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WHITE PAPER / **GRID MODERNIZATION**

Changing the way the grid's future is planned

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The way we consume electricity is changing, placing demands on the electric distribution grid that its creators never envisioned. To address evolving needs, the grid must transform. Yesterday's grid planning methods must yield to holistic, data-driven distribution planning to optimize the investments of limited capital resources into grid infrastructure and maximize the effectiveness of transformative technologies.

How the grid is changing

Imagine life in the early decades of the electric distribution grid. Electric vehicles were the stuff of science fiction. Consumers couldn't conceive of rooftop photovoltaic (PV) panels or microturbines. Few businesses or universities dreamed of building their own microgrids. Homeowners accepted that sustained power outages were unavoidable. Electric utilities, which faced little or no competition, used available technology to deliver safe, reliable and affordable electric service to all customers.

Today's service-conscious consumers have increasing expectations. We expect utilities to harden their assets to minimize the impact of a storm or major disaster. Should an outage occur, we want a quick response and to know when the lights will be back on.

Modern consumers are increasingly eager for outage and grid health information on demand. That's not all. Some want rooftop solar, home batteries and electric vehicles. Others want easy access to details on our energy use and its impact on the environment, and we want to participate in energy efficiency and demand response programs. Customers seem to be interested in everything from dynamic pricing and green energy to community solar projects.

All of this while maintaining affordable rates.

The majority of electric utilities, however, are doing the best they can with the technology and budgets their forebears handed them. With few pressures to evolve the grid, utilities developed a "MacGyver"-like capability of maintaining the distribution grid using fewer resources every year. As a result, some utilities applied a "we'll fix it when it breaks" strategy to grid maintenance, wherein a majority of invested capital is focused on failed assets, rather than upgrades to meet emerging needs, opportunities and technologies.

It's comparable to taking a broken 1970s-vintage television to the repair shop to have a tube replaced instead of upgrading to the latest, smartest flat-screen technology. The repair might cost less, but the TV won't perform at the level today's consumers expect. This mentality, along with the slow adoption of new technology it engenders, goes a long way toward explaining why today's grid is ill equipped to meet future customer demands.

Components of holistic planning

- Load flow (voltage, loading, etc.)
- Subsystem performance (reliability)
- Network complexity
- Coordination, protection and system resiliency
- Failure risk, incorporating asset health and age
- Operational efficiency

A better approach to grid planning

Albert Einstein said: "We cannot solve our problems with the same level of thinking that created them." To transform the 21st-century grid, we need to think about it on a different level than our predecessors. Today we need more efficient, effective ways to identify problem areas and risk hot spots. We must rethink how we allocate capital resources, focusing not just on fixing problems, but on improving grid performance and finding comprehensive, sustainable solutions to the issues before us.

In short, the electric industry must recognize that it is on the cusp of a technological paradigm shift. It must replace the "break-fix" mentality with a holistic approach to decision making and grid capital planning.

To understand what that looks like, let's compare the two approaches and how each might handle a circuit voltage problem.

Think of a circuit like a tree with many branches. With traditional planning methods, utilities typically analyze one branch of the tree for a single issue at a time. Holistic approaches study the entire tree and the host of issues impacting it.

In the case of a voltage issue, traditional planning often results in studying the circuit's voltage in isolation. To improve it, planners might decide whether they wish to add or upgrade a conductor or place a voltage regulation device on the line. And that is usually the end of it.

Holistic distribution planning, on the other hand, begins with the big picture. Instead of studying a single voltage issue, a

