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GETTING MORE GRANULAR:
HOW VALUE OF LOCATION AND TIME MAY CHANGE COMPENSATION FOR DISTRIBUTED ENERGY RESOURCES

The fourth 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 (DER) 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.

DER, 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 to allow more transparency into system needs, enable more robust data exchange between utilities and DER providers, and include DER as a standard component of utility load forecasts.

This paper, the fourth in SEIA's series on grid modernization, focuses on the ways in which the location of a DER can provide various grid benefits and may lead to changes in DER compensation. As with the rest of the papers in this series, the experiences of two leading states, California and New York, are examined. These two states are in the process of conducting extensive work examining new locational values and location-based tariffs and can serve as models for other states that are considering similar policies.

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.

VALUING DISTRIBUTED ENERGY RESOURCES: MORE GRANULARITY ON TIME AND LOCATION

Electricity supply and demand must be balanced on an almost instantaneous basis at all times and in all locations of the power grid. To accomplish this, utilities must plan their systems around the hours when demand is forecasted to be highest and ensure that they have enough capacity to meet this demand. To meet reliability requirements, utilities must also maintain an additional amount of capacity beyond this peak load as a reserve margin. Each part of the utility system, whether the total capacity of the power plants, the amount and size of transmission lines, or the equipment on a distribution circuit, must be designed to provide reliable service during the most challenging times that equipment is expected to face. DER such as solar PV can help avoid or delay investment in the grid infrastructure required to meet these needs by reducing load at the exact time when utility systems are most challenged. These resources can also be actively targeted to meet a distribution system need, through a solicitation, tariff or other mechanism.

Defining Locational Value

As part of their annual distribution planning process, utilities look closely at expected needs on the distribution grid in the following ten years. During this process, utility distribution engineers consider localized load forecasts based on demographic trends, such as population growth and household size, as well as planned construction, such as new housing communities and shopping centers. Based on current conditions and its forecast, the utility will determine if and where there are emerging or anticipated deficiencies for capacity or power quality. For example, expected home construction in an area may lead to projected load growth that requires replacing wiring on a distribution circuit, adding capacity to a substation, or some other upgrade. These projections are based both on the location of deficiencies as well as the specific time of day driving those needs. For example, certain circuits may need additional capacity to meet planned loads on hot summer afternoons, while other circuits may have high winter morning heating loads that must be addressed.

Once the utility understands its local capacity needs, the cost of the project – and thus the value of avoiding the project – can be determined. The cost of the project or projects needed to address an identified shortcoming should be based on the incremental cost of adding a unit of capacity to that area, for example $/kW-year. This is called the “marginal cost of capacity” as it reflects the cost to add new capacity, not the cost of the capacity already on the grid. The locational value of a DER system can be determined based on the contribution the resource makes to meeting that need, whether through energy, capacity, or reactive power produced during the hours when there is a need in that location. For example, if a set of circuits that peak in late August hours are driving the need for a multi-million-dollar substation, the locational value for a DER in this area would be equal to the marginal cost of adding that new substation capacity and any other needs on the distribution grid driven by those peak hours.

Getting Time-Value Right: Time of Use Rates

Locational value is based both on where distribution grid upgrades are needed as well as the hours that are causing the need in that location. However, other factors that drive the need for new power plants or transmission expansion projects also vary across times. Properly designed time-of-use rates can be a way to align the behavior of all utility customers – both with and without solar – to the needs of the grid. TOU rates may also be designed to support new technologies such as energy storage. For example, SEIA has proposed a suite of solar-plus-storage TOU rates in a recent Pacific Gas & Electric rate case.[1]

Defining Locational "Hot Spots"

