The rising popularity of electric vehicles brings together new loading challenges that did not exist in the era of traditional distribution systems. Fast chargers of electric vehicles can certainly double the peaks of customers' demand. Moreover, it is difficult to confidently predict the exact periods of charging, and consequently the periods of peak demand. Therefore, without proper predictability and management of electric vehicles, their integration into the distribution grids can be very challenging. Only if they are properly managed, with an exact cognizance of the whole system and its correspondent constraints, can a high penetration of electric vehicles be safely integrated.

4. Enhance existing equipment and minimize new capital investments:-
To escape and defer new capital investments in grid assets, DSOs are pressured to use existing equipment in an optimal way. Optimal utilization of existing equipment can be attained through reduction of energy losses, peak shaving, and performing conservation voltage reduction (CVR) techniques. However, conventional ways of achieving these goals by using only traditional resources fail to provide an optimal solution in the novel distribution grid environment, especially when the penetration of DER is substantial. This is where the advanced ADMS applications designed to maintain optimal voltage levels by better utilizing existing assets, and more intelligently using a mix of traditional resources along with emerging grid edge technologies like smart inverters, can play a major role in helping DSOs achieve their desired goals.

5. Support higher levels of customers' engagement and satisfaction:-
In the present-days, where electrical appliances are used to execute almost every task essential for daily living, customers need a high level of the power quality and reliability. Hence, the customers are increasingly opting for more control over the energy future for sustainability, reliability and cost reasons. To accomplish the highest level of customer satisfaction, and prosper to offer new energy services, DSOs need to ensure that power distribution is reliable, affordable and supportive of a diverse energy amalgam. This cannot be successfully performed through old-style manual and often paper-driven processes.

CONCLUSION

Remarkable energy sector revolution poses substantial challenges for distribution utilities. Conventional paper-driven processes for managing formerly-overbuilt distribution grids cannot provide an adequate solution. Properly adapting to these changes requires the deployment of modern digital grid management technologies. An ADMS solution gives network operators a way to cope with increasing complexity and to pave the way for future business success amidst ongoing industry disruption.

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