State Strategies for Valuing Distributed Energy Resources in Cost-Effective Locations

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About This Report

This paper was produced by the Clean Energy States Alliance (CESA), a national nonprofit organization, through its work as part of the Solar Energy Innovation Network. The Solar Energy Innovation Network is a collaborative research effort led by the National Renewable Energy Laboratory (NREL) and supported by the U.S. Department of Energy Solar Energy Technologies Office. The Solar Energy Innovation Network assembles diverse teams of stakeholders to research solutions to real-world challenges associated with solar energy adoption. More information about the Solar Energy Innovation Network can be found at www.nrel.gov/solar/solar-energy-innovation-network. More information about CESA can be found at www.cesa.org.

As part of the Solar Energy Innovation Network, five states—Connecticut, New Hampshire, Rhode Island, Washington, and Wisconsin—and the District of Columbia, with coordination and support from CESA, forged the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid* in 2018. Over the ensuing year and a half, that initiative aimed to advance state decision-making for identifying high-value locations for the development of Distributed Energy Resources (DERs), such as solar, solar-plus-storage, energy efficiency, and demand response, but each participating state had its own approach and specific goals.

CONNECTICUT GREEN BANK

In **Connecticut**, the Connecticut Green Bank tested the use of a solar incentive program to defer infrastructure upgrades on two distribution circuits.

OPC-DC Office of the People's Counsel ADVOCACY | EDUCATION | PROTECTION

In the **District of Columbia**, the Office of the People's Counsel commissioned a study of the city's solar growth trajectory by ward and the impact to ratepayers of meeting the city's solar targets.

New Hampshire Public Utilities Commission

In **New Hampshire**, staff from the Public Utilities Commission worked with stakeholders to develop a solicitation for a statewide study of the locational value of distributed generation.

State of Rhode Island Office of Energy Resources

In **Rhode Island**, the Office of Energy Resources leveraged its experience participating in a non-wires alternative project in 2015 to enable greater grid transparency and to improve screening standards for future non-wires projects.

In **Washington**, the Department of Commerce deepened its locational-value-of-solar knowledge base by convening stakeholders and sharing information.

In **Wisconsin**, the Office of Energy Innovation analyzed the value proposition of a resilient solar-plus-storage solution for Washington Island in the wake of a weather-induced power outage that lasted for more than two weeks.

By exploring the locational value of DERs as a multistate team coordinated and supported by CESA, the states participating in the project were able to share information and resources and jointly refine their ideas. This report provides background information on locational value of solar, but it also incorporates insights and lessons learned in the course of conducting our collaborative initiative. More information about the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid* can be found at https://www.cesa.org/projects/locational-value-of-distributed-energy-resources/.

Introduction

The deployment of Distributed Energy Resources (DERs), small-scale electricity generation sources or controllable loads connected to the distribution system or a facility served by the distribution system, can have wide-ranging and positive impacts for the electricity grid. Interconnecting a DER in a high-value location on the grid can unlock benefits beyond those that accrue to the off-taker or asset owner. When DERs are deployed optimally, not only can the individual consumer benefit, but the local utility, the electricity system, and other ratepayers can benefit as well. By engaging in locational DER planning, states can help protect their communities and ratepayers and can help ensure the reliability and resilience of the electricity system.

This report explores states' role in better integrating locational value into DER siting and development. It first outlines some of the benefits that can be achieved through the deployment of DERs in high-value locations. It then looks at state policy and regulatory roles and the tools states can use to influence the location of DER development. The report next examines the challenges of locational DER planning, with a particular focus on the challenges that states face in influencing the location of DER development. It highlights three case studies from states that engaged in locational DER planning through the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid* and then presents several lessons learned from these efforts. The final section of this report summarizes some recent publications related to locational value of DERs in the form of an abbreviated literature review.

Potential Benefits of Optimal DER Siting

Optimally deployed DERs can provide an array of benefits. Notwithstanding any financial benefits that might flow to a DER off-taker or owner, DERs can offer electrical system benefits and broader societal benefits, such as increased public safety and air quality along with other social and environmental benefits. This section broadly discusses locational DER valuation concepts before introducing individual DER value streams that can be achieved through optimal project siting.

Before embarking on a discussion of potential DER benefits, it is important to recognize that a DER may have costs. Valuation requires accounting for both benefits and costs. **For the purpose of this paper, we understand locational value to be a function of net benefits—where the benefits of deployment of a DER in a particular place outweigh the costs**—but there may well be instances where costs exceed benefits. It is also important to note that certain benefits may be valued differently by different stakeholders. Considering to whom certain DER value streams accrue and how different value streams interact are critical pieces of the locational value puzzle too.

Non-Wires Alternatives and Avoided Grid Infrastructure Costs

Many of the benefits of DERs to the electricity grid can be understood in terms of avoided costs—grid-related expenditures that would otherwise be necessary but for the deployment of DERs. The targeted use of DERs to defer or avoid a wires-based grid upgrade is often referred to as a *non-wires alternative* but, in reality, the potential avoided costs associated with DERs can extend beyond electricity poles and wires to other categories of avoided costs such as avoided environmental costs.

Whether a DER deployment serves to defer or avoid a planned wires-based grid upgrade (i.e., a non-wires alternative) or it is intended to supply other avoided-cost benefits can impact how its value is assessed. For this reason, non-wires alternatives may be treated differently from DERs delivering other services.