Figure 1: New York Local System Relief Value Map

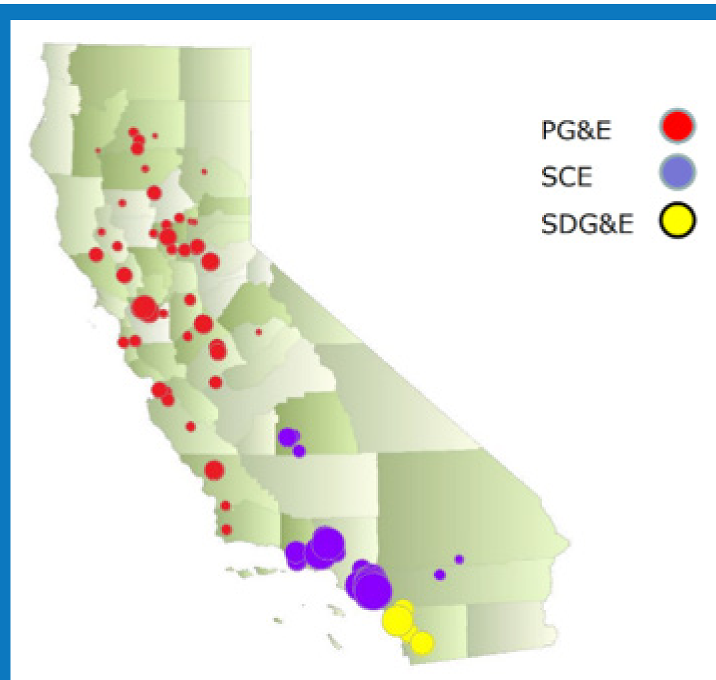

Figure 2: California Distribution Cost "Hot Spots"[2]

USING LOCATIONAL VALUE

Locational analysis can be a useful tool in unlocking the additional value that solar can provide to distribution system. Gaining a better understanding of locational value can help guide the placement of DER – including solar – to high value locations, provide the basis for compensation through location-specific utility solicitations or tariffs, and improve the accuracy of DER cost effectiveness evaluations. However, as useful as locational value is in some contexts, it should not necessarily replace other policies such as net metering, especially in emerging markets. Net metering has a demonstrated record of creating strong markets for renewables, and a location-based-variable tariff has yet to be demonstrated anywhere in the US. Only when emerging markets have reached a certain level of maturity should regulators begin the process of considering more location-based compensation frameworks.

[1] Jeff St. John, "California Solar Industry and Utilities Unveil Dueling Solar-Storage Tariffs", Greentech Media (March 17, 2017). Available at: https://www.greentechmedia.com/articles/read/california-solar-industry-utilities-unveil-dueling-solar-storage-tariffs

[2] Snuller Price, Energy and Environmental Economics (E3) Presentation to the New York REV Value Stack Working Group (September 20, 2017). Available at : http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/8a5f3592472a270c8525808800517bdd/$FILE/E3%20VDER%20Workshop%20California%20LNBA.pdf

Guiding DER to High Value Locations

Locational value can be used to guide resources to high value locations. Utilities can create, and should publish maps[3] showing the specific locations of any needs on the distribution system, the specific grid constraints to avoid the need (e.g., high loads during hot late summer afternoons), and the value of the avoidance in terms of dollars per amount of capacity. If a developer knows in advance that there will be a utility solicitation for the identified needs, it can begin seeking customers or project sites in anticipation of the opportunity to bid in its projects.

