A Distribution Grid Management Platform for the Future
Optimizing operational needs for an evolving grid

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Table of Contents

Disclaimer 1
Introduction 1
  Distributed Energy Resources — A Challenging Proposition for the Grid 1
  The Need for a Customer-Centric Distribution Grid 2
Distribution Network Modeling—Now and Into the Future 4
Outage Management—From Alarms to Islanding 4
Smart Field Device Management—Providing Value-Based Services for the Future 5
A Way to Move Forward 5
DER Lifecycle Management is a Phased Approach for Utilities 6
Oracle Utilities’ Grid Management Platform Provides a Path to the Future 8
A Partner for Unlocking Your Potential 9
Introduction

Solar energy capacity is expected to increase from 25 GW in 2015 to 246 GW by 2040, representing the largest increase in renewable capacity over that time period, according to the U.S. Energy Information Association. At the same time, the cost of distributed energy resources (in particular solar) and storage continues to drop. According to a White House report, storage systems have seen almost 60-percent drop in prices since 2007. In Germany, solar photovoltaic (PV)-generated power was around 38.5 terawatt hours in 2015, which covered almost 7.5 percent net electricity consumption that year. The rapid growth of solar PVs, storage systems, electric vehicles, microgrids, sensors, and consumer devices is adding tremendous complexity to the electricity distribution network. This means utilities will need to gradually transform their business models to adapt to this new, customer-centric grid.

The question is: How will utilities innovate to make this transformation into a customer-centric platform and energy service provider while still maintaining a reliable grid?

Distributed Energy Resources — A Challenging Proposition for the Grid

Clearly rooftop solar and other distributed energy resources (DER) are growing much faster than anticipated, and consumers are adding interconnected devices to the grid at a staggering rate, increasing the need for exceptional management of high-volume data. The growth of DER generation outside the utility’s direct control is quickly becoming an issue: to control and optimize the edge of the grid requires utilities to have visibility and to be able to model all the way down to the consumer level.

Utilities often run into following challenges when integrating DER:

Most distributed energy resources are outside utilities’ direct control. Intermittency in distributed generation and variations in consumption patterns create the need for information, which is vital to the efficient control of the network, but that information usually resides outside the reach of utility SCADA systems and traditional distribution management systems (DMS).

It’s difficult for utilities to predict and accurately forecast granular intermittent renewable generation, their aggregated impact on the grid connection points, and overall energy supply. Because solar and

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wind are not dispatchable, utility operators can’t choose when to use the electricity from these resources. Instead, they must take and mitigate any impacts of its inherent intermittency. In order to continue to provide safe, reliable, and affordable grid services, utilities must transform the view of distribution to safely connect, model, operate and optimize customer distributed energy resources (DER) as part of the distribution platform.

The Need for a Customer-Centric Distribution Grid

Electric utilities recognize the need for new distribution network technologies to accommodate sustainable growth and customers’ growing interest in grid-connected, customer-owned energy technologies such as solar rooftops, home/building energy management systems, and smart appliances. As policies that concern these technologies—customer choice, emissions reductions, weather-related outage response—begin to unfold around the world, a fundamentally different approach to the electricity distribution infrastructure is needed.

This paper will discuss critical aspects of managing a customer-centric distribution grid with an innovative approach to advanced distribution management—one that is flexible, integrated and scalable—that supports utility business transformation and the integration of customer, grid, and asset operations.
Balancing the Pace of Change

Those individuals and business owners that own DER want to be digitally connected with their suppliers just as they are in many other aspects of their life. They want information, control, and options, and they want access and control from wherever they may be.

In particular, two different categories of consumer-driven technologies are playing an enormous role in pushing transformation of the electricity distribution grid. These are:

» Dispatchable and non-dispatchable DER including storage batteries, rooftop solar, electric vehicles, microgrids, and combined heat and power that can supply power to the grid. While regulations vary, the global trend is toward requirements that utilities connect both small solar and wind DER to the grid and use the electricity they intermittently produce as part of their regular power supply to balance load.

» Another class of customer DER includes smart, grid-connected equipment—home appliances, building-level energy management systems, smart thermostats, 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.

These consumer-owned, consumer-driven technologies 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.

To resolve this dilemma, utilities must re-examine near-term and long-term plans for DER technology integration and whether their current enterprise systems are able to support the needed changes. Utilities need an integrated approach to address DER planning that includes future customer demands, grid operations, asset management, and workforce enablement.

Five years ago, it might have been difficult to find technologies to accommodate both current and future needs. That is no longer the case. Following are three pertinent examples.
Distribution Network Modeling—Now and Into the Future

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 utility-scale as well as each customer’s granular 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. Planning functions will need to aggregate these granular resource models to their connected points in the planning models in order to fully accommodate their impacts and leverage them as the grid-side resource for which they are typically compensated.

