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IMPROVING DISTRIBUTION SYSTEM PLANNING TO INCORPORATE DISTRIBUTED ENERGY RESOURCES

The Second in SEIA's *Improving Opportunities for Solar Through Grid Modernization* Whitepaper Series

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EXECUTIVE SUMMARY

Built during the last century, the United States electric grid was primarily designed to transport electricity from large central station power plants to end-use customers. But with rapid growth of distributed energy resources, such as solar, resulting from falling costs and technological advances, customers are increasingly taking charge of their own energy. These resources offer the promise of a more innovative, economic, and cleaner electric grid.

This is a future in which distributed energy resources (DERs), such as solar power, will play an important role providing power and grid services where they are needed most. To reach this goal, however, distribution grid planning must evolve from a largely closed process (a "black box") to one which allows transparency into system needs, plans for distributed energy resources growth, and ensures that the capabilities of distributed energy resources are fully utilized.

This paper is the second in SEIA's series on grid modernization and focuses on distribution planning and operations, which is foundational to various facets of grid modernization. We start by reviewing the utility distribution system planning process today and identify key processes and concepts. Next, we discuss how two leading states are attempting to modernize distribution planning to both plan for distributed energy resources as well as leverage their capabilities.

ABOUT THIS WHITEPAPER SERIES

This series of SEIA policy briefs takes an in-depth look at state-level efforts to modernize the electric utility grid. Built during the last century, the United States electric grid was primarily designed to transport electricity from central station power plants to end-use customers. But with rapid growth of distributed energy resources such as solar, customers are increasingly taking charge of their own energy. Today's electric grid must allow distributed energy technologies to flourish and provide reliable, low-cost power for consumers. Distributed energy resources, like solar, can also provide power where it is needed most and help avoid investments that a utility would otherwise need to make.

This series explores the elements of electric grid modernization, compares the ways in which two leading states are tackling these issues, and discusses how these efforts are creating new opportunities for solar power. Grid modernization efforts in states present significant risks and opportunities for solar. These efforts will determine how much new solar and other distributed energy resources can interconnect to the grid, identify areas where solar can provide grid services in lieu of utility investments, and in some states, will shape the future of net energy metering.

OPENING THE BLACK BOX: UNDERSTANDING THE CURRENT PRACTICE OF DISTRIBUTION PLANNING & OPERATIONS

Distribution system planning is the process utilities undertake to evaluate their system needs based on forecasting demand, anticipating load shapes, and considering the tools available to them to meet system needs. The process includes two overlapping cycles: a multi-year review and funding cycle in utility general rate cases before a public utilities commission, and an annual planning process undertaken by utility distribution engineers. The former is an arcane regulatory process with some outside input from intervening parties, and the latter has been the sole purview of the utility.

Utilities upgrade their distribution grids based on forecast loads and replacement of aging equipment. Utilities annually review their distribution systems against load forecasts to identify areas where distribution system functioning may be challenged by new loads. They also use an ongoing asset management process to ensure that equipment, such as wooden poles, capacitor banks, and transformers, are replaced as they reach the end of their useful lives.

As part of the planning process, utilities evaluate whether an issue can be addressed by reconfiguring their distribution system. This reconfiguration involves shifting load through switches in the distribution system, moving load served by a substation and feeder to another feeder potentially served by another substation. If reconfiguration is insufficient to address the forecast need, the utility will plan investments in new infrastructure, such as substation upgrades, replacement of capacitor banks, or reconductoring of a feeder. Over the course of an annual planning cycle some investment needs will fall away while others will emerge as new system conditions arise.

With the advent of distributed energy resources, the basic tenets of this process remain intact. However, customers are not simply passive loads. Rather they increasingly have distributed energy resources. Where customers adopt these resources and how they are operated could mean substantially different utility needs in specific locations of the distribution grid over time. As distributed energy resources become more widespread distribution planning must move from simply planning, in a deterministic manner, based on forecast loads, to planning that is based on scenarios of distributed energy resource adoption and includes processes for guiding distributed energy resources to provide alternatives ("non-wire alternatives") to traditional utility investments.

DATA IS CRITICAL TO MODERNIZING DISTRIBUTION SYSTEM PLANNING

Enabling the distribution grid to readily incorporate distributed energy resources, and leverage their capabilities, begins with data. Efforts to change distribution planning and operations are, at their core, exercises in looking at the constraints on the distribution system. Will a new distributed solar system drive voltage beyond accepted limits? Will a new shopping center and housing development require a substation upgrade? The equipment that comprises the distribution system, along with the distribution grid's configuration, define what the distribution grid is capable of handling in terms of load and generation and where it might need to be upgraded.