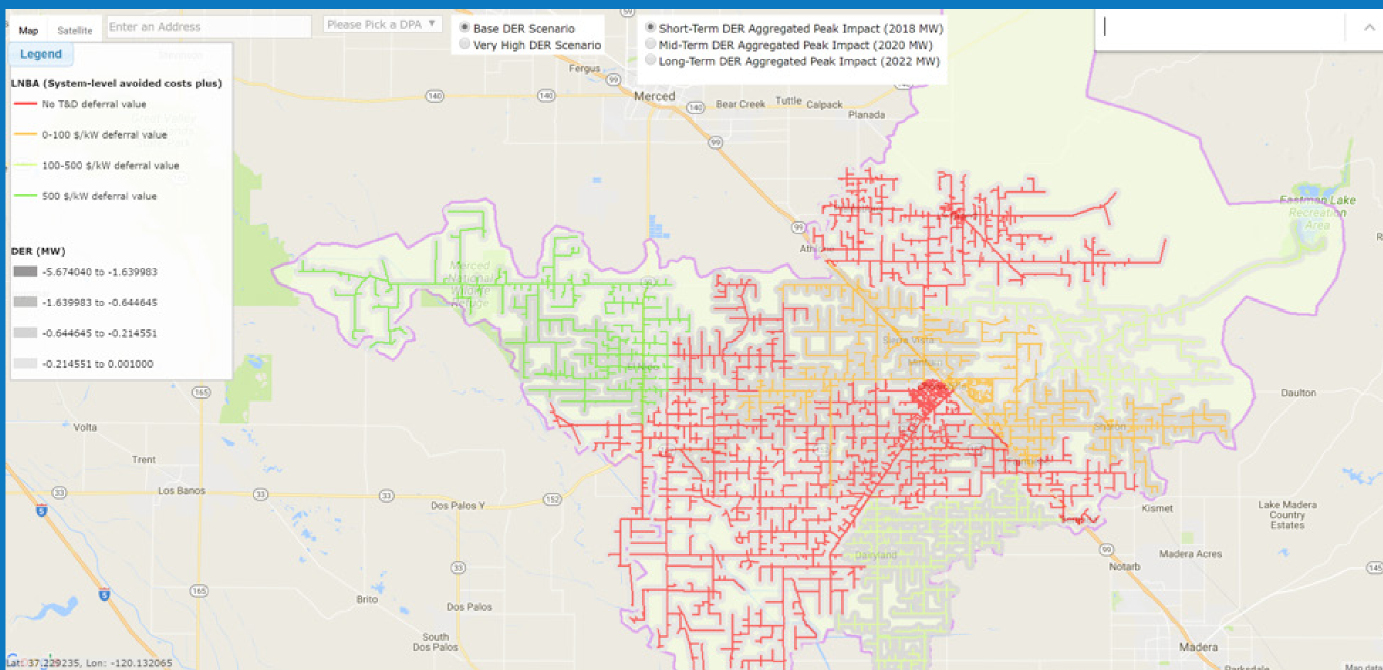

Figure 3: Locational Value Map for a Distribution Planning Area in Pacific Gas & Electric's Service Territory[4]

Providing the Basis for Compensation

In addition to competitive utility solicitations, there are alternative means of providing targeted tariffs, programs or incentives to drive DER to locations to meet identified needs. If identified needs are too small or have too short of a lead time to be met through a competitive solicitation, the utility could have a tariff- or program-based mechanism that can step in on short notice. For example, voltage issues are often very isolated and managed with small utility investments. However, smart inverters are increasingly being deployed widely and can be used to provide voltage management services in the locations where a utility has challenges managing voltage within an acceptable range. In addition, tariffs enable customers of all stripes to adopt solar and other DER, which delivers the generalized grid benefits we discuss, but also ensures that a state's clean energy market grows equitably in a manner that distributes the social, environmental, and economic benefits to all ratepayers. This is an emerging topic and it is expected that California's Integrated Distributed Energy Resources proceeding will explore non-solicitation based sourcing mechanisms.

[3] For example, see Pacific Gas & Electric's demonstration Locational Net Benefit Analysis map. Available at: https://www.pge.com/b2b/energy-supply/wholesaleelectricsuppliersolicitation/PVRFO/DemoBMap/DemoB.html

[4] Screenshot from Pacific Gas & Electric's demonstration Locational Net Benefit Analysis map.

Improving Cost-Effectiveness Evaluations

California's Locational Net Benefit Analysis is a modification of the state's Distributed Energy Resources Avoided Cost (DERAC) calculator. The DERAC is a spreadsheet tool incorporating utility costs that can be avoided by DER and is used to evaluate the cost-effectiveness of all demand-side programs in California, including net metering. The locational net benefit analysis has sought to take state-wide[5] averaged avoided costs for transmission and distribution and unbundle these values into specific sub-categories. The Commission has ordered the utilities to modify the DERAC tool to create a spreadsheet which incorporates locational values for approximately 500 distribution planning areas. While this may, in theory, provide a more precise view of the cost effectiveness of different DER programs, one must be cautious not to overestimate the precision of long-term locational forecasts that underpin these types of tools.