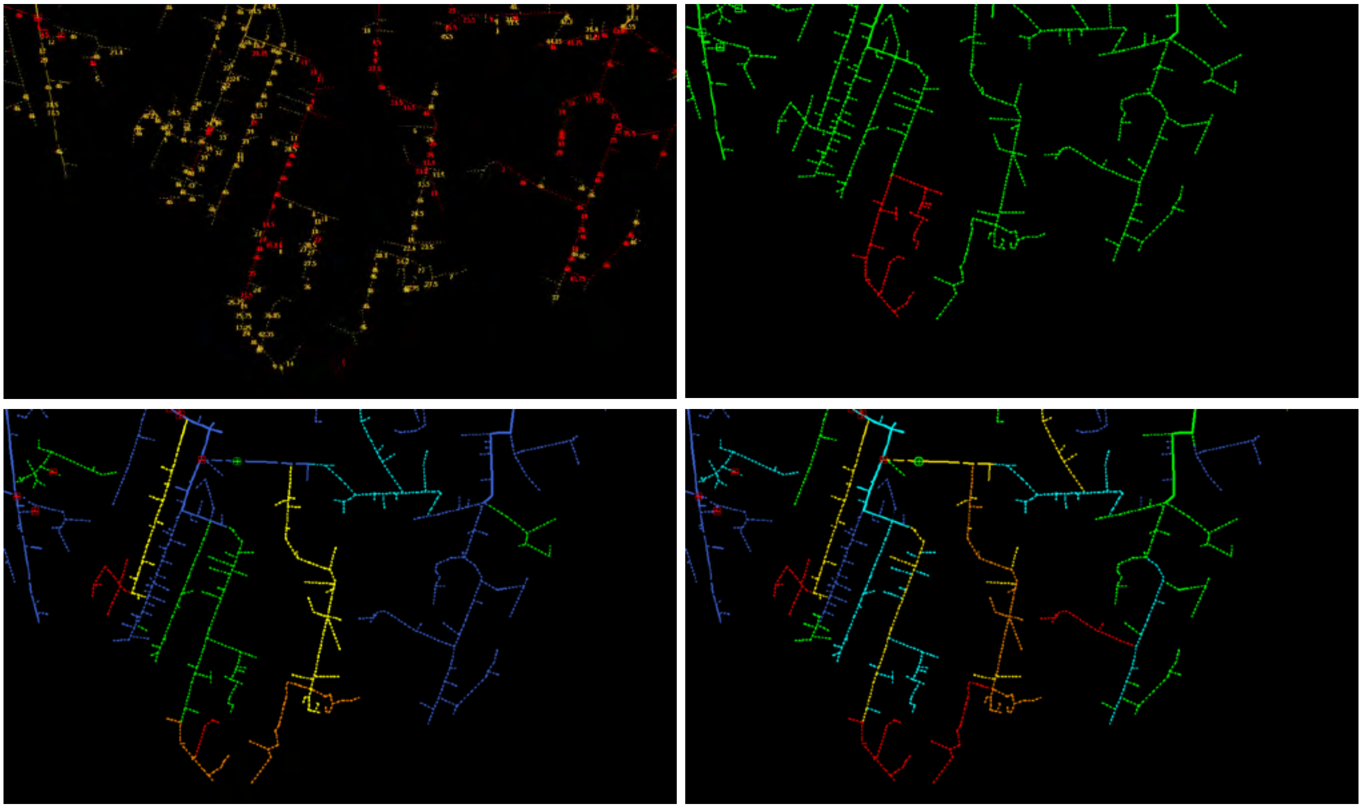

Figure 1: *Holistic analysis of data captures observations about (clockwise from left) asset health, voltage compliance, vegetation issues and performance (SAIDI).*

holistic planning strategy calls for examining everything from sub-circuit (and maybe surrounding circuits) device reliability data and forecasted equipment failure risk, to the operational waste associated with non-value-added truck dispatches.

An analysis of reliability data might find, for example, that this section of the system also has a history of vegetation events. While a new conductor would significantly increase the line's capacity and improve voltage, it would do nothing to prevent a tree branch from later falling on the line. A cost analysis might even find that the marginal cost of adding tree-trimming to a project would be small, considering trucks were already rolling to mitigate recurring issues.

Holistic planning doesn't end there; it also incorporates an asset management perspective. Further study on this voltage case, for example, might discover a significant population of poles or other assets nearing or exceeding the end of their useful lives. To minimize risk, it might make economic sense to replace the old assets cost effectively while the conductor is being addressed.

The added costs might lead the holistic planner to ask another question: If the poles and conductor are being replaced anyway, should we explore opportunities to reroute the line or go underground and eliminate the vegetation risk altogether?

As this example illustrates, broadening the line of questioning can dramatically alter the way a utility approaches a problem — and the circuit's long-term health and performance will be better for it.

