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Flexible Grids of the Future

by Tanuj Khandelwal, CEO ETAP

Transmission operators perform a balancing act with grid supply-and-demand every day. Meanwhile, distribution operators work to ensure quality and continuity of service to end-users. Customers and regulators expect all to be done flawlessly. However, distributed energy resources (DERs) are creating unprecedented challenges for the electric grid. DERs are disrupting utility business models and operations at their core. Instead of transmitting and distributing power onto a grid they own and control entirely, electric utilities must adapt to a new energy landscape paradigm.

At the transmission level, the **challenges are linked to installed capacity, balancing, reserves, stability, lack of inertia, and lack of visibility at the distribution level**. Utilities have years and years of experience forecasting system loads and control of large, conventional generators to meet national or regional demands. Wind or solar-powered generators are a wild card, as generation is dictated by uncontrollable weather.

Additionally, instead of being able to count upon the **robust grid inertia** that the spinning masses of conventional thermal generators provide, operators now need to manage a grid, possibly with a much higher rate-of-change-of-frequency. Not only do renewable generators **create disturbances themselves, in lowering the grid inertia they allow any disturbance to last longer and propagate further**. With renewable generation, sudden spikes or drops of power can overburden the carefully balanced grid; either coming from bulk renewable generators connected at the transmission level, or by the aggregation of much smaller yet numerous distributed generators connected at the distribution level.

At the distribution level, the challenges are hidden loads, power feedbacks, and voltage quality issues. 'Hidden loads' refer to the share of consumption, covered by embedded generation, blocking direct visibility to the grid operator. Traditional operation systems manage only the net flow on the power lines, however accurate and complete visibility of the two components of the net flow (native consumption and embedded generation) is essential to many core distribution grid management processes. For instance; upon a fault, ensuring a faulty feeder is de-energized is paramount for the safety of workers in charge of the repair.

In addition, **protection setting schemes** are inverted with embedded generation; i.e., a DER that can provide substantial current during a short circuit fault can change the fault current pattern.

In further examination of the backfeed, imagine an entire neighborhood investing in rooftop kits. Mid-day, the sun beats down on those solar panels, but no one is home using the energy. The utility's transformer feeding the neighborhood, which had initially been architected for a load of "X" MW serving the customers, now sees a negative load of "2X" pushing back into the grid. Distribution transformers were not dimensioned for these types of scenarios.

Finally, voltage profiles that previously decreased alongside a feeder, from feeder's head to feeder's end, now begin to feature much more varied profiles along the feeder depending on the location of newly embedded generators or storage devices.

As these distribution level challenges aggregate up to the interface with the transmission level and transmission remains responsible for ensuring that enough power is running on the grid to match instantaneous consumption, Transmission System Operators (TSOs) and Distribution System Operators (DSOs) need close collaboration.

Utility leaders need an end-to-end solution to coordinate the modelling, monitoring, forecasting, and ultimately controlling and dispatching these new DER objects, across all internal and external systems and stakeholders.

United Kingdom's Electricity System Flexibility Initiative

In the UK, a nationwide "electricity system flexibility" effort has set a series of tasks before the country's six distribution network operators (DNOs). First, they have built up the technology to monitor and manage these distributed energy resources (DERs) on a large scale. Next, they have begun signing long-term contracts, or "flexibility tenders," to pay DER aggregators for storing and shifting energy usage in key locations and times, in order to avoid or defer grid upgrades.

The end goal of this effort, set in place by the regulator Ofgem, is to create markets that can align moment-to-moment DER flexibility with real-time grid needs. This is a major challenge, given the complexity of valuing and verifying the responsiveness of DERs outside the utility's direct control, considering additional on-the-fly capacity and resiliency.

Tapping the responsiveness of DERs to match the moment-to-moment power flows across a distribution network bsimultanously being reconfigured in real-time is a complex endeavour, even if those DERs are under direct grid operator control.

Ofgem devised a performance-based model RIIO (Revenue = Incentives + Innovation + Outputs) designed to encourage network companies to put stakeholders at the heart of the decision-making, innovating and delivering a low-carbon energy system, while investing efficiently to deliver value for customers.