Figure 4: Improving Locational Granularity of Cost-Effectiveness Frameworks[6]

Likewise in New York, to help inform the ongoing Reforming the Energy Vision (REV) effort, the Public Service Commission (PSC) published a Benefit Cost Analysis (BCA) Framework Order[7] (Order) that sets out the standard elements that enable a fair comparison of benefits and costs for a range of utility investment decisions, as well as the development of future tariffs. While not directly taking on the task of identifying locational value for utility planning areas, the Order establishes the categories of value upon which successor tariffs to net metering are based. Further refinement of the detailed methodologies for calculating values was delegated to the utilities through the publication of specific BCA Handbooks.

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[5] The term "statewide" is used generally here. In practice, the DERAC tool accounts for the area of the Independent System Operator which accounts for over 80% of the state's load.

[6] Pacific Gas & Electric's Distribution Resources Plan (July 2015). Available at: http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5141

[7] New York State Public Service Commission, Order Establishing The Benefit Cost Analysis Framework, Case 14-M-0101 (January 2016). Available at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={F8C835E1-EDB5-47FF-BD78-73EB5B3B177A}

Modifying or Developing Tariffs

New York and California are examining tariffs where value varies over time and location. As part of its REV initiative, New York is now requiring that large commercial and industrial customers, and community solar customers, use the Value of Distributed Energy Resources tariff. California's "Net Metering 2.0" tariff requires all net metering customers to take service on a time-of-use rate. Both moves are motivated by regulators' intent for DER compensation to better reflect the locational and temporal value that distributed energy resources provide.

New York's Value of Distributed Energy Resources (VDER) Tariff

In March 2017 and in subsequent Orders, the New York PSC approved a new compensation framework to replace net metering with value-based compensation for larger solar projects, including community solar projects.[8] While maintaining net metering for residential customers through 2020, the VDER Orders establish compensation for electricity delivered to the grid on an hourly basis. They base compensation on categories of value making up a "value stack." The components include: the actual value of the energy and capacity, the value of avoided environmental externalities, the value of avoided distribution system costs, the value of avoided distribution costs in specific locations, and a transition value that allows for a gradual shift away from retail rate net metering. But instead of using detailed utility analyses to determine locational value, which in many instances does not yet exist, the PSC approved the use of proxies to stand in for demand reduction and locational values until better methods can be developed. Successor VDER tariffs are expected to refine the way locational values are calculated and there is considerable debate by stakeholders over the proper methods.

California NEM 2.0 and a view towards NEM 3.0

Unlike New York's "top down" approach of using proxies to inform new tariffs for DER, California has taken a "bottom up" approach to grid modernization. It has begun with new processes and methods for leveraging distribution system data for hosting capacity maps, modifying the distribution planning process, and determining locational value. The California Public Utilities Commission's NEM 2.0 decision acknowledges this, stating that while the Commission recognizes that the full value of distributed PV is hard to quantify, the state's grid modernization proceedings should continue to seek to better understand those values. The Commission determined the best course of action is to revisit net metering in 2019 after these proceedings have concluded.[9] Currently the utilities and stakeholders are in the process of developing Locational Net Benefit Analyses for consideration by the Commission. Locational values are expected to be available in maps across the state with full locational values in mid-2019.

[8] New York Public Service Commission, Order on Net Energy Metering Transition, Phase One of Value of Distributed Energy Resources, And Related Matters (Case 15-E-0751), (March 2017). Available at: https://www.nyserda.ny.gov/-/media/NYSun/files/VDER-Implementation-Order.pdf

[9] California Public Utilities Commission, Decision D1601044 - Decision Adopting Successor to Net Energy Metering Tariff (January 28, 2016) pp.58-60. Available at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M158/K181/158181678.pdf

PRINCIPLES FOR DEVELOPMENT AND USE OF LOCATIONAL VALUES IN COMPENSATION MECHANISMS

Locational valuation and compensation are emerging areas of utility regulation and DER compensation. Net metering, by contrast, is simple, easy for customers to understand, and is a proven, cost-effective way to achieve solar customer savings and provide benefits to all utility customers. SEIA and Vote Solar, together with numerous associations, environmental groups and clean energy advocates, has established net metering and rate design principles which guide SEIA's view on the creation of locational values.[10] SEIA is committed to developing accurate locational values that reflect the needs of the distribution system, identifying potential new revenue opportunities for DER projects from solicitations or new tariffs and programs, and working constructively in states that are considering modifications to net metering to incorporate locational value.

