Implementing Distributed Energy Resources

Making the Journey to Distributed Energy

White Paper

Distributed Energy Resources (DERs) may well prove to be the single most disruptive and transformational influence in the history of the electric grid with respect to operations and underlying utility business models. DERs are revolutionizing how consumers and prosumers value electricity services and reliability and they provide new opportunities for utilities to optimize real-time operations across a decentralizing grid.

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The Transformation of the Electric Grid

Electric utilities are part of a century old industry that is facing significant disruption at an unprecedented rate. The electric ecosystem is transforming and shifting towards a future characterized by the marked increase in the use of utility and third-party owned DERs. DERs include demand- and supply-side resources—such as photovoltaics (PVs), energy storage, electric vehicles (EVs) charging infrastructure, and energy efficiency measures—deployed throughout the electric distribution system to reliably meet customers' energy needs.

The proliferation of DERs on the grid introduces heightened levels of complexity and presents new opportunities and challenges related to their integration and management. Recent industry reports and surveys have painted a consistent picture—the integration and management of DERs is viewed as critical by utilities and these aspects are integral to unlocking the potential of DERs. For example, a recent survey of more than 600 electric utility employees in North America indicated that 60% of respondents viewed the reliable integration of renewables and DERs as either important or very important today.[1]

Utilities are facing a new reality in which DERs play an ever-increasing role in the operation of the electric network and they need to prepare for the transformational impact of DERs in decarbonizing, digitalizing and decentralizing the grid. Some utilities view this transformation as a threat to their business, but significant opportunities await those able to transform themselves ahead of the curve to create new business value. For those who recognize this opportunity there are nevertheless uncertainties in exactly how they should adapt and prepare. This paper will outline considerations for effective DER management to meet the business challenges ahead.

The Journey to Distributed Energy

To survive and thrive in the new energy paradigm, we believe that certain themes need to be contemplated by utilities—they include decarbonization, digitalization and decentralization. Below we will walk through the trends and challenges associated with each.

The Decarbonized Grid

One of the initial and continued drivers of distributed energy is the focus on decarbonization. Many now view this heightened level of focus as an opportunity to transform grid operations—especially with the rapidly declining costs associated with renewables and storage.

THE CLEAN ENERGY FUTURE. Worldwide, the clean energy trend continues to gather steam. A 2017 survey of North American utility personnel[1] indicates that the sector is transitioning towards this more steadily than in previous years, with respondents indicating increased levels of confidence in renewable energy integration and heightened interest in deploying DERs.

GRID PARITY. In the cases of solar and onshore wind, grid parity is now increasingly well established[2] which means that, from the consumer perspective, no financial subsidies are required to make their costs equal to, or less than, centralized generation. Additionally, technology costs associated with renewables are expected to continue to decrease, making them a more attractive proposition going forward leading to increased demand.

MORE RENEWABLE CAPACITY. The year 2016 saw 150 GW of new renewable power capacity installed globally with renewables contributing up to 86% of new capacity in the EU, 61% in the USA and 52% in China.[3] As these resources have variable generation output, utilities also expect to add significant gas and storage capacity in years to come to level supply and demand. Storage is becoming increasingly viable economically and is expected to play in all areas, including micro-optimization of distribution networks.

INTEGRATION CHALLENGES. As renewable power output lacks the reliability and predictability that centralized power generation offers, some are struggling to integrate new power sources effectively and efficiently into a balanced distribution system. When DER energy output cannot be integrated, it is wasted—China estimates that in the first three quarters of 2016 approximately 19% of their wind power output was wasted (curtailed).[3]

REGULATORY CHANGES. Regulatory reforms are needed to enable new business models and, worldwide, governments and regulatory frameworks are encouraging greener standards for generation and consumption. Currently, under the predominant utility regulatory model, the advantages of DERs are not fully captured. Instead many utilities currently have an incentive to build more capacity (i.e., power lines). To realize the full benefits of DERs the utility regulatory incentive model must change—regulatory reforms are needed such that utilities are properly incentivized to provide coordination and stewardship of such DER. For example, a 2013 report from the Rocky Mountain Institute (RMI) proposes that utilities be required to take on a critical coordination and stewardship role requiring regulatory incentives.[4]