Assessing the value proposition for DERs to serve as a non-wires alternative in a particular location often involves technical analysis: projecting load growth in an particular area; estimating the cost of capacity infrastructure upgrades to accommodate that growth; assessing the load reductions needed to avoid those upgrade investments; evaluating the feasibility, reliability, and cost of using DERs to achieve those load reductions; and comparing costs between the traditional infrastructure upgrade and the non-wires alternative approach.

Quantifying DER Value Beyond Non-Wires Alternatives

Outside the non-wires alternatives context, locational DER valuation can be complex because, rather than focusing on the wires-based infrastructure cost, there may be a wide range of other value streams to be considered. Quantifying them can be challenging.

> **Valuing DERs Based on Need for Infrastructure Upgrade Deferments**
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> A DER's value proposition may change considerably depending upon whether or not it is deferring a planned infrastructure upgrade. Under most valuation methodologies, if a utility pursues a non-wires alternative where a particular electricity feeder line is 95 percent loaded (i.e., at 95 percent of capacity), the value proposition for the non-wires alternative would account for the entire avoided infrastructure cost. If, on the other hand, a feeder is only 75 percent loaded and need for an infrastructure upgrade at the location has not been triggered, the avoided wires-based infrastructure cost will be valued at zero even though there may well be value to deploying distributed generation assets on the feeder to ease the loading constraint.

Compiling multiple values streams, often called "value stream stacking," for the purposes of locational DER valuation is not simply an additive process for several reasons:

- The value proposition for a DER at a given location on the grid is temporally anchored. It may depend on daily peak loads, seasonal peak loads, and changing variables such as the amount of other DERs operating on the same feeder.
- Different DER configurations and combinations have different characteristics. For example, pairing solar systems with battery storage can provide synergistic benefits—benefits that extend beyond what separate solar and battery storage systems by themselves can provide.[1]
- Harnessing a DER for one value stream may diminish its ability to provide another value.[2] Using a battery storage device to discharge electricity into the grid during distribution system peak loads, for instance, may limit the battery's ability to serve regional capacity markets during transmission system peaks.

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[1] *Benefit-Cost Analysis for Distributed Energy Resources: A Framework for Accounting for All Relevant Cost and Benefits*, SYNAPSE ENERGY ECONOMICS (September 2014), https://synapse-energy.com/sites/default/files/Final%20Report.pdf.

[2] *Capturing More Value from Combinations of PV and Other Distributed Energy Resources*, REGULATORY ASSISTANCE PROJECT (August 2019), https://www.raponline.org/wp-content/uploads/2019/08/rap_shenot_linvill_dupuy_combinations_pv_other_ders_2019_august.pdf.

- Evaluating which potential societal benefits should be considered (i.e., what values belong in a value stack) is not always clear. Just how far should we extend our resilience, public safety, environmental, and economic development lenses? When accounting for the environmental benefits of DERs, for example, is it a narrow look at avoided greenhouse gas emissions or should other environmental factors, such as air pollution and water quality impacts, be considered too?

Even if a decision can be made on which values should be incorporated into DER valuation, how to accurately account for these values offers its own set of challenges. For example, it is widely acknowledged that pairing battery storage with solar can provide resilience benefits under certain circumstances,[3] but how to assign a value to these benefits has not been definitively settled. A recent survey of methods that have been used by state regulators to value resilience found a variety of different approaches have been used, but all of them examined resilience solely as a function of avoided power interruption and none met all the usefulness and usability criteria evaluated. The study notes that "[t]he difficulties involved in valuing resilience relate directly to the challenges inherent in analyzing high impact, low probability power interruption events."[4]

As DER valuation efforts have advanced, methodologies for locational DER valuation have refined, but no consensus methodology has emerged. These methodological differences underscore both the complexity and contextual nature of the exercise.

Potential DER Benefits to the Electricity System

When DERs are deployed in optimal locations, they can help avoid or defer grid-related expenditures. These avoided electricity system costs include the following:

Avoided energy and fuel costs

DERs can provide generation that reduces the need for electricity from other electricity generators. Unlike traditional centralized generating facilities, most DERs do not require ongoing fuel expenditures.

Avoided transmission and distribution losses

DERs are interconnected to the grid's distribution system, meaning they are located near the electricity loads that they serve. As such, DERs avoid the electricity line losses that occur when electricity is transported over distance between the point of generation and the electricity end-user. Traditionally, electricity losses between the generation facility and the consumer can be between 8 percent to 15 percent. By virtue of their proximity to the electrical load, DERs can avoid these lines losses.

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[3] *Valuing the Resilience Provided by Solar and Battery Energy Storage Systems*, NATIONAL RENEWABLE ENERGY LABORATORY, https://www.cleanegroup.org/wp-content/uploads/Valuing-Resilience.pdf.

[4] *The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices*, CONVERGE STRATEGIES (April 2019), https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198.

Avoided operations and maintenance costs

In most cases, DERs are not utility-owned assets. That means the onus of operating and maintaining DERs does not fall on ratepayers as a class; it falls on the individual customer or third-party developer that owns the asset. As a result, harnessing DERs can result in avoided labor and other operations and maintenance costs that would otherwise be required for traditional electricity generators.

Avoided generation capacity costs

DERs provide value when they avoid investments to build new, large-scale generation capacity to meet peak electricity loads. Capital expenditures for centralized generation facilities include land, equipment, construction, and regulatory (e.g., siting and permitting) costs. Assessing avoided generating capacity cost may require projecting load growth in areas over different time horizons.

