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Introduction

Electric utilities recognize the need for new network technologies to accommodate customers' growing interest in grid-connected, consumer-owned energy technologies, such as solar rooftops, energy management systems, and smart appliances. Left to a natural progression, the technologies will be disruptive to utilities. As policies that concern these technologies—customer choice, emissions reductions, weather-related outage response—begin to unfold around the globe, fundamental questions need to be answered by utilities. Should utilities begin to implement new network technologies now, before the demand for grid connection reaches critical mass? Or should they postpone implementation until trends are clearer?

Utilities can avoid both of these risky alternatives if instead they establish a strategy now to begin implementing network technologies that serve a dual purpose: solving today's problems, and laying the foundation for incrementally addressing future needs.

Balancing the Pace of Change

The history of technology is full of tipping points.\(^1\) One day, there's an intriguing idea—a laptop, a smart phone, a streaming video; the next, there's a product no one can live without. Connected consumers and prosumers are driving a number of these tipping points within the electric utility industry. These individuals and businesses desire to take control of their energy choice and want to be digitally connected with their suppliers like they are in other aspects of their life. They want information, control, options, etc.…..and they want access and control from wherever they may be.

Electric utilities face a number of consumer-driven potential tipping points among technologies that connect to the grid and that are owned by consumers and business customers. They fall roughly into two categories:

» Small distributed energy resources (DERs), such as large storage batteries or rooftop solar that can supply power to the grid. While regulations vary, the global trend is toward requirements that utilities both connect small solar and wind DERs to the grid and use the electricity they intermittently produce as part of their regular power supply to balance load.

» Smart, grid-connected equipment—home appliances, building-level energy management systems, electric vehicles, and the like—that can play a role in grid reliability as well as in demand response (DR) programs. DR programs increasingly encompass both large and small customers, and regulators clearly favor programs that use grid-connected equipment to embrace sustainable growth, meet peak demand, decrease supply costs, reduce air pollution, and lower customer bills.

Have technologies like residential solar and EV charging stations reached a tipping point? Most observers would probably say they have not. But both are growing at a rate much faster and being adopted far more widely than expected. Even utilities that at one time never expected these technologies to have much of an impact are now generally wondering when, not if, they will impact business.

Dealing with that uncertainty is a challenge. On the one hand, selecting and implementing those technologies now would be appropriate. On the other, immediate implementation could be seen as imprudent. In the relatively conservative fiscal environment in which most utilities operate, investments in technologies that are never fully used are unacceptable. An intelligent approach to balancing this uncertainty is necessary.

To resolve this dilemma, utilities must re-examine near-term plans for technology upgrades, expansions, and replacements to ensure that all serve a dual purpose. Systems must be able to support both traditional and distributed grid models while also enabling utilities to respond to a wide variety of potential future customer demands.

Five years ago, it might have been difficult to find technologies to accommodate both current and future needs. That is no longer the case. Here are just three examples:

Distribution Network Modeling
Most regulators assume distribution grid-side resource benefits in the DER rates, and thus it is up to utilities to fully leverage their value in planning and operating models. Distribution network modeling—the ability to see and to profile all grid-connected sources of supply (including beyond-the-meter customer DER) and demand, no matter how small—is one obvious example of how utilities can gain that value.

Present

Hidden load visibility: Because most utilities have little visibility into beyond the meter they only see the net of the load from the DER production. When distribution switching is required, they will find the “hidden load” (i.e. that load being supplied by customer DER) must be accounted for, because when there is an outage, all DER trips off (per IEEE 1547) so as to not back feed into the distribution system for crew and public safety reasons. Switching steps must make assumptions regarding the amount of hidden load or risk tripping the line on overload.

Future

Load shifting: As DER proliferate, the need for detailed network modeling escalates. Profiles of each DER device help grid operators accurately predict generation based on variables like time, weather, and condition of the equipment. Similarly, profiles of equipment enrolled in DR programs will help utilities reduce load in the precise
places and amounts needed. If permitted, the utilities can also offer incentives for DER and DR enrollment that can ease bottlenecks and further maximize grid efficiency while reducing the need for emissions-plagued generation.