Based on our experience in these two jurisdictions, and building on our rate design and NEM principles, SEIA developed the following four principles for consideration with respect to the development and use of locational value for compensation.

1. Include the "full stack" of values of when designing compensation

Locational values have multiple components. First, there is the value in offsetting planned or potential investments in the distribution and subtransmission grid with less expensive DER options. Second, when properly authorized and wired, DER can help utilities and customers respond to localized system outages by providing power during times of interrupted service. Third, reduced electricity consumption also produces localized environmental and public health benefits and these benefits can be calculated and incorporated. Finally, there are values that DERs can provide for maintaining power quality, reducing line losses, and providing data to the utility for situational awareness.

Each of these locational values should be considered and rigorously analyzed when evaluating or developing compensation tariffs to capture the entire range of benefits that these resources provide. These values are additional to benefits that are system-wide (i.e., accrue evenly across the utility system), such as reduced need for powerplants, reduced greenhouse gases, and reduced high-voltage transmission. Both locational and system wide values should be considered together when using these values to evaluate DER programs or tariffs.

2. Ensure that locational values are long-term, stable, and financeable

As is done with utility investments, the locational value of DER should be structured to provide a consistent revenue stream over the life of the asset to ensure ease of financing. Utilities enjoy a regulatory structure that offers a return on- and return of- capital needed to make long-term investments. This proven mechanism has enabled utilities to confidently finance billions of dollars of assets and countless infrastructure improvements to meet the electric needs of society. Financial markets look kindly on this structure, which ultimately results in a lower cost of capital for the incumbent utility and lower costs for its customers. Distributed energy resource providers do not have such regulatory guarantees on their rate of return, but they should be afforded similar long-term financing treatment for the resources they deploy in lieu of utility-owned distribution equipment.

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[10] Solar Energy Industries Association, Vote Solar, et al, "Principles for the Evolution of Net Energy Metering and Rate Design" (May 2017). Available at: https://www.seia.org/initiatives/principles-evolution-net-energy-metering-and-rate-design

Compensation tariffs to support DER investments must be structured to provide long-term revenue certainty to non-utility assets that are meeting utility customers' needs. If this fails to happen, and compensation tariffs instead rely on short- or medium-term time horizons that don't match the life of DER assets, the resulting tariffs will shortchange the value of the asset and make it difficult to arrange financing. When moving toward a more granular valuation of DER, regulators must ensure that the long-term value of the resource is recognized and properly included in compensation.

3. Ensure the reliability benefits of DER have value

Recent natural disasters have demonstrated the ability of solar coupled with battery storage to provide electricity service to individual buildings or groups of buildings.[11] In California, however, the value of DERs to provide reliability has, to date, been viewed narrowly. In piloting solicitations of DERs to meet distribution needs, California has defined reliability as the ability to provide "back-tie" capability. Specifically, DERs can reduce load, effectively increasing the amount of incremental load that could be transferred through a tie line should another line face an outage. For resiliency, the utility's LNBA demonstration projects considered the value of a micro-grid providing excess reserves for restoring customers and providing power within the microgrid during outages.

Looking forward, we expect that customer investments in stationary battery storage and other distributed energy resources (e.g., fuel cells) that can provide islanding capabilities from the grid and provide electricity service during outages will increase. This value should be incorporated into valuation and compensation frameworks moving forward.

4. Create opportunities for distributed grid services

Solar projects avoid generation, transmission, and distribution capacity projects that would otherwise have been needed.[12] While locational valuation creates an opportunity to better understand this value to the distribution grid, there are new capabilities that DER can provide unrelated to avoiding capacity-driven projects such as substation upgrades needed to meet growing loads. Specifically, DER could help provide new grid services including situational awareness and voltage and power quality management.