For Britain's local electricity network companies, their current price control period (ED1, Electricity Distribution 1) runs from 2015-2023. ED2 (Electricity Distribution 2) will run from 2023-2028. ED2 will straddle from 2022 to 2030, when electric vehicles are being rolled out in the millions. In addition to electric vehicles, storage and more renewables will cause a lot of uncertainty at a domestic level as well as an industrial and commercial level. For the regulator to predict the future in a regulatory regime of eight years is a daunting task. The call is for ED2 to be shorter, else regulatory settlements and uncertainty mechanisms will be difficult to manage. Innovative solutions need to be introduced to combat the uncertainty.

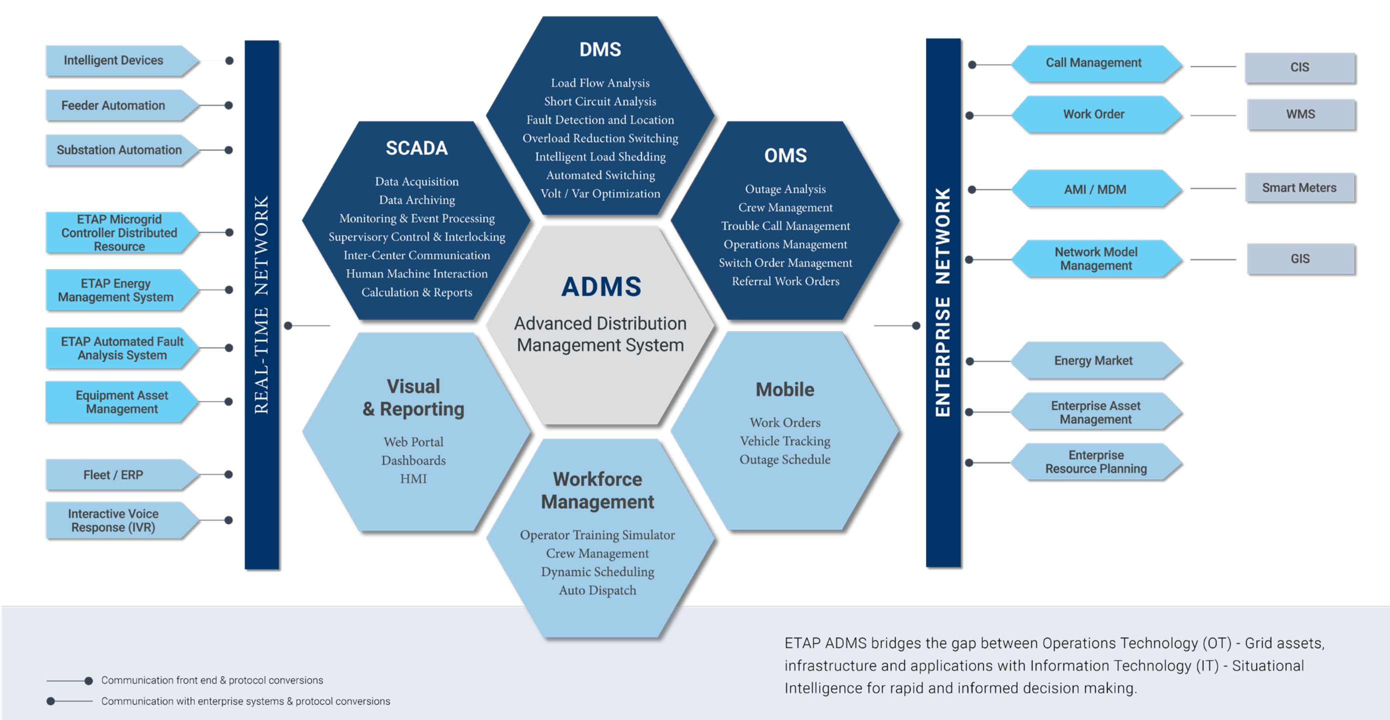
Network Planning

Utilities must prepare to better integrate additional DERs into their networks. This will strongly rely on modernizing the grid, optimizing network planning, maximizing the use of distributed generation, and creating an overall plan for improvement, including increasing the use of smart and connected tools and adapting advanced software and analytics.

Successful integration of DER into distribution networks is only possible using DER tools that maximize the use of distributed generation resources. They can provide global monitoring, control, and forecasting abilities of different DERs spread throughout the grid so utilities may observe, operate, and coordinate their use while ensuring high quality, reliable power.