Avoided transmission and distribution capacity costs

Like avoided generation capacity costs, avoided transmission and distribution system costs result when DERs reduce system peak loads and obviate the need for additional transmission and distribution infrastructure investments. Avoided transmission and distribution infrastructure investments can take the form of forgone costs for upgrades to poles, wires, substations, and feeders—costs that non-wires alternatives serve to avoid.

Avoided grid support services

Grid support services represent a broad array of values that help to enable power quality and grid reliability. These services include reactive supply and voltage control, regulation and frequency response, operating reserves, and system control. The specific grid-support services that DERs provide depend on the technology deployed and when and where it is being utilized. The intermittency of DERs can increase the variability of system loads, making it more difficult for grid operators to maintain adequate power quality. On the other hand, DERs can be used to reduce system peak loads, thereby helping ease power quality constraints. Certain DER technologies, such as advanced inverters or battery storage, can provide grid support services that pave the way for the integration of other DERs such as solar.

Potential Societal Benefits of DERs

DERs can offer a range of benefits that extends into the public sphere. When deployed in optimal locations, DERs can provide the following societal benefits.

Resilience benefits

Resilience in the context of the electricity system typically refers to electricity security and recovery characteristics that maintain service or mitigate interruptions during extreme events such as natural disasters. Resilient DERs can respond quickly to electricity disruptions, can isolate from the larger grid and discharge stored power to serve critical needs during a grid outage, can flexibly adjust their output to match rapidly changing load, and can provide grid services that support reliability during disruptions.[5] Depending on scale and design of the resilient DER, these benefits can extend to a household, building, neighborhood, or community.

Avoided public safety costs

DERs can lower peak electricity loads resulting in reduced fire risk and other safety-related emergencies, as well as reduced insurance costs for electric utilities—costs that are often borne by ratepayers. But DER deployments can present safety risks too. Although battery storage systems can provide fire mitigation benefits through peak load reduction on the grid, in rare cases, it may also represent a potential fire risk due to the chemical composition of some types of battery cells.

Avoided health and environmental costs

Distributed generation can displace traditional fossil fuel-powered plants with clean, renewable electricity sources. Ultimately, renewable distributed generation investments can mitigate the climate change impacts of the energy sector and improve air quality in areas impacted by fossil fuel-powered generators. In terms of avoided climate-change related costs, various efforts have attempted to put a price on the cost of greenhouse gas emissions. In terms of avoided air-quality costs, the US Environmental Protection Agency recently released a set of values that can be used to estimate the outdoor air quality-related public health benefits of investments of renewable energy.[6] There may be other avoided environmental costs, such as land use or water quality impacts,[7] that are associated with displacing traditional centralized generating facilities with clean distributed generation as well.

Economic and social benefits

DERs can provide economic and societal benefits such as economic development, job opportunities, and tax revenue, as well as energy democratization and equity benefits. How these benefits stack up for a potential DER deployment compared to a business-as-usual case is not always clear, however. It may not be readily apparent, for example, whether a non-wires alternative will provide an increase in net jobs compared to a wires-based infrastructure investment.

[5] *Advancing Electric System Resilience with Distributed Energy Resources: A Review of State Policies*, NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS, (forthcoming October 2019).

[6] *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (July 2019), https://www.epa.gov/sites/production/files/2019-07/documents/bpk-report-final-508.pdf.

[7] DERs have smaller land-use footprints than traditional centralized generating facilities. Water quality impacts from traditional centralized electricity generation facilities could include effluent discharges during plant operation (e.g., coal ash) or impacts from fossil fuel extraction processes (e.g., water quality impacts associated with hydraulic fracturing or "fracking").

The Role of States in Locational DER Planning

Locational DER planning is often embedded in other planning activities. In many cases, these planning activities are led by non-state stakeholders (for example, utility integrated resource plans, DER developers' siting decisions, and municipal zoning). But states have an important role in locational DER planning as it relates to utility regulation, ratepayer advocacy, public safety administration, environmental oversight, and economic development facilitation.

Locational DER planning is a multi-stakeholder, multi-step effort. It requires both the identification of high-value locations for DERs and the deployment of DERs in the identified locations.

Why States Should Engage in Locational DER Planning

Because the electricity system benefits of locational DER deployment most immediately flow to utility grid operators, it may not be readily apparent why states would want to engage in locational DER planning. After all, utility grid operators are most familiar with the conditions on the grid, and states may not have access to data about grid constraints. So, why should states care? Below are a few potential reasons:

Reducing Ratepayer Costs

Under the United States' traditional monopoly utility model, electricity regulation is a necessary market intervention to ensure that the public interest is served. And, it has long been the province of states—principally, through their public utility commissions and ratepayer advocate offices—to protect the economic interests of their ratepayers. States can advance this goal through locational DER planning because optimally deployed DERs can reduce grid congestion and provide cost-effective alternatives to traditional utility infrastructure upgrades. By identifying optimal locations for DERs and encouraging their deployment in those areas, states can help utilities avoid expensive utility infrastructure investments, the costs from which ultimately get passed onto ratepayers.

Ensuring Public Welfare

With broad authority to oversee the wellbeing of their citizenry, states have a vested interest in other societal benefits that DERs can provide. State powers extend to emergency services that protect the public from harm. With growing threats to the electricity system from weather-related disasters, such as hurricanes and wildfires, and human-made perils, such as cyberattacks, grid resiliency becomes an increasing public-interest concern for governments. By encouraging resilient DER deployments in high-value locations, states can help ensure their communities have electricity to power critical services during a grid outage by supporting the deployment of resilient power technologies that can function when the grid goes down. And, as noted above, DERs can provide environmental, economic development, and equity benefits as well—all values that directly impact the welfare of a state's citizenry and hinge on locational considerations.