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<td><strong>Hidden load visibility</strong> is an enormous issue when DER comes back online after an outage. All customer-side DER load trips off during an outage (per IEEE 1547) for crew and public safety purposes. Hence utility professionals need an accurate accounting of the hidden load for forecasting risk management purposes.</td>
<td><strong>In-depth network modeling</strong> is going to be central piece to load forecasting and capacity planning. It starts with the customer, to automate processes to register and connect DER and offer programs and incentives that engage customers as active grid participants. Grid operators need accurate profiles for each DER device to improve generation predictions based on location, time, weather, and condition of the equipment. Similarly, profiles of equipment enrolled in DR programs can help utilities reduce overloads or mitigate voltage violations in the precise places and amounts needed. Utilities can also offer incentives for DER and DR programs that can ease bottlenecks and further maximize efficiency while reducing the need for emissions-plagued generation. This customer-centric network is part of the vision of a future transactive energy market being discussed in New York, California, and other regions.</td>
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Outage Management—From Alarms to Islanding

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 metrics 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 distribution management functions, it can automatically isolate an outage and temporarily restore power to surrounding areas.

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<th>Future</th>
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<td><strong>Alarm management with multi-source data ingestion:</strong> A comprehensive network model—all the way down to customers' smart meters—helps improve decision making during service disruptions and outages. The outage management system helps dispatchers to harness outage alarms and restoration notifications data by incorporating data from the geographic information system, customer information system, advanced metering infrastructure (AMI), supervisory control and data acquisition, and mobile field operations. 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.</td>
<td><strong>Islanding—a new way to manage outages and restorations:</strong> With DER coming onto the grid, the outage management system must harness a broad range of customer 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. Islanding will permit a utility to isolate parts of a grid and power each part individually using local solar gardens, batteries, backup and rooftop generators, and even demand response. Islanding will permit a utility to isolate parts of a grid and power each part individually using local solar gardens, batteries, backup and rooftop generators, and even demand response to balance the local requirements in real time. Similar to effective alarm management, islanding requires accurate visibility of the distribution grid combined with intelligent data management. To enable safe and reliable operations, utilities will need detailed granular, customer-specific, weather-sensitive load and DER models based on AMI and load research that can be aggregated up to connection points such as a service transformer or low-voltage junction. In most cases, they will also need the profiles of relevant power-drawing equipment that would participate in demand response programs so that they can be called upon to help 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 work day, and then power surrounding neighborhoods at night. Islanding can significantly lower the negative economic consequences of widespread or prolonged outages.</td>
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Smart Field Device Management—Providing Value-Based Services for the Future

Traditional asset management systems handle a relatively limited number of specifications: manufacturer, serial number, and maintenance schedule. Smart equipment, however, requires a far greater number of specifications: tables to support configuration compatibility, calibration measurements, firmware versions and patches applied to each device module (e.g., metrology or telecommunications), scheduled battery replacements, and audit compliance that can grow to support millions of devices for large utilities.

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<td><strong>Smart field device management:</strong> Often utilities manually (or building a one-off spreadsheet/database) track smart devices. This practice will fail as the edge device footprint grows. Most traditional asset management systems don’t support this field device management function, though utilities can add this feature by implementing integrated smart-device management systems or incrementally adding functionality with existing smart grid projects such as AMI/MDM. 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 the 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. Utilities need a device registry and lifecycle management process and systems in order to engage customers and fully leverage these grid-connected resources.</td>
<td><strong>Value-based services based on location and devices:</strong> To scale up to millions of devices, utilities will need automated information management processes with customers/contractors involved to capture key attributes and populate a DER device registry that, in turn, can be used to model the customer connections and grid impacts. When utilities begin offering multiple programs involving customer-owned equipment (or allowing third-party providers to do so), a smart device asset management system will become imperative. The utility will need the system to support scalable data management processes required for the exponential growth of sensor-based devices. Smart device management will facilitate very sophisticated outage, distribution, DER and demand management programs. Coordinated demand response is a perfect fit not just for demand response required only a few days of the year, but also for targeted demand programs that use smart appliance cycling as a way to balance load 24/7.</td>
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A Way to Move Forward

As utilities move from supplying energy to providing differentiated services based on customer needs, they need a long-term technology plan. Utilities need to ensure that current technology investments and upgrades act as stepping stones to support the programs they want to offer and the expectations of future customers. A decision today to invest in a 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 current and future benefits, including:

» **Long-term business planning including transformation.** Prevent dead-end investments in applications that will clearly need to be changed out in the future. Focus instead on business planning and strategic vision to include DER into the technology landscape. This can also include enabling incremental responses to growing customer demands.

