NATIONAL RENEWABLE ENERGY LABORATORY

A discussion paper for fostering open dialogue on energy challenges

Exploring New Models for Utility Distributed Energy Resource Planning and Integration: SMUD and Con Edison

As a result of the rapid growth of renewable energy in the United States, the U.S. electric grid is undergoing a monumental shift away from its historical status quo. These changes are occurring at both the centralized and local levels and have been driven by a number of different factors, including large declines in renewable energy costs, federal and state incentives and mandates, and advances in the underlying technology. Higher levels of variable-generation renewable energy, however, may require new and increasingly complex methods for utilities to operate and maintain the grid while also attempting to limit the costly build-out of supporting grid infrastructure.

Utilities in the United States and internationally are looking at new approaches to incorporate and manage higher levels of distributed energy resources (DERs) in both traditional and innovative ways. NREL developed this discussion paper to highlight examples of U.S. efforts to incorporate greater levels of DERs and to foster dialogue about new ways to approach this challenge.[1] Traditional mechanisms would typically involve the installation of more grid equipment (wires, substations, backup power plants), whereas emerging mechanisms encompass a variety of approaches to reduce, delay, or eliminate the need for the expensive grid infrastructure upgrades.

Case Studies Background

This discussion paper provides two examples of utility organizations analyzing and experimenting with new ways of incorporating greater levels of variable renewable energy into the grid. Specifically, it looks at the Sacramento Municipal Utility District (SMUD) in California and Consolidated Edison, Inc. (Con Edison) in New York. These examples illustrate how utilities with vastly different markets, locations, and regulatory structures are exploring ways of addressing an early shared challenge of managing higher levels of distributed energy resources.[2] Many of the experiences in these markets can be applied to other utilities and markets, despite seemingly disparate circumstances.

This brief is part of a broader study under the 21st Century Power Partnership (21CPP) to help program partners coordinate on DER planning and other shared energy priorities to assist in meeting the demands of an evolving generation mix and grid.

SMUD

The state of California has been at the forefront for promoting alternative energy and is one of the leading markets for multiple types of DERs. California is also home to SMUD, the sixth largest municipal utility in the United States.[3] SMUD's municipal regulatory structure has allowed it to design and implement a pilot program that is unique from other investor-owned utility programs within the state that are managed by a statewide regulatory entity. Furthermore, SMUD has an extensive history of being a pioneer and early adopter in the transition to clean energy solutions.[4]

Like other utilities in California, SMUD has experienced a rapid increase in customer adoption of DERs (e.g., rooftop solar, electric vehicles) and is trying to understand the implications of a DER-prominent future on its customer energy usage, grid infrastructure network, underlying revenues, environmental goals, and overall portfolio of energy sources. As an early step in this analytical-based planning process, SMUD undertook what is widely recognized as an industry-leading DER planning study to understand the effect of multiple DER technologies on the grid.[5]

SMUD's DER Planning Study Approach

One of the key distinguishing characteristics of SMUD's DER planning study is that it analyzed the impact of multiple DERs simultaneously, including combined heat and power (CHP), distributed photovoltaics (PV), energy efficiency, demand response, distributed energy storage, and electrical vehicle (EV) charging. The DER planning approach consisted of five principal steps, which were analyzed using a variety of in-house and commercial modeling tools. These steps included:

1. Forecasting customer adoption of DERs
2. Modeling the impact of DERs at the distribution system level, such as transformer overload
3. Modeling the impact of DERs on the bulk power system, including effects on system sales, peak load, CO_2 emissions, and load profiles
4. Estimating the financial and revenue impacts
5. Incorporating next steps for future iterations of a DER study

DER Planning Study Results

While the results of a DER planning study will be unique to each entity, several interesting SMUD-specific results illustrate the types of insights that can be gained from a DER planning study. For example, the SMUD planning study found that DER adoption in Sacramento would be widespread but uneven and clustered (i.e., occurring in "hotspots") based on neighborhood characteristics. A technical finding of the DER study was that transformer overload was likely to be one of the key impacts resulting from increasing EV charging and variable PV output on the distribution grid, and that a range of possible infrastructure upgrades could be implemented to mitigate the overload.