Enabling More Renewable Energy

Through stand-alone mandates or Renewable Portfolio Standards, many states have established solar, renewable energy, carbon-free, or emissions-free electricity goals. The higher the mix of intermittent renewables in an electricity supply, the harder it can be to reliably integrate more renewables; the challenges associated with balancing renewable power supply with electricity demand profiles and power quality needs only intensify. Locational DER planning becomes increasingly important with more states facing the technical challenges associated with enabling higher levels of renewable energy penetration.

How States Can Influence the Location of DER Deployment

States are well positioned to engage in locational DER planning not only because they have an important stake in the outcome, but also because they can encourage the deployment of DERs in high-value locations. States have several tools at their disposal to influence the location of DER deployment, described below.

Requiring Greater Distribution System Transparency

Several states have required their investor-owned utilities to provide more information to DER customers and developers about conditions on the grid. In many cases, this has taken the form of public maps of the distribution system's hosting capacity. Hosting capacity is an estimate of the amount of DERs that may be accommodated by the grid under existing configurations without adversely impacting the system's reliability or triggering additional infrastructure upgrades.

Some states have required investor-owned utilities to make hosting capacity maps publicly available. For example, the California Public Utilities Commission required the state's investor-owned utilities to conduct hosting capacity analysis and place hosting capacity maps online. Beyond California, utilities such as Eversource, Exelon, Hawaiian Electric, National Grid, NV Energy, United Illuminating, and Xcel Energy offer hosting capacity maps.[8] In some cases, hosting capacity maps are provided for some parts of a utility's service territory but not others. Some maps require a customer to register to access them for security reasons. Some, but not all, offer loading forecasts for the system. There are also differences in the granularity of the maps, the frequency of data input updates to the map, and the types of DERs modelled.

Requiring utilities to engage in more transparent distribution planning processes and to provide greater visibility into conditions on the grid can result in more DER deployments in sound locations even absent the financial incentives for projects in high-value places. When DER developers can target project deployments in locations on the grid with known hosting

[8] See, e.g., https://www.xcelenergy.com/working_with_us/how_to_interconnect/hosting_capacity_map.

capacity, it can enable more streamlined interconnection approval. It can also enable DER developers to design projects that accommodate hosting capacity constraints in the planning phase of the project. Where infrastructure upgrades may be required to interconnect a project, DER developers can build that into the design of the project as well.

Under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid*, the Rhode Island Office of Energy Resources worked with the state's investor-owned utility, National Grid, on a public system data portal that maps the state's distribution system with feeder-level loading forecasts and hosting capacities. The goal of the system data portal is to provide information to encourage developers to site DERs in beneficial locations on the grid, thereby providing cost savings for ratepayers.

On July 19, 2019, the Rhode Island Office of Energy Resources, with facilitation support from Rocky Mountain Institute, held a workshop with solar developers to get their input on the functionality of the system data portal and their level of engagement with it during project development. Feedback from the workshop suggested that commercial-scale developers were using the system data—specifically technical information about substations, mapping distances from project location to the distribution system, and available hosting capacity—for threshold screening of project viability. If the project location seemed feasible, developers supplemented system data with information from the utility's interconnection portal to further refine projects. Developers that used the portal reported their motivations were split between reducing interconnection pains and searching for grid-beneficial locations. The workshop also revealed the importance of timely updates to system data as well as clear instructions for how developers should use the portal.

Even when conducting in-depth distribution system analysis may be cost-prohibitive or otherwise infeasible, there may be other ways to guide DER development toward cost-effective locations. For example, under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid,* the Office of the People's Counsel for the District of Columbia commissioned a study examining the city's solar growth trajectory by ward. Rather than providing an expensive examination of the distribution system, the study instead looked at technical and economic potential of solar siting characteristics under the city's urban space constraints. The study found that there is considerable achievable potential for solar installations on parking lots in the city, particularly in wards with higher percentages of low- and moderate- income households. Using this information, the Office of the People's Counsel for the District of Columbia can better guide solar development toward cost-effective deployment locations within the city in a manner that offers access to low- and moderate-income households.

Encouraging DER Development through Tariffs and Incentives

The most common way to compensate distributed generation in the US is through net metering. Under a basic net metering regime, customers receive utility bill credits based on the amount of electricity generated by their project that is exported to the grid. Increasingly, jurisdictions are exploring other tariff-based approaches for compensating solar and other distributed generation not based on the market *cost* of electricity produced, but instead based on the *value* that distributed generation provides. Currently, 17 states along with Washington, DC, are exploring value of distributed generation tariffs, including value of solar, as a possible compensation mechanism.[9] Some of these efforts are exploring value of distributed generation not as a static compensation figure, but as something that fluctuates temporally and geographically.

Under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid*, the New Hampshire Public Utility Commission is conducting a locational value of distributed generation study that will inform the development of its next DER tariff. For more information on this effort, see page 22.