» **Performing while undertaking digital transformation.** Give staff time to drive digital transformation by gaining 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.
Analyzing risk carefully and early on. Lower 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. As the most successful pilots transition smoothly into permanent programs, there is no loss of momentum while staff members struggle to scale up technologies that work well only when the number of program participants is small.

There are, as well, technology characteristics that can go a long way to 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 will 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.

The most successful and forward-looking utilities will start with a strategic vision for the technology that brings together the customer (including their DERs), grid, asset, and workforce operations. By filling today’s needs with technologies that can incrementally accommodate a variety of future scenarios, utilities can maintain an important 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.

**DER Lifecycle Management is a Phased Approach for Utilities**

Utilities have to rapidly develop new processes to manage DER assets and maintain them over time. It is important to note that the DER lifecycle management process starts with the customer and ensures that they remain engaged throughout the entire lifecycle.
Start with customer engagement and enrollment. Utilities will identify customers with DER and qualify them into the right programs. Utilities may have specific programs with specific prices tailored for customers with DER assets. Utilities need an integrated Customer Information System with a customer engagement solution, and Service Order Management (SOM), to manage these procedures.

1. **Integrate distribution network planning.** Utility professionals need to perform a comprehensive network planning and modeling exercise to integrate DER assets. It starts with a network model and inventory of assets. Capacity and impact planning on the existing systems with an integrated Distribution Management System and Outage Management System enables utilities to perform capacity and impact planning.

2. **Make use of the granular load forecasting and analytics.** Grid operators have to account for load models from the customer to the system level. Any reverse feedback on the feeders and circuits can have a negative impact on the distribution system. Utilities are looking for an integrated network model that combines device-level data and advanced analytics to develop a much-improved forecast.

3. **Validate customer connection points.** Asset registration and connection is an important step to ensure an ongoing record of each DER device. Utility professionals need to be able to take care of the whole process associated with asset commissioning and decommissioning.

4. **Prepare your asset operations for ongoing DER management and maintenance.** Utility professionals will need to keep tabs on the health of DER devices, manage configurations and upgrades. An integrated mobile workforce management system with asset management can identify, fix, and restore a DER device much faster. Utilities can offer new services with integrated mobile workforce solutions that constantly track equipment as well as keep the network model up to date.

5. **Review your billing systems and settlement processes.** Customers need accurate billing based on the granular metering and device data to settle DER consumption. For instance, utilities need accurate data for setting net metering, critical peak, and time-of-use prices. Customer operations and IT require an integrated view of billing, metering, and customer engagement solutions.
6. **Equip your IT operations to support ongoing customer experience.** Utilities can use multi-channel tools to keep customers updated on their consumption, new programs, and events. Utilities can improve customer satisfaction when they’re able to present unique information tailored for each customer based on their consumption, market participation, rate changes, programs, equipment maintenance, and outages.

**Oracle Utilities’ Grid Management Platform Provides a Path to the Future**

Our leading enterprise-class Oracle Utilities Network Management System provides a secure, scalable, and open/integrated grid management foundational platform, surrounded by a number of Oracle Utilities applications and Oracle technologies. Using this platform approach, the system can drive any number of applications, including OMS for electricity, gas and water; DMS, DERMS/DRMS; microgrids, distributed grid management, and operational analytics.

Further, using standard functionality, Oracle products can be configured to address a multitude of business objectives. The advantages of the Oracle platform include:

- Proven end-to-end scalable performance in grid management.
- Full visibility and optimization to the edge of the grid.
- The most comprehensive IT, OT, and Consumer Energy Technology (CT) platform, customer-to-grid.

Using Oracle Utilities Network Management System as a platform for modern grid management, utilities can tie customer and operational processes together to meet secure and scalable performance needs with cost-effective outcomes, deliver operational responsiveness needed to build regulatory and customer trust, and turn the challenges of a changing distribution grid into a business opportunity.

As a customer-centric grid innovation platform, this platform and application suite, along with accompanying technology, will enable utilities to realize powerful benefits:

- Bring new thinking to monitoring, control and optimization of the grid to improve safe and reliable service while integrating significantly more renewable and customer-installed DER.
» Harness DER as a way to improve grid reliability, customer service, and overall performance.
» Revolutionize customer engagement as integral grid participants.

Using this platform-based approach to distribution grid management, utilities can ensure that today’s technology selections and upgrades act as a springboard to establish a customer-centric network that will support the future programs they will want to offer and the expectations of future customers.

Oracle Utilities’ grid management system will enable utilities’ digital transformation to improve grid safety and reliability, operational performance, renewable resources integration, granular DER management, and customer service through integration management, control and analysis.

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.

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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