At the higher system-level, the DER planning study also found a likely reduction in customer energy sales of 10%–20%, a shifting of load profile to later in the evening, a flatter net load (somewhat counterintuitive but reflective of a study that analyzes the combined impact of all DERs, not just PV), and a reduction in carbon emissions. The financial impacts were largely found to be detrimental to the utility's estimated revenue. However, more refined analysis that incorporates advanced rate structures, changing cost profiles of DERs over time, and new revenue streams could show different results.

Utility Benefits

The SMUD DER planning study found several enterprise-wide benefits that other entities considering a similar DER planning study could likely realize from such an effort. It highlighted the importance of creating, frequently improving, and updating a customer database for better analytics and modeling specificity. The study revealed insights about the process itself and where parts of the study can be streamlined or automated, allowing for more frequent updates or deeper analyses to be carried out while reducing the associated time and costs. It identified the human and corporate capacity constraints involved in creating a multidisciplinary team to oversee and execute a DER study. Finally, the SMUD DER planning study demonstrated the planning value of the study and pointed to the efficacy of considering a similar approach as part of a more widespread and common utility integrated resource planning process.

Con Edison

In the state of New York, several different electric utility companies were grappling with multiple grid-related challenges, including an aging infrastructure that likely would require significant upgrades, a high degree of exposure to natural gas prices, a growing peak demand, and rising electricity rates for consumers.[6] To help address these issues, utilities and regulatory authorities in 2014 initiated a structural transition of the state's energy system called Reforming the Energy Vision (REV). The primary objective of the REV initiative is to build a clean, resilient, and more affordable system for state residents by increasing consumer participation and renewable generation.

Under the larger REV process, Con Edison—an investor-owned utility (IOU) that serves more than 3.3 million customers in New York City and Westchester County—sought an innovative program to use DERs in new and innovative ways to either complement or offset traditional utility grid upgrades.[7] Within Con Edison's service territory, the New York City boroughs of Brooklyn and Queens are experiencing high growth in both population and electricity demand that is estimated to overload certain subtransmission feeders by up to 69 megawatts (MW) for up to 48 hours during the summer months.[8] To alleviate the possible future overload hours, Con Edison estimated that an investment of approximately $1 billion would be needed for grid expansion under a business as usual (BAU) scenario reflecting the high cost of infrastructure in a congested urban environment with assets both above and below ground. This high cost estimate was part of the impetus for looking at nontraditional ways of alleviating the constraints on the distribution grid.