Under a locational tariff-based approach, distributed generation would receive higher compensation rates at places on the grid where it provides more value. This would have the effect of incentivizing the development of distributed generation development in high-value locations. Operationalizing a value of distributed generation tariff with a locational component is far from straightforward, however. For example, finding a balance between the locational and temporal granularity necessary to provide meaningful grid benefits with practical considerations for DER developers, who need consistency and clarity to make their projects bankable, has proven to be a challenge. To date, Minnesota and New York are the only states have developed value of solar (or value of distributed generation) tariffs with locational components.[10]

It is conceivable that, even under more basic net metering compensation regimes, states could provide compensation adders for distributed generation in certain locations. Vermont, for example, offers a net metering adder—a per kilowatt hour financial incentive—for distributed generation deployed on certain preferred sites, including parking lots, brownfields, landfills, and specific locations designated by municipalities for renewable energy. Vermont's preferred sites have more to do with land use and aesthetic concerns than grid conditions, but a state could theoretically incentivize distributed generation deployment on a geographic basis using a similar approach.

Steering Utilities toward Non-Wires Alternatives

Utilities can procure DERs for grid services directly. These procurements may be all-source—allowing for different resource options to fulfill the need (i.e., technology agnostic)—and they may allow for resource aggregation, enabling multiple DERs to pool to fulfill the need. In some

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[9] O'Shaughnessy and Ardani, *Key Considerations and Emergent Approaches for Locational Value of Solar Tariffs in the United States*, NATIONAL RENEWABLE ENERGY LABORATORY, (forthcoming 2019).

[10] Ibid. California has an ongoing distribution resource plan proceeding, which may result in a location-based solar compensation tariff as well.

cases, they may seek out geographically-specific services or rely on locational evaluative criteria.

Through the rate oversight process, state regulators can nudge utilities toward non-wires procurements when they prove cost-effective. Regulators ultimately sign off on utility distribution system plans and procurements.

But several states have also taken proactive steps to steer utilities toward non-wires solutions with incentives and mandates. The California Public Utilities Commission approved a pilot program that offers a 3 percent to 4 percent pre-tax incentive for utilities deploying cost-effective DERs as non-wires alternatives in the state. It also directed California's investor-owned utilities to procure at least 150 MW of "preferred resources" such as distributed generation. Maine requires regulators to consider non-wires alternatives before approving new transmission and distribution projects and has established a non-transmission alternative coordinator post to assist in developing cost-effective alternatives to transmission projects. The New York Public Service Commission, through its Reforming the Energy Vision (REV) proceedings, requires the state's investor-owned utilities to publish their non-wires opportunities online. Rhode Island requires National Grid, the state's only investor-owned utility, to annually submit a System Reliability Procurement report that identifies qualifying non-wires alternative projects. Vermont requires a committee to identify potential deferrals when examining new transmission projects.

Developing Targeted Programs and Campaigns

Some states have launched targeted incentive programs and campaigns to enable the deferral of grid infrastructure upgrades in specific locations.

Between 2012 and 2017, Rhode Island's only investor-owned utility, National Grid, conducted a non-wires alternative pilot in the towns of Tiverton and Little Compton.[11] The project aimed to defer a $3 million substation investment through energy efficiency and demand response programs. Starting in 2015, the Rhode Island Office of Energy Resources (RI OER) provided funding to help support the integration of distributed solar generation into the non-wires alternative.[12] For its part in the project, the RI OER helped sponsor Solarize initiatives—solar bulk purchasing and community-focused marketing campaigns—for Tiverton and Little Compton. In addition to the pricing discounts available through the program, RI OER offered a special rebate incentive to area homeowners who installed west-facing panels. The incentive for west-facing projects was designed to help National Grid reduce late-afternoon system peak

[11] *National Grid Rhode Island System Reliability Procurement Pilot: 2012-2017 Summary Report*, OPINION DYNAMICS (July 2018), http://rieermc.ri.gov/wp-content/uploads/2019/05/national-grid-ri-srp-pilot-2012-2017-summary-report_final.pdf.

[12] *System Reliability Procurement Solar DG Pilot Project*, RHODE ISLAND OFFICE OF ENERGY RESOURCES (May 2018), http://www.energy.ri.gov/electric-gas/future-grid/oer-system-reliability-solar.php.

loads and to offset the reduced production of the westerly-facing solar panels for customers (rather than southerly oriented for maximum production).[13]

The results of the pilot showed that orienting solar arrays to the west successfully increased solar production during periods of high electricity demand on the local distribution system. But maximum summer peaks still occurred late in the day relative to solar system output. A full program evaluation, however, found that although the pilot only reached a third of its load reduction goal, the savings was sufficient to postpone investment in the substation through 2017.

Under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid*, Connecticut Green Bank worked with the electric utility United Illuminating on a pilot project to explore the capability of DERs to defer a planned capacity upgrade on two distribution circuits in Fairfield, Connecticut. As part of this non-wires pilot, Connecticut Green Bank ran a Solarize-style campaign with special incentives for customers who installed solar or solar + storage systems. For more information about this pilot project, see page 21-22.

In New York, the state initially launched its Community Distributed Generation program in two phases. The first phase was restricted to projects that 1) were sited in utility-identified Community Distributed Generation Opportunity Zones—places on utility's grid where locating Community Distributed Generation projects would be most beneficial, or 2) had at least 20 percent low-income customer participation. The second phase was broadly open to Community Distributed Generation projects within a utility's entire service territory, without any customer income restrictions. Similarly, other states could embed locational components in their DER programs, either as part of a phased program rollout, an eligibility requirement, or as one of many project selection criteria.