DER management tools, such as an ETAP ADMS-DERMS, improve the areas of automation, communication, planning, and network management. For example, ETAP advanced distribution management systems (ADMS) is a comprehensive platform for distribution management and network optimization, which is central to improve DER use and management. ETAP distributed energy resources management systems (DERMS), either as a function of ADMS or stand-alone, are used for monitoring, awareness, control, and commands of networks. Utilities can use ETAP software with an enterprise asset management solution for efficiently planning, designing, and operating their infrastructure. Enterprise asset management technology allows utilities to create, manage, and disseminate geographic information utilize and manage their assets at full potential.

ETAP ADMS' hosting capacity heat maps improve DER integration and network planning because they enable the interconnection of all utility- and customer-owned DERs. This allows for fast validation when planning new DER connections. The heat map tool also qualifies DER's impact at all locations of the grid and checks the technical feasibility of DER connections, in addition to analysing alternative grid planning scenarios when connections are not possible.



ETAP ADMS bridges the gap between Operations Technology (OT) - Grid assets, infrastructure and applications with Information Technology (IT) - Situational Intelligence for rapid and informed decision making.

DERMS

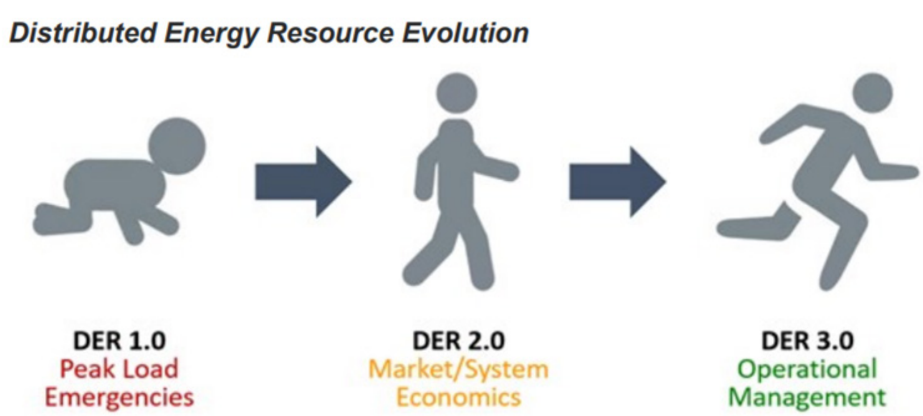
DERMS is an answer to the challenges of the Distributed Energy Future. DERMS are state-of-the-art systems that seamlessly integrate high penetrations of solar energy and other distributed energy resources into the grid. When properly deployed, their capabilities provide multiple benefits to both utilities and their customers, a win-win.

Consisting of a suite of software management tools that allow distribution utilities and wire operators to manage an array of DERs, they offer near real-time control of grid assets.

ETAP DERMS is a control system that enables optimized control of the grid and DERs, including capabilities such as Volt/ VAR optimization (VVO), power quality management, and the coordination of DER dispatch to support operational needs. It is coupled with ETAP ADMS and ETAP Microgrid Controllers allowing for a DER-ready ADMS.

There are many different technologies that are marketed under the name DERMS. As such, a request for a proposal for a DERMS is likely to see respondents that may not actually consider each other as competitors. Centralized DERMS solutions are available from some vendors. Others have taken a distributed approach and are placing more of the intelligence closer to the DER; yet other vendors are incorporating this functionality into DMS or ADMS. To date, few actual DERMS solutions have come to market in standalone form. While the focus of DERMS is often on (behind the meter) BTM assets, such systems can also optimize front-of-the-meter resource management and improve the overall grid stability.

DR and DER are evolving more broadly along a path where management technologies must grow along with the resources by incorporating faster and more discreet capabilities.



(Source: Peak Load Management Alliance)

Energy Storage

At the end of 2020, the UK had 19,000 GWh of gas storage, and only 1GWh of electric storage in the form of batteries. Multiple 100MW grid-connected battery storage projects are currently deployed across the UK and Ireland along with the rest of Europe and TESLA is rolling out their Megapack solution in Australia and USA. Adding larger and larger Lithium-Ion batteries to the grid, therefore increasing energy storage capacity, is also an essential part of the solution.