The Digitalized Grid

With decarbonization spurring increased adoption of DER, the grid now requires an increased digitalization of resources to enable visibility and control. Utilities see a strong digitalization strategy as essential to support their business transformation towards DER enablement. A digitalized grid also incorporates the notion that we can push optimization models closer to the edge (the interface between the distribution network and the consumer).[5]

DIGITALIZATION. To be truly effective and efficient, DER management and integration relies on digitalization efforts across traditionally siloed organizational areas within utilities. For example, DER-aware network applications (e.g., Powerflow, Volt-Var Control, Fault Location, Isolation and Service Restoration, etc.) often require data from parts of the utility and external sources outside of the control room.

THE NETWORK MODEL. An accurate modern grid network model that is DER-aware, i.e., a "digital twin", is required to effectively deliver on the value of DERs. This includes modeling DERs from a technical capabilities standpoint as well as from a contractual standpoint (ownership, cost and limitations associated with dispatching of this flexibility, etc.).

COMPLEXITY. The introduction of DERs on the modern grid is adding complexity to the task of balancing supply and demand, pushing the need for digitalization to efficiently manage through increased visibility and accountability. This type of generation complicates conventional load forecast methodologies, the modeling of distribution feeders, as well as communications, by introducing new kinds of input sources or modifying load profiles. For example, bi-directional communications to DERs and DER aggregators will now be necessary.

ACCURATE DIGITAL INPUTS. Increased DER penetration levels highlight the need for digital data, via sensing and automation equipment, for optimal management of the distribution network. Valuable data includes asset locations and associated information, both spatial and temporal, as well as external data such as weather forecasts and irradiance data. The challenge is transforming the data coming from a massive number of sensors into situational intelligence that can improve power delivery. For example, DER forecasting that accounts for predicted weather conditions will give utilities the ability to look ahead and be proactive rather than reactive.

The Decentralized Grid

Decarbonization and digitalization of the grid have spurred the grid towards a decentralized ecosystem. Deploying decentralized intelligence closer to the edge delivers resiliency—if the central site or communications go down, the utility still has local control capability available—and scalability in the face of millions of DER endpoints. DER has the potential to allow for additional levels of isolation/fault tolerance—at a substation level, there may at times be enough distrusted energy to allow the branch (distribution and below) to run independently. Decentralized intelligence will also enable more robust real-time analytics and data sharing. The grid edge will transform from traditionally being passive to becoming active, enabling a more extensive range of controls and therefore greater resiliency across the grid.

PROSUMERS AND DEMOCRATIZATION OF THE GRID. Traditional customers are also proactively contributing to the decentralized grid with many both consuming and producing energy. New channels to customers, including smart grids, microgrids, local generation and local storage, all create opportunities to engage with customers in new ways. These "prosumers" are increasingly playing a larger role in managing their own electricity use, in some places going as far as exchanging services between themselves (peer-to-peer) and providing electricity services to the grid through utilities and aggregators. Customers for example who deploy rooftop solar and other DERs to satisfy environmental concerns also reduce their utility bills, achieve energy independence and ensure reliable access to energy. The electricity industry is continuing to evolve from a traditional value chain to a highly networked participatory model at the distribution edge, where suppliers and consumers interface with the distribution grid.

THE OMNI-DIRECTIONAL GRID. Conventionally, power moves in one direction, from generation through transmission to distribution circuits to the customer. The decentralized nature of DERs on the distribution grid is creating two-way or "reverse" power flows that most existing networks were not designed to support. Resources on the other side of the meter, for example customer solar, are pushing utilities to restructure their systems to accommodate two-way power flow. Currently this reverse power flow can be problematic when protection settings do not account for or cannot be readily adapted for the possibility of such reverse flows, leading to voltage or frequency violations, stressing and wearing on grid assets and possibly resulting in output curtailment (waste).