**PROFILE CREATION**

<table>
<thead>
<tr>
<th>Type of Grid-Connected Device</th>
<th>Examples of Factors Needed in the Network Model</th>
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<tbody>
<tr>
<td>Solar and wind DER</td>
<td>Anticipated output under different weather conditions at different hours of the day</td>
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<tr>
<td>Customer-owned equipment enrolled in DR or other programs that may or may not be drawing power at any given time</td>
<td>Contractual restrictions on the grid’s ability to cycle the equipment or draw on stored power</td>
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<tr>
<td>Batteries or generators with limited fuel supply</td>
<td>Remaining life before mandatory refueling or shut-down</td>
</tr>
<tr>
<td>Mobile DER, like solar panels or propane generators mounted on trucks</td>
<td>Current location, anticipated location and duration of use, safety-driven operating limitations</td>
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**Outage Management**

A solid outage management system has clear benefits. It increases customer and regulator satisfaction by shortening outage times and improving SAIDI, SAIFI, and other reliability indicator scores used around the globe. It gives accurate restoration times to help customers plan around the outage. It quickly integrates mutual aid crews. And, with the addition of advanced distributed management functions, it can automatically isolate an outage and temporarily restore power to surrounding areas.

**Present**

Alarm management: To maximize the effectiveness of decisions that occur during service disruption, an outage system must first be capable of providing a view of the entire distribution network model – all the way to the customer meter. By doing so, dispatchers can harness more alarm-related data from across the network—GIS, CIS, AMI, SCADA, mobile field operations, etc. Additionally, by adding a data analysis intelligence layer between field signals and operators, the system can aggregate data into an event, correlate it, and determine what activities are of the highest priority and benefit.

**Future**

Islanding: Looking ahead, the same principles apply—the outage system must harness a range of data and resources across the entire distribution grid. It must then aggregate that information and present it with operational context so that outage management personnel can determine a prioritized way to more quickly restore power to customers.

With the addition of substantial DERs, the ability to aggregate and prioritize can evolve into islanding, which permits a utility to isolate parts of a grid and power each individually using local solar gardens, batteries, and back-up and rooftop generators. Isolation continues until the utility reverses the process, protecting field personnel and equipment from power flows within the islanded microgrid.
Similar to effective alarm management, islanding requires accurate visibility of the distribution grid combined with intelligent data management. Utilities must know the supportable load for each DER under a wide range of conditions. In most cases, they will also need the profiles of all power-drawing equipment available for cycling so that they can balance supply and demand within the island. Islanding will permit power sharing during an outage; for instance, an industrial park that owns substantial DER might use its own islanded resources during the normal workday, then power surrounding neighborhoods at night. The partial or periodic power flow available through islanding can significantly lower the negative economic consequences of widespread or prolonged outages.

To maintain safe and reliable operations, power-system analysis can identify if protection and control systems may be at risk under islanded conditions. This could also include near real-time assessment of potential islanded microgrid instability when there are insufficient spinning inertia resources to support high inertia loads (such as air-conditioning and heat pump compressors).

**Smart Device Management**

Traditional asset management systems handle a relatively limited number of specifications—manufacturer, serial number, maintenance schedule. Smart equipment, however, requires a far greater number of specifications—tables to support configuration compatibility, calibration measurements, firmware versions and patches applied, scheduled battery replacements, audit compliance.

**Present**

Asset performance management: Manually (or building a one-off spreadsheet/database) tracking even a few smart devices quickly becomes chaotic. Chaos grows exponentially as more smart equipment comes on line.

Given the growing numbers of smart devices on utilities near-term roadmaps, a smart device asset management system that provides a registry specifically to handle smart devices is easily justified. Since many of these devices support two-way communication with smart equipment (including IoT or Internet of Things), a smart device management system can be leveraged to support automated processes for firmware updates and configuration changes. Additionally, the system provides an audit trail for device activity, recording those device-level configurations and related communications.

By using the registry to manage configuration and commands, firmware upgrades become simple and low cost. Proactive adjustment and maintenance also ensure the device life is optimized. And when combined with analytics, this asset registry becomes a system for predicting and preventing asset failure and operational risk.
Automating smart device lifecycle management opens extensive avenues for operational efficiency, risk reduction and business growth.

Utilities not planning near-term replacements of existing asset management systems can add this registry by implementing stand-alone smart-device management systems or choose an add-on to an existing application.