Maryland Energy Administration's Resiliency Hubs program provides grants to microgrid developers to offset costs for projects in high-density, low- and moderate-income communities. The program defines a resiliency hub as a facility within short walking distance from economically disadvantaged populations and that can allow for medication refrigeration and the charging of small personal devices and can serve as a heating, cooling, and lighting center in the event of an emergency. Applicants must submit plans for the operation of the resiliency hub during an extended grid outage. Although program eligibility does not contain explicit geographic restrictions, the program prioritizes projects in high-density under-resourced communities—a preference which effectively serves as a proxy for locations with high resilience value.

[13] Sliding-scale incentives were offered for west-facing projects based on the system's incremental value to distribution system or its lost revenue as compared to a south-facing system.

Challenges

Considerable benefits can be achieved through locational DER planning, but there are also many challenges involved in carrying out this planning, in part because locational DER valuation is still an emerging area of exploration. This section first discusses underlying locational DER valuation challenges and then turns to the challenges states face related to locational DER planning.

Underlying Locational DER Valuation Challenges

- There is no standard methodology for assessing locational value of DERs.
- Defining value may depend on who you are and what your role is. The environmental benefits of some DERs may not be valued as much by grid operators as by community members, for example. Consideration of what gets baked into DER valuation and compensation can be contentious.
- The value of a DER deployment at a specific location is partially dependent on other DERs already installed nearby. As more DERs are added to the grid and electricity load profiles in a location change over time, so does a particular DER's incremental value in that location. Identified high-value locations where DER deployment is incentivized can become low-value or even negative-value deployment locations in a short amount of time.
- When use of a particular DER value stream is incompatible with other uses, it is not clear which DER use should be prioritized. For example, if a DER at a given time can either provide load reduction to alleviate an hourly distribution system peak, or provide capacity value to the regional electricity market, which use should take precedence? How priorities for competing uses should be established and controlled is largely uncharted territory as a policy matter and these operational questions have an important bearing on locational DER valuation.
- DERs vary in terms of flexibility, load shape, and operating characteristics. Certain DER technology combinations can enable value stacking and synergistic benefits but these benefits can be difficult to capture.
- DER valuation is infused with uncertainty. Methodologies are being refined to achieve greater precision, but they still rely on projections, proxies, and placeholders. Some load forecasts, for instance, erroneously assume load changes at a constant rate over time and fail to capture the degree of uncertainty inherent in longer-term planning. DER valuation efforts typically focus on enumerating and calculating potential value streams, but as noted above, it is difficult to quantify these values. There is no universally-

accepted formula for assessing the value of resilience or the capacity deferral value provided by various DERs, for example. DER valuation efforts are approximations, but the values they attempt to appraise are often technical, precise, and time-bound.

- Distribution grid transparency must be balanced with grid security and customer privacy. Utilities have been reluctant to provide detailed distribution system maps publicly due to concerns that doing so will reveal security vulnerabilities or private customer information. Consumer protection advocates have also voiced concerns about yielding customer control of DERs to utilities to meet certain grid needs.

Challenges Pertaining to the Role of States in Locational DER Planning

- States must rely on utility data and commitments in locational DER valuation efforts, but the traditional utility rate paradigm can serve as an obstacle for utility engagement in locational DER valuation efforts. Under the traditional cost-of-service model where electric utilities can deliver shareholder returns for capital project investments, utilities are not particularly motivated to work with states to find non-wires opportunities, to accord DERs much compensatory value, or even to share data in furtherance of these aims. Utilities typically do not see the same returns on their investment for non-wires alternatives as they do for infrastructure projects. Plus, as the cost of distributed generation assets become more affordable and customer uptake increases, the grid's electricity loads may go down, stranding utilities with unnecessary infrastructure assets.

- States may not have the capacity or expertise to conduct the complex, technical analyses that locational DER valuation requires. Understanding how particular combinations of DERs might impact voltage levels and reactive power at a specific times and locations on the grid is the bailiwick of distribution system engineers and grid operators. State energy offices focused on policy and program administration may not have the technical capacity to tackle these questions, and it can be problematic to rely on utility expertise to conduct these assessments absent technical oversight from states.

- The conditions of the grid at any given location can vary considerably over time with changing loads and incremental DER additions, but price signals for DER developers need to be stable to make projects financeable. This tension underscores the challenge states have in translating technical and time-bound valuation determinations into practical policies that are understandable, transparent, consistent, and fair for customers and DER developers. As one New York Public Service Department filing on compensating locational DER value states, "The desire to compensate for precise grid values must be balanced with the risk that a more sophisticated tariff may result in price signals that do not fully incentivize and motivate developers and customers to make decisions based on the objective of maximizing grid value."[14]

- It can be difficult to set a DER incentive or compensation rate to motivate enough DER adoption to relieve a grid constraint without overloading the distribution system with DERs in a location. Relying on the private market adoption of DERs as a non-wires alternative can be risky, because there is no guarantee that there will be enough adoption to avoid a grid infrastructure upgrade.

Despite these challenges, states are finding ways to move forward with locational DER planning efforts, learning from and building off one another in the process, and collectively advancing the state-of the-art on locational DER valuation. The following section of this report provides several examples of how states are approaching locational DER planning.

[14] *Final Whitepaper Regarding Future Value Stack Compensation*, NEW YORK DEPARTMENT OF PUBLIC SERVICE STAFF (December 2018), https://www.cesa.org/assets/SEIN-Team-Page/Staff-whitepaper-on-VDER-Compensation.pdf.