Providing Utilities with More Data to Improve Distribution Grid Operations

Using smart inverters and other devices located at customer premises, third-party DER providers could provide data services for utilities that would otherwise install sensing and communications equipment. By leveraging existing DER assets, the utility will not need to invest in duplicative hardware. The data from these systems helps inform the utility about the operations of its distribution grid, an ability known as "situational awareness."

Two important operational metrics are line voltage and line status (e.g. operating or experiencing an outage). In providing voltage and outage information, DER can provide functions similar to Advanced Metering Infrastructure, line sensors/fault detectors, and communication with line equipment, though DER can only provide the monitoring function and not the control function.

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[11] Some recent news stories have demonstrated the value of DERs in providing reliability during natural disasters. See for example: 1) examples of homes continuing to operate following this summer's hurricanes using solar and batteries: https://www.forbes.com/sites/peter-detwiler/2017/09/17/after-irma-solar-plus-storage-a-small-beacon-of-light-in-a-sea-of-darkness/#3a3aaaed340f; 2) a microgrid with solar and storage operating through California's wine country fires in October 2017: https://microgridknowledge.com/islanded-microgrid-fires/

[12] For example, see Robert Walton, "Straight Outta BQDM: Consolidated Edison Looks to Expand its Non Wires Approach" Utility Dive (July 19, 2017), https://www.utilitydive.com/news/straight-outta-bqdm-consolidated-edison-looks-to-expand-its-non-wires-appr/447433/

In addition to voltage, frequency, and the occurrence of an outage, DER can also provide loading information at each site to determine how much generation is being produced and used on site. By capturing and utilizing this information, utilities can use DER to help drive more effective smart grid programs, increase reliability, and increase grid utilization. Intelligence at the end of the line can be used to more efficiently operate the system. Power quality problems can be identified and resolved sooner, outages can be detected faster, modeling accuracy can be improved, and distribution state estimation could be implemented.

Improving Power Quality and Reducing Electricity Losses Through Voltage Management

As part of their core responsibilities, utilities must supply electricity to customers within established power quality standards. Because utilities do not always have visibility to the voltage on each line segment, they often raise line voltages at the substation to the upper end of the operating range to ensure customers at the end of the line are within acceptable standards. While this brute-force method keeps voltage within the required operating limits throughout the feeder, it also wastes electricity.

To address this waste from excess voltage, utilities are increasingly deploying conservation voltage reduction (CVR) programs. CVR is a demand reduction and energy efficiency technique that flattens voltage across a distribution circuit and allows the voltages to be lowered across the whole circuit. The impacts are significant: a 1% reduction in distribution service voltage can drive a 0.4% to 1% reduction in energy consumption.[13] CVR programs typically save 0.5% to 4% of energy consumption on individual circuits, and are often implemented on a large portion of a utility's distribution grid.[14] Because distributed PV with smart inverters can increase or decrease the voltage at any individual customer location, these resources can be used to more granularly control customer voltages.

CONCLUSION

The modern grid must more effectively use DER such as solar to meet system needs. Increasingly, states leading the way in grid modernization are determining locational values and considering compensation mechanisms to guide DER to areas where they can have the most impact. Although these compensation mechanisms can take multiple forms, when designing any such mechanisms, regulators must incorporate the full range of values that DER brings to the system. Offsetting traditional capital investment, reducing demand in specific locations, and providing consistent power during periods of interruption are all values that should be captured when designing compensation methods for DER; these values are in addition to system-wide values such as the ability to avoid new power plants and high voltage transmission. Furthermore, regulators should design compensation based on a long-term time horizon, with an eye toward establishing stable DER revenue streams. By developing appropriate compensation mechanisms that will enable DERs to flourish, regulators, utilities, and customers can transform the electric grid into one that will better meet the needs of all customers.

[13] Wang and Wang, "Review on Implementation and Assessment of Conservation Voltage Reduction", IEEE Transactions on Power Systems (May 2014).

[14] SolarCity, "Energy Efficiency Enabled by Distributed Solar PV via Conservation Voltage Reduction: A methodology to calculate the benefits of distributed PV with smart inverters in providing conservation voltage reduction" (June 2016). Available at: http://www.solarcity.com/sites/default/files/SolarCity-CVR_Benefits_Methodology-2016-06-28_v2.pdf

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