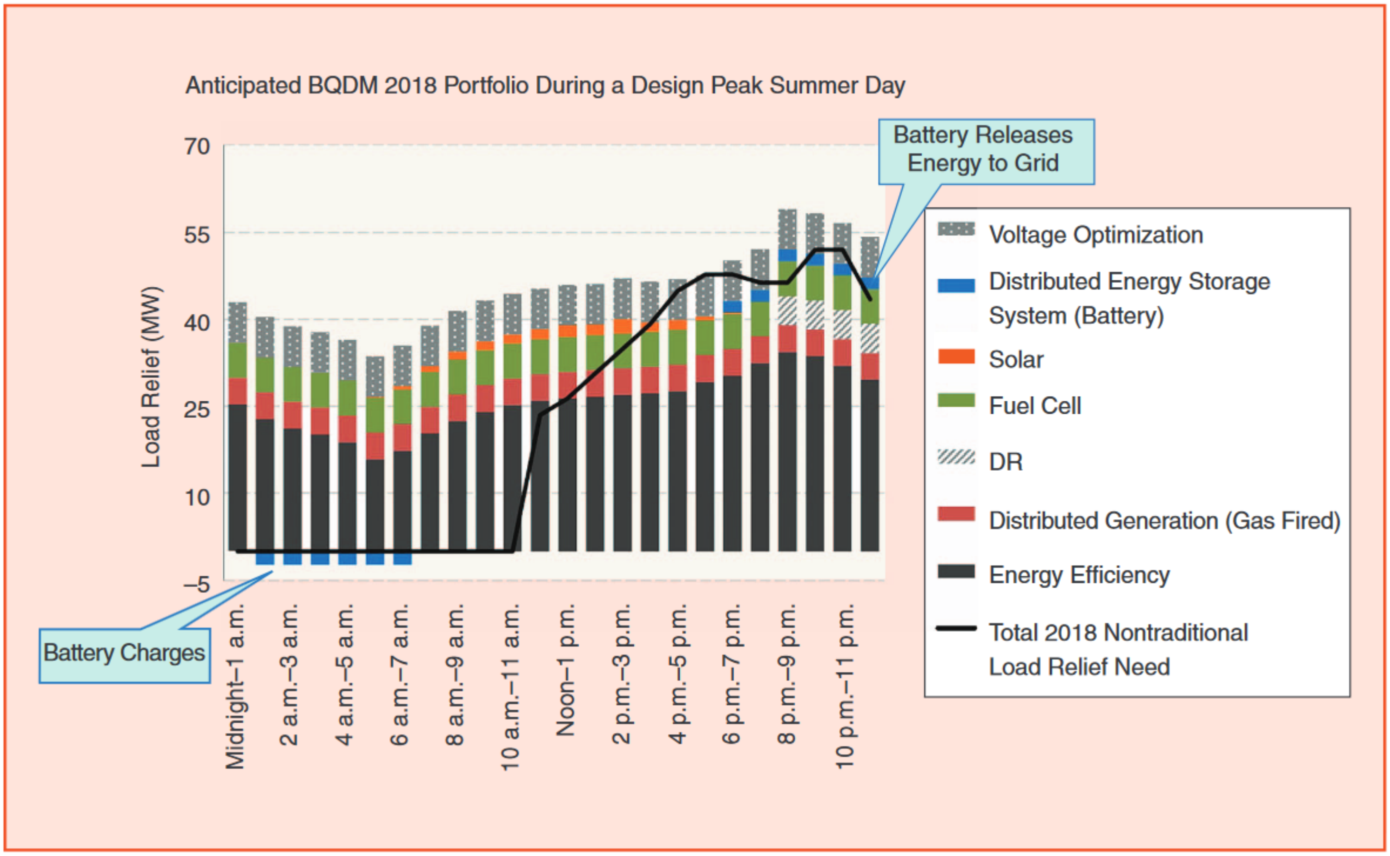

Figure 1. Anticipated BQDM portfolio during a design peak summer day. Source: Coddington, Sciano and Fuller, 2017

Brooklyn Queens Demand Management Program

As an alternative to the BAU approach, Con Edison proposed the Brooklyn-Queens Demand Management (BQDM) Program under its distributed system implementation plan submitted to the New York Public Service Commission. At approximately $200 million, the program is anticipated to defer the need for traditional grid expansion investments by several years. Recent filings also suggest that Con Edison achieved its BQDM goals for less than the original budgeted amount and is seeking additional distributed energy resources with the savings.

Con Edison's proposed solution includes approximately 52 MW of nontraditional utility upgrades, often referred to as "nonwire alternatives." The 52 MW of nonwire alternatives would include approximately 41 MW of customer-side DERs and 11 MW of DERs directly tied to the utility distribution network.[9] Con Edison has reported that approximately $150 million (75% of the BQDM budget) will go to customer-side solutions while the remaining $50 million (25% of the budget) will go to measures on the utility side.

Figure 1 shows a possible DER portfolio in the BQDM Program, including distributed solar, distributed energy battery storage, demand response, energy efficiency, voltage optimization programs, and other resources.[8] Con Edison's local distribution grid demand typically peaks in the evening, requiring a mix of DERs capable of providing more than 50 MW of grid relief during the requisite hours, which the analysis showed was available during the evening peak, as illustrated in Figure 1.