These big-picture assessments are especially valuable when working with significantly outdated design and aged assets. By taking a step back, planners can assess reliability on a system level and prioritize investment in solutions that will have the greatest impact on system performance and reliability. Temporary patches take a back seat as planners focus their attention on the areas of a system with the greatest need, and on investments and design projects that don't just solve one problem, but a multitude of problems simultaneously. This holistic planning approach balances system performance, cost and risk for increased stakeholder value.

A way around the roadblocks

To be sure, holistic distribution planning is more complex than traditional approaches. It requires regular analysis of everything from load flows, reliability and risk reduction, total life cycle cost. Increasingly, it requires the evaluation of distributed energy resources (DER), defined as distributed generation, DSM/DR, electric vehicle (EV) charging and storage.

This level of analysis requires accurate and complete asset and system data, some of which hasn't always been readily available to planners. One of a holistic planner's first challenges, therefore, is to identify sources for a core set of system asset and performance data. In addition, accurate DER interconnection data will be needed. To be most useful, this data must then be funneled into a single database that planners can readily access to support both day-to-day problem solving and strategic capital planning to meet emerging needs.

Planning databases like this, however, are few and far between at present. To remove this roadblock, we developed a proprietary datacentric planning architecture and methodology that allows our utility clients to route data from multiple sources into a dedicated planning database. The coalesced data allows all of a system's or subsystem's characteristics to be considered, helping planners develop solutions that address all issues related to a section of the system in a single cost-effective project. The result: utilities get the biggest bang for their capital investment buck.

The planning tool supports both short-cycle work and long-range planning. Should a utility customer wish to install PV panels on a roof, for example, the database could be tapped for information on circuit changes and other needed alterations. Conversely, utility planners can draw on the database to forecast load movement, address electric vehicle charging needs, assess automated load transfer technologies, and formulate long-term strategies for emerging issues.

Three steps to grid modernization

By applying a three-phase process, this planning tool can be used on behalf of utilities pursuing a holistic distribution planning approach.

Phase one: Review current distribution planning practices

As a first step, we review a utility's current practices. That includes everything from design, engineering and construction standards to operating standards and guidance documentation. We also work with utility staff to assess the utility's existing planning processes and analytical tools, as well as the accuracy, quality and availability of system data.

Phase two: Examine the health of the distribution system

In the next phase, engineers take a close look at the age, health and performance of a utility's physical assets and the technologies associated with them.

This may include a field evaluation of the system and asset data quality. Power flow simulations are also used to assess current performance and adherence to best practices and standards. Further, system outage data is mapped to specific assets and circuit sections. The goal is to identify problem areas that might be targeted for investment.

Phase three: Develop an initial distribution investment plan

In this plan, the findings of the first two phases are used to define circuit- and asset-level projects that both address current problem areas and prepare for the next generation utility. This phase includes developing the processes, data and tools needed to execute day-to-day and long-term distribution capital planning effectively. Using simulations and data to quantify the benefit of individual projects in terms of loading, reliability, risk and operational efficiency, projects get prioritized using a scorecard that balances performance, risk and cost. Multiple investments are proposed across the system at the circuit level with associated quantified benefits to optimize the allocation of investment dollars in the distribution grid and improve overall system performance, risk and life cycle cost.

The foundation for grid transformation

The specific outcome of a holistic distribution planning process is different for every utility that undertakes one. But each should emerge with a solid foundation for planning its grid's future transformation.

Designed to optimize system performance, cost and risk, the resulting long-range distribution investment plan includes recommendations to achieve an upgraded set of distribution standards that support the consistency, performance and efficiency of utility operations. It also provides the framework, business process, guidance, technology and data that regulators seek, and which utilities need to perform ongoing short- and long-term distribution planning.

The shift to holistic distribution planning, in short, will change the way utilities think about and plan the future of their distribution networks. It not only benefits asset planning and management, but supports long-term capital planning.

Customers' demands on distribution grids are accelerating as the legacy assets continue to age. The time to move to the 21st-century, next generation utility grid is now.

Biographies

Jason De Stigter, PE, is the business line lead for capital asset planning at 1898 & Co, part of Burns & McDonnell, with 13 years of experience performing business planning case evaluations on a variety of project types to help utility clients with difficult investment decisions. He has a deep financial and economic analysis background. Jason has extensive experience modeling risk for utility industry clients, including developing complex and innovative risk analysis models using industry leading risk analysis software tools, employing Monte Carlo simulation, decision trees and genetic algorithms.

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