The various analyses that states are pursuing in grid modernization proceedings are dictated by these grid constraints: 1) hosting capacity is a reflection of distribution grid constraints to accommodate new generation or load;[1] 2) locational value of distributed energy resources is based on the value of avoiding distribution grid upgrades needed for reliability;[2] and 3) non-wires alternatives are pursued in lieu of the identified upgrades underpinning locational values.

Given the importance of understanding the underlying grid needs that drive hosting capacity analyses and locational values, transparency is critical. If the cost-effectiveness of distributed energy resources, and/or their compensation, is going to be dictated by the cost of the needs they are offsetting, there is a reasonable expectation that those costs be publicly available.

Greater data transparency, and non-utility solutions for meeting grid needs, also provide a new opportunity to address an old problem of ensuring that utility expenditures are just and reasonable. To understand distribution system operations today, regulators, ratepayer advocates, and solar companies work through arcane quasi-legal processes to pull what data they can from the utilities using discovery requests, poring over utility filings, and carefully analyzing utility rate case testimony and exhibits. Further, utilities often provide these data in cumbersome formats such as locked spreadsheets or PDF files. While policymakers and interested stakeholders must use this information to determine whether utility investments in the electric grid are "prudent and reasonable," they must also rely on this information when considering methods of modernizing our grid.

To achieve the needed level of data access, regulators must begin considering and implementing new data rules that allow for reasonable access to data about distribution system capabilities and needs. These data include the needs the system has (e.g., capacity, voltage issues, reliability, resiliency, etc.), the scale of that need (e.g., MW, kVAR) and the underlying causes of those needs.[3]

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[1] The next paper in this series will examine developing better hosting capacity analysis.

[2] Other elements of DER locational value include the cumulatively avoided cost of energy and capacity, as well as cumulatively avoided transmission upgrade and maintenance costs.

[3] An excellent resource for understanding what types of data are needed is "Unlocking Grid Data: Enabling Data Access and Transparency to Drive Innovation in the Electric Grid," a white paper jointly authored by TechNet, SunSpec Alliance, and DBL Partners.

These data should be provided in a machine-readable format so that non-utility parties can use modern data analytics to evaluate utility needs and utility investment proposals, and identify areas where ratepayer savings can be realized by bringing distributed energy solutions to bear instead of more costly utility investments.

While reasonable protections must be made for customer privacy and security, protections have been defined to address concerns. Utilities should be specific about any unaddressed privacy or security concerns they believe exist. But such concerns should not be used as a rationale when the underlying concern is a reduction in utility capital expenditure that may result from better insights into utility distribution investment needs and potential third-party alternatives.

IMPROVEMENTS IN DISTRIBUTION PLANNING UNDERPINS NEW METHODS OF VALUATION AND TOOLS FOR INTERCONNCTION

Improved distribution planning yields data that underpins core products of grid modernization proceedings: Locational valuation, hosting capacity analyses, and non-wires alternative opportunities. Outlined below are ways that improved distribution planning provides the inputs to these grid modernization products.

1. Determining Locational Values

Historically, cost benefit analyses used for distributed energy resource programs, such as net-metering, have determined values for avoiding transmission and distribution that are averaged across a utility system. In reality, the value of distributed energy resources varies by location and what needs are driving utility investments. In some places, there may be a need for an expensive upgrade; in other locations, no forecast investments will be needed. Ensuring that all investments that could potentially be deferred or avoided by distributed energy resources are captured and valued requires transparency about distribution system needs, their drivers, and the costs of the utility investments needed to meet those needs. Short of these values it will not be clear to stakeholders whether these locational values are accurate and, therefore, if cost-effectiveness evaluations are fair.

> ***"To achieve the needed level of data access, regulators must begin considering and implementing new data rules that allow for reasonable access to data about distribution system capabilities and needs"***

2. Identifying Non-Wires Alternatives

Just as the type of utility distribution need, and the cost of the utility investment required to address that need, drive locational value, so too do those needs create the opportunity for non-wires alternatives (i.e., distributed energy resource alternatives to utility investments). Transparency on data about needs on the distribution system can ensure that distributed energy resource providers are afforded the opportunity to identify all opportunities where they may be able to provide more cost-effective solutions than a utility investment.

3. Making Interconnection Faster & Less Costly

Through power flow modeling, utilities use data about the equipment on- and configuration of- their distribution system to determine where upgrades are needed for their distribution systems due to load. The same underlying distribution grid data and power flow modeling can be used to identify how much additional distributed generation (or load, such as electric vehicle fast charging) can be interconnected to the utilities' distribution system. Transparency of these limitations both through hosting capacity maps, and the data underlying these maps, can help reduce interconnection costs and uncertainty for distributed energy resource developers.