State Case Studies

From April 2018 to October 2019, CESA worked with five states and the District of Columbia to advance state decision-making on the locational value of DERs under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid*. Three case studies from this work are included below to illustrate some of the goals and approaches states can take on this topic.

Connecticut

In Connecticut, the local utility United Illuminating (UI), with the support of the Connecticut Green Bank, tested the use of a DER-production incentive program to defer an infrastructure investment. Under the project, the entities collaborated on a demonstration project to explore the capability of DERs to defer a planned capacity upgrade on two distribution circuits in Fairfield, Connecticut.

Ash Creek Substation Circuit 2670 was anticipated to exceed its circuit rating by approximately 92kW as early as the summer of 2017, increasing to 550kW by 2024. Ash Creek Substation Circuit 2660 was expected to exceed its circuit rating by 90kW as early as 2020, increasing to 400kW in 2026. The traditional solution for this capacity constraint would be to transfer load to another substation and construct a new feeder, providing 4.9 MW of load at a cost of approximately $625,000 dollars.

Instead, UI designed a project to avoid the infrastructure upgrade by incentivizing the adoption of DERs (primarily solar and battery storage systems). The project sought to reduce localized energy demand during peak summer hours (between 2 pm and 6pm) on Circuit 2670 and Circuit 2660 by a combined 1 MWh. The program had three components:

- **Targeted marketing campaigns**: Two 16-week Solarize-style outreach campaigns with collaboration from UI and the Town of Fairfield. The effort pre-screened customers for solar potential and targeted and customized communications with the pre-screened customers.
- **Modifications to interconnection conditions**: Participating customers were required to install a battery storage-ready advanced inverter with ride-through capability. The advanced inverter requirement was designed to reduce interconnection costs and provide grid support benefits. UI reimbursed customers for the cost of a revenue-grade meter and provided customers with an additional production meter to track customer generation.
- **Incentives**: Participating customers were offered a $0.05/kWh bill credit for solar production or battery storage discharge between 2pm-6pm between June and the end of September. The bill credit functioned as a rate rider that would last for five years. For

battery storage systems, Connecticut Green Bank offered a $231.50/kWh storage incentive pilot as well as discounted pricing from a selected contractor.

Although the pilot did not achieve its intended adoption targets (nine residential customers on circuit 2660 adopted solar during the program period), several important lessons were learned from the program. In this pilot, the circuits in need of capacity relief were located in a jurisdiction that was fairly saturated with solar (although not on the specific circuits in question). The town of Fairfield had already conducted four Solarize campaigns for community bulk purchasing of solar systems prior to the launch of the pilot, so households located on the circuit suffered from message fatigue.

This issue highlights the challenges that arise when locations are selected solely based on grid need without considering additional characteristics of the location, as well as the challenges of running circuit-specific campaigns as opposed to more readily understood geographies (i.e., town-wide).

In addition, several technical challenges took significant time to unravel, including equipment metering requirements, equipment configurations, and data access issues. Finding common technical standards when trying to work with multiple equipment manufacturers and contractors made it difficult to establish uniform standards for customer participation. Lastly, the production incentive provided to program participants was calculated based on the avoided cost of a utility infrastructure investment. While this was a fair compensation level, it did not yield a large enough financial incentive to induce customer participation, especially at the level needed to achieve the pilot's objectives.

New Hampshire

In New Hampshire, staff from the Public Utilities Commission worked with stakeholders to develop a solicitation for a statewide study of the locational value of distributed generation.

In 2016, the New Hampshire legislature passed a bill requiring the New Hampshire Public Utilities Commission to initiate a proceeding to develop new alternative net metering tariffs. Recognizing that more information would be needed to inform the proceeding, the Commission ordered a value of DERs study and non-wires alternatives pilot to be conducted. In 2018, a system-wide value of DERs study scope was proposed, but the Commission decided to modify its non-wires alternative pilot into a study of the locational value of distributed generation. The identified aim of the locational value of distributed generation study was to determine avoided costs of deferred capacity investments at the distribution level, which then became the focus of New Hampshire's work under the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid* project.

In 2018, Commission staff began convening stakeholders to develop a locational value of distributed generation study scope. The New Hampshire Public Utilities Commission held a public, in-person technical workshop on its locational value of distributed generation study scope on September 18, 2018, at which NREL presented on other states' locational DER valuation efforts.

In 2019, staff filed a proposed study scope, which was followed by a public hearing and written comment period and eventual final Commission approval with some modifications. The selected study approach will closely follow current utility planning methods and practices to best represent investment decision-making in the New Hampshire context. Consultants will work closely with the state's three regulated utilities through three high-level steps: identifying locations for detailed analysis, determining avoided or deferred investment costs, and assigning values using load profiles to map against generation profiles. This study scope has formed the basis of Request for Proposals to solicit a vendor to conduct the study.[15]

Wisconsin

In Wisconsin, the Office of Energy Innovation analyzed the value proposition of a solar and battery storage solution for Washington Island in the wake of a power outage that lasted for more than two weeks.

Washington Island in Lake Michigan has a full-time population of 700 residents with about 350 utility customers. The island is served by the Washington Island Electric Cooperative, which purchases electricity primarily from the Wisconsin Public Service Corporation but can also purchase power from the Midcontinent Independent System Operator (MISO) when necessary. The island has two 1,600-kW diesel back-up generators that are used in emergencies as the cost of power from MISO is usually less expensive than deploying the diesel generators. In June 2018, Washington Island lost power for more than two weeks due to damage to an underwater cable caused by an "ice-shove." Without the underwater cable, the island had no ability to purchase power and was forced to run the diesel generators for 17 days. After the ice-shove incident, the underground cable was replaced at a cost of approximately $4 million.