Future

Value-based services: In a future in which utilities offer multiple programs involving customer-owned equipment (or allow 3rd party providers to do so), a smart device asset management system becomes imperative. The utility will need the system to support scalable data management processes required to support the exponential growth of sensor-based devices. Smart device management will facilitate very sophisticated outage, distribution, DER and demand management programs. Imagine, for instance, utility control of a 50 percent saturation of smart thermostats. Coordinated cycling is a perfect fit not just for today’s demand response programs—required on just a few days per year—but also for demand programs that use smart appliance cycling as a way to balance load 24/7.

A Way to Move Forward

Making sure that current technology investments meet both current and future needs requires considerable a strategic vision of the future utility. Utilities need to ensure that today’s technology selections and upgrades act as a stepping stone to support the programs they will want to offer and expectations of future customers. A decision today to invest in one-off, limited-use technology, or to contract with third-party service companies, could significantly increase the technology costs to offer new programs or support new business models in the future.

In contrast, investments in technologies that align with a strategic vision of the future utility will provide both current and future benefits:

» Preventing dead-end investments in applications that will clearly need to be changed out in the future.
» Giving staff time to gain experience with new procedures and business processes while there is still a relatively small amount of customer-owned energy technologies, DER and DR on a system.
» Lowering the cost and risk of pilot programs. Planners can have a fully tested, real-life technology structure within which to design, offer, and evaluate the results of a wide variety of possible offerings. They can gain experience not only with the technology itself, but also the business process changes that will inevitably accompany the widespread adoption of DER. And the most successful pilots transition smoothly into permanent programs; there’s no loss of momentum while staff members struggle to scale up technologies that work well only when the number of program participants is small.

» Enabling incremental responses to incremental customer demands.

There is, of course, no crystal ball that eliminates the risk of unknown market developments—breakthroughs in equipment efficiency, for instance, or changes in customer behavior that upend the most carefully devised business strategies. There are, however, technology characteristics that can go a long way ensuring the future value of today’s investments. For applications, these include the ability to:

» View—at a granular level to individual distributed resources and their operational context within the network model. The volume of customer-owned equipment and grid edge connected devices will continue to grow. Utilities will inevitably need to plan for and manage DER impact on reliability and create business models to capitalize on the new revenue and demand response opportunities.

» Scale—to handle not just more customers and more devices but also steeply escalating amounts of detailed information about each customer and each asset.

» Prioritize—to separate activities and processes that must take place in real time from those that can have less rigorous scheduling requirements. Utility staff and other resources are not increasing at the same rate as utility data, devices, and processes. Applications that treat equally every alarm, every device reading, or every transaction all but ensure that resources will be wasted and real emergencies receive short shrift.

» Integrate—to help utilities build a system of systems. Applications must relate to each other in logical ways so that business processes to manage data can flow seamlessly from one to the next given a wide range of possible scenarios.

» Recover—to guard against data loss no matter the severity of security breaches or equipment breakdown. The volume of smart metering data will likely, in the future, seem almost trivial compared with data volumes associated with DER management and grid-connected customer equipment. And grid efficiency will require extensive historical analysis of this data. Once lost, such data cannot be reconstructed.

A modern distribution grid will require a system-of-systems supporting a diverse range of integrated processes, customer types, and service models.
In short, the most successful utilities will start with a strategic vision of network technology platform. By filling today’s needs with technologies that can incrementally accommodate a variety of futures, utilities carve for themselves a central role as the electric grid changes from one-way power delivery to a complex, multi-directional system of inputs and outputs offering customer convenience, greater reliability, and adherence to emerging international environmental goals.

**A Partner for Unlocking Your Potential**

As you embrace the challenges of an evolving distribution grid, Oracle Utilities is your partner for progress, delivering value at the pace of your business needs.

We combine world-class innovation with the industry’s most complete suite of customer-through-grid solutions to help you turn the challenges of an evolving distribution model into opportunities—every step of the way. For DER and other smart, grid-connected customer equipment, Oracle has the most forward-thinking solutions to address the entire process lifecycle:

- Connection and energizing
- Operations and control
- Service and maintenance
- Outage management
- Risk analysis and planning
- Customer interaction

At Oracle, we’re looking forward. On top of our complete platform of utility solutions, we are investing in new capabilities and tackling industry challenges. We are exploring what’s possible and charting the best path forward. On that path, on the leading edge of innovation, your potential to excel is limitless.
Integrated Cloud Applications & Platform Services

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One Foot in the Future
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