Distribution Operations: The next frontier beyond improved planning

In addition to an evolving paradigm and process for grid planning there is discussion of new operational models. As new telecommunications technologies are developed and deployed by utilities, the ability of a utility to remotely monitor conditions and control equipment on the distribution system has increased. Telecommunications equipment ("SCADA") has allowed utilities to remotely monitor and control major equipment like substations and switches. Smart meters have provided far more insight into conditions at individual customer locations. With the advent of distributed energy resources there is a question of whether further telemetry and controls are needed to monitor distribution grid conditions that may be altered by distributed energy resources.

Utilities are proposing new equipment and software to monitor their distribution systems at a more granular level and potentially to control distributed energy resources directly or through aggregators. But the natural tendency of utility planners and operators to desire control over equipment on the grid should be resisted in favor of providing opportunities for customer devices and third party IT infrastructure, using the internet, to demonstrate their full capabilities to provide the necessary services at lower costs. Using existing third party equipment will deliver more value to customers than allowing utilities to make potentially expensive new investments and passing on those costs to ratepayers.

Going beyond new technology changes, operations of the distribution grid should change the role the utility plays as a distribution system operator. Utility operations could transition from a distribution system operator (DSO) where grid conditions are managed through utility operation of traditional infrastructure to an independent distribution system operator (IDSO) where a financially disinterested entity can orchestrate the operation of resources, both utility and third-party owned, to meet distribution system needs. For example, in New York the utilities have been directed to establish a distribution system platform provider (DSP) for their service territory. The DSP will be operated by the utility and generate revenue through the establishment of to-be-determined platform service fees, but remain functionally separated by a firewall from the utility's traditional role as a distribution company.

As distributed energy resources meet customer needs, local distribution needs, and wholesale market needs there will also need to be a capability for the DSO or IDSO to better communicate with the bulk transmission system operator to understand how transmission-level dispatches of DERs will impact locations on the distribution grid and the transmission system.

LEADING STATE EFFORTS TO REFORM UTILITY DISTRIBUTION PLANNING

1. California

In response to Assembly Bill 327, California's major utilities have filed distribution resources plans (DRPs). The methodologies of these plans have been under further development in the Distribution Resources Planning (DRP) proceeding and Integrated Distributed Energy Resources (IDER) proceeding.

The DRP proceeding has evaluated geographically-granular forecasts of distributed energy resources down to the feeder-level. These forecasts will inform a revised distribution planning process, potentially including a Grid Needs Assessment[4] which will outline all needs, both for traditional distribution grid upgrades as well as any grid modernization to accommodate DER.

This Grid Needs Assessment will provide the inputs to a deferral framework, which will identify projects that are deferrable or entirely avoidable through the deployment of distributed energy resources. This assessment, in turn, will determine locational net benefits in the locational net benefit analysis.

> ***Distribution planning must become more dynamic, and the methods applied must adapt to and account for the changing environment.***
> ***-NY PSC***

[4] CPUC Energy Division Staff "Staff Whitepaper on Grid Modernization" (April 2017) http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M186/K580/186580403.PDF.

Data access has been an area of disagreement between the utilities and distributed energy resource providers. The Commission has established rules for customer privacy, which include aggregation of customer data to ensure their individual usage is not publicly disclosed. The utilities have argued, however, that though much of this data may not result in privacy or security concerns it is "market sensitive," meaning that if they disclosed the costs of various needs on the distribution system any non-wires alternative solicitation would result in distributed energy resource companies bidding to the utilities' cost. This is an illogical outcome, but the argument has heretofore meant that only indicative values are available for the locational value of distributed energy resources.

Distribution system operations are being discussed in several forums. Southern California Edison's current recent general rate case[5] is exploring new tools for operating the distribution system, with one of their rationales being operation at high penetrations of distributed energy resources. Interconnection rules have established communications standards and pathways for the utilities to communicate with distributed energy resources directly.[6] Ongoing conversations between the California Independent System Operator (CAISO) and the state's utilities are seeking to determine how distribution utilities and the ISO can better coordinate as distributed energy resources participate in the ISO's markets.[7]