BUSINESS MODEL CHANGE. The ever-increasing role of DERs in the grid is leading to a shift in the fundamental business model of the industry as the centralized generation paradigm deteriorates in some markets. Recent industry survey results indicate that utility executives believe the traditional business model set up over a century ago is becoming increasingly irrelevant and needs transformational change, but they are unsure how to build a business model around emerging DERs.[1] To make matters worse, new DERs and technologies offer a growing number of customers the possibility to "disconnect" from the grid. What is certain is that the changes and challenges that utilities face will continue to intensify as competition and the number of new market entrants increase.

ECONOMICS. DER deployment has the potential to eliminate the need for capital expenditures on costly grid and generation upgrades. In one notable example, at PG&E in California a combination of energy efficiency and rooftop solar eliminated the need for a $192 million investment in transmission projects.[6]

Effective DER Management Delivers New Opportunities

Many utilities see transformation as a threat, but significant opportunities await those able to envision and deploy a solution for the effective management of DERs. Seamlessly integrating DERs and supporting the digitalized grid requires a new generation of technology, namely a distributed energy resource management (DERM) solution.

It takes more than a point solution to effectively manage DERs—it requires a comprehensive solution that addresses modeling, planning, grid operations, and ultimately markets. A DERM solution must address the uncertainties presented by the high-penetration of DERs by using these resources as a tool for distribution networks, making these resources more accessible and beneficial. An effective DERM system leverages the digitalization of DER to manage grid-connected DERs that are enabled by big data analytics to drive the alignment of supply and demand and deliver insights on grid stability.

- **DERM can enhance grid resiliency**: Rather than relying solely on centralized generation, utilities will be able to utilize DER flexibility to maintain continuity of supply and power quality under adverse conditions. By providing local options for energy supply, DERs can help avert blackouts during storm conditions and provide additional flexibility for restoration efforts.
- **DERM can optimize grid investments**: Utilities have traditionally planned and designed grids for peak-load scenarios, which can be expensive and are a sub-optimal use of critical resources. Utilities will be able to utilize DER flexibility to manage grid reliability and defer capital investments through non-wires alternatives.
- **DERM can reduce physical and cyber-vulnerabilities**: Utilities will be able to use real-time information and DER flexibility to withstand attacks to the physical grid and its cyber control systems. Decentralization could also provide an added layer of security to manage the grid should its central control system be attacked—meaning that one failure does not compromise the entire network. Similarly, by distributing the processing and making the edge devices semi-autonomous, compromise of one of the edge controllers, the central control platform or the network does not necessarily compromise the entire system.

Summary

Looking towards the future, one of the next key steps will be enabling grid democratization, meaning utilities will be able to provide a true digital platform for collaboration between consumers, producers, prosumers, aggregators and themselves. New technologies such as Blockchain could further reduce the cost and complexity of these exchanges, through DER exchanges supporting micro payments.

For the near-term future, DERs may well prove to be the single most disruptive and transformational influence in the history of the electric grid with respect to grid operations and their underlying utility business models. These resources are revolutionizing how consumers and prosumers value electricity services and reliability. Next-generation DERM solutions provide new opportunities for utilities to optimize real-time grid operations, while harnessing the value of all their grid assets. Utilities taking their first step on this journey – now – could differentiate the winners and losers in this dynamic and evolving trend.

Endnotes

1. "The State of the Electric Utility 2017." Utility Dive. 2017.
2. "A different energy future – Where energy transformation is leading us." PwC. 2015.
3. "A Year for the Record Books Tracking the Energy Revolution—Global 2016 edition." Clean Energy Canada. February 2016.
4. "New Business Models from the Distribution Edge - The transition from Value Chain to value constellation." Electricity Innovation Lab, Rocky Mountain Institute. April 2013.
5. Sioshansi, Fereidoon P., "Innovation and Disruption at the Grid's Edge: How distributed energy resources are disrupting the utility business model." Academic Press. 2017.
6. Pyper, Julia. "Californians Just Saved $192 Million Thanks to Efficiency and Rooftop Solar." Greentech Media. March 31, 2016.

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