One of the first projects Con Edison undertook as it rolled out the BQDM Program was holding a new demand response resource auction for commercial customers in lieu of a preexisting commercial program. The BQDM demand response program was designed to offer load relief for up to four hours during the peak season for the BQDM area. Con Edison reports that more than half of the winning bidders proposed new technologies such as battery energy storage, whereas historical demand response requirements had typically been met by curtailment or on-site generation.

Conclusion

Although SMUD and Con Edison are different types of utilities, they have each taken first steps to either plan for or implement innovative DER programs designed to accommodate a higher level of renewables and a more modernized grid and business structure. Some of the key takeaways and early learning from these projects include, but are not limited to:

- **The importance of including the impact of DERs in the distribution planning process.** The SMUD DER planning study demonstrated the high value of the study and pointed to the efficacy of considering a similar approach as part of the more widespread and common utility integrated resource planning process.
- **The importance of piloting the use of a broad mix of DERs and other nonwire alternatives to offset traditional utility capital expenditures.** Con Edison has devoted resources to develop business models that depart from the traditional model of wire and substation build-out, resulting in the successful reduction, delay, or elimination of expensive grid infrastructure upgrades.

These case studies offer just two examples of many potential options utilities can consider as they seek to address the challenges associated with incorporating a greater number of DERs into their energy mix portfolios. Analyzing the impacts of DER planning through a formal study or pilot program can provide insights that assist in guiding and informing the evolution of the traditional utility business, enabling higher levels of renewable energy potentially without costly build-out of supporting grid infrastructure.

More Information

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Endnotes

[1] NREL provides technical assistance to countries requesting support in making the transition to clean, advanced energy systems. As part of its work in China, NREL developed this fact sheet on Distributed Energy Resources, which will play a key role in 21st century power transformation. This work was funded by the *Children's Investment Fund Foundation* (CIFF).

[2] DERs can include a wide variety of technologies designed to produce, store, or control electricity resources. These can include, but are not limited to, solar photovoltaics, energy storage, electric vehicles, control systems like advanced inverters, and other energy sources.

[3] 2016–2017 Annual Directory and Statistical Report. 2016. "U.S. Electric Utility Industry Statistics, 2014." Arlington, VA: American Public Power Association. Ref HD9685.U4 A746 2016/2017. *http://appanet.files.cms-plus.com/PDFs/Directory%20-%20Statistical%20Report.pdf*.

[4] Sacramento Municipal Utility District (SMUD), "SMUD's Renewable Energy Portfolio." *https://www.smud.org/en/about-smud/environment/renewable-energy/renewable-energy-portfolio.htm*.

[5] Wilson, D.; K. Cory; D. Chung; V. Kassakhian. 2017. Beyond the Meter: Planning the Distributed Energy Future Volume II: A Case Study of Integrated DER Planning by Sacramento Municipal Utility District. Smart Electric Power Alliance and Black & Veatch. *https://sepapower.org/resource/beyond-meter-planning-distributed-energy-future-volume-ii/*.

[6] New York State of Opportunity. 2015. Reforming the Energy Vision: What it Means to Consumers. *http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/26be8a93967e604785257cc40066b91a/$FILE/88708408.pdf/NEW%20REV%20FEB%202015.pdf*

[7] Consolidated Edison, Inc. "Our Businesses." *http://investor.ConEdison.com/phoenix.zhtml?c=61493&p=irol-homeprofile*.

[8] Note that the BQDM portfolio represented in Figure 1 is intended to be primarily illustrative and that the actual composition of the portfolio will evolve over time. Coddington, M.; D. Sciano; J. Fuller. "Change in Brooklyn and Queens." IEEE Power and Energy Magazine, March/April 2017. *http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7866936*.

[9] Elcock, G. 2017. Brooklyn and Queens Demand Management Program Implementation and Outreach Plan. New York: Consolidated Edison Company of New York, Inc. *http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BEA551051-F5C8-4E51-9B83-F77017F0ED0D%7D*.

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