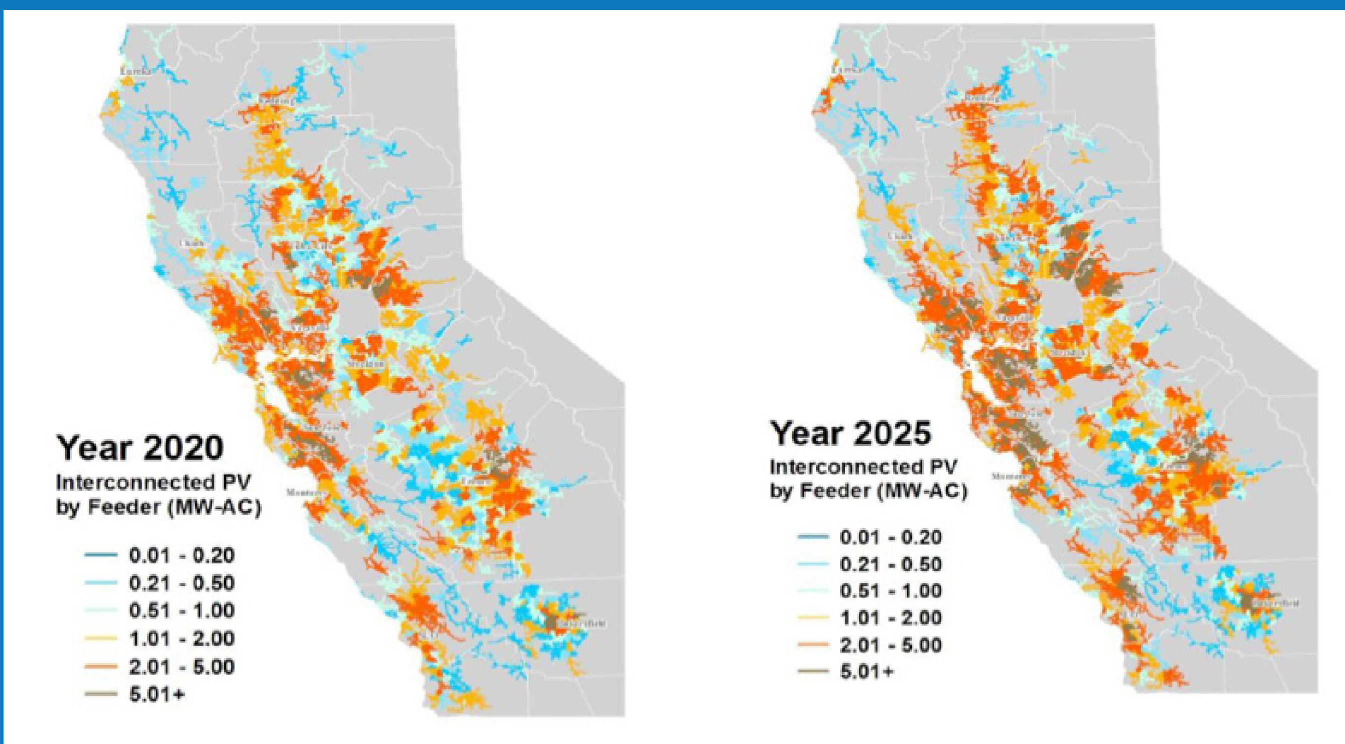

Figure 1: Pacific Gas & Electric Distributed PV Generation Forecast

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[5] "Test Year 2018 General Rate Case Application of Southern California Edison" California Public Utilities Commission docket A.16-09-001.

[6] Each utility has filed advice letters which will, beginning in March 2018 or 9 months following the establishment of relevant SunSpec standards, will require smart inverters to be capable of three different communications channels.

[7] For a discussion of these issues see More Than Smart, "Coordination of Transmission and Distribution Operations in a High Distributed Energy Resource Electric Grid" (June 2017) http://morethansmart.org/wp-content/uploads/2017/06/MTS_CoordinationTransmissionReport.pdf

2. New York

The New York Public Service Commission (PSC) also directed the utilities to file plans to better identify and integrate distributed energy as a major means of meeting distribution utility infrastructure and operational needs.[8] The PSC stated, "Distribution planning must become more dynamic, and the methods applied must adapt to and account for the changing environment."[9] The PSC identified two key areas of advanced planning: integrated system planning and hosting capacity analysis.

CONCLUSION

Utility distribution planning has begun to move from a focus on meeting passive loads to anticipating distributed energy resources, both in terms of how many DERs can be expected on the system and where these resources are likely to be located. To benefit ratepayers and unlock the full value of a modernized grid, updated distribution planning must leverage DERs, such as solar, to meet distribution needs where they may have traditionally used utility installed, owned, and operated equipment. Some states are leading the way toward reforming distribution planning, but much more work must be done. A key for regulators will be to guard against over-investment by utilities under the rationale of enabling distributed energy resources in the marketplace. Distribution planning done correctly will create opportunities for solar firms and other distributed energy resources, better value for customers, and help state's meet their energy and economic development goals.

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[8] See Market Design and Platform Technology Report at 50

[9] See DSIP Guidance at 9

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