Under the *Multistate Initiative*, the Wisconsin Office of Energy Innovation explored the costs associated with serving the island's load through a solar and storage solution rather than via cable replacement. Washington Island's extended outage experience and its load size and relative isolation offered a particularly compelling test case with the potential for wider applicability in other scenarios. The model that was applied did not show cost-effectiveness for adding solar and storage to the island, however, modeling constraints may have masked some of the real-world value of a solar-plus-storage deployment in this case.

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[15] *Request for Proposals: Locational Value of Distributed Generation (LVDG) Study Consultant*, NEW HAMPSHIRE PUBLIC UTILITIES COMMISSION (April 2019), http://www.puc.state.nh.us/Home/RFPs/2019-003/20190404-PUC-RFP-2019-003-LVDG-Study-Consultant.pdf.

Lessons Learned

In the course of conducting the *Multistate Initiative to Develop Solar in Locations that Provide Benefits to the Grid*, CESA and the participating states gleaned some important insights about locational DER valuation. Lessons learned include the following:

1. Locational DER valuation is difficult, but a precise value may not be necessary. In the non-wires alternative context, for instance, it may be enough to know that a DER can perform as cost-effectively as a wires-based solution on balance, without assigning a specific locational market value to DER.
2. The potential of DERs to perform certain services does not always mean they will reliably perform those services. The effectiveness of a DER to defer a grid infrastructure investment, for example, hinges upon the answer to an array of questions, including:
    1) Does the DER output match the timing of the capacity need (both in terms of hours of the day and seasons of the year)?
    2) Can the DER consistently provide power at that time (e.g., solar on cloudy days)?
    3) Will the DER be available over time and for the full deferral period?
    4) Can the DER be monitored and controlled by the utility to effectively meet the distribution system needs?
    5) Does activating the DER to provide one service hamper its ability to provide other services?
3. A state's goals for locational DER planning may impact the level of granularity and methodological approach used. Locational analysis can be assessed in several ways: as a DER compensation mechanism, as an incentive for DER development in particular locations, as a grid transparency tool, as a means for a utility to meet a non-wires alternative mandate, as a way to mitigate potential cross-subsidization between DER customers and other ratepayers, or as part of a utility's integrated resource planning process. Different objectives may influence the level of precision and value streams that need to be considered for a locational analysis.
4. Overriding public policy considerations may come into play. For example, DER valuation methodologies typically do not factor in equity considerations, but equity may emerge as an important issue if all the identified locations for DER deployment and associated incentive opportunities fall in high-income neighborhoods. In some cases, location-based tariffs or incentives could make DERs relatively more expensive for low-income customers. These policy considerations should be considered.

Locational Value of DERs Resources

Advancing Electric System Resilience with Distributed Energy Resources: A Review of State Policies, NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS (forthcoming in 2019): This report describes how DERs can be used to support resiliency. The report explains regulatory barriers for DER use cases for resilience and offers best practices.

Capturing More Value from Combinations of PV and Other Distributed Energy Resources, REGULATORY ASSISTANCE PROJECT (August 2019): The report discusses how different combinations of DERs can create synergistic value and different mechanisms for capturing that value. It also includes use cases that explain why a customer might install a particular DER combination, including earning wholesale market revenue, resilience benefits, non-wires alternatives, and addressing environmental issues, https://www.raponline.org/wp-content/uploads/2019/08/rap_shenot_linvill_dupuy_combinations_pv_other_ders_2019_august.pdf.

Final Whitepaper Regarding Future Value Stack Compensation, (NEW YORK DEPARTMENT OF PUBLIC SERVICE STAFF (December 2018): New York State is phasing out of a locational component in its value of distributed energy resources (VDER) tariff. The white paper from New York Department of Public Service Staff explains the basis for New York's decision to forgo the locational element in its VDER tariff, https://www.cesa.org/assets/SEIN-Team-Page/Staff-whitepaper-on-VDER-Compensation.pdf.

Illinois Distributed Generation Valuation and Compensation, PACIFIC NORTHWEST NATIONAL LABORATORY, (October 2018): The Illinois Commerce Commission partnered with the Pacific Northwest National Laboratory (PNNL) to develop options for a Distributed Generation Valuation and Compensation structure in Illinois. The white paper primarily focuses on potential valuation components specific to distributed generation, namely avoided distribution capacity costs, reduction in distribution losses, distribution voltage support, and operating reserves, as well as the data needs to assess these types of components and perform the overall valuation, https://www.icc.illinois.gov/downloads/public/IL%20DG%20Rebate%20Calculation%20Considerations%20November%202018.pdf.

Integrated Distribution Planning: Utility Practices in Hosting Capacity Analysis and Locational Value Assessment, ICF (July 2018): This report provides a reference of emerging industry practices for hosting capacity analysis and locational value assessment. It is organized by use case and focuses on current practices, challenges, and intended outcomes, https://www.cesa.org/assets/SEIN-Team-Page/ICF-Integrated-Distribution-Planning.pdf.

Key Considerations and Emergent Approaches for Locational Value of Solar Tariffs in the United States, NATIONAL RENEWABLE ENERGY LABORATORY (forthcoming in 2019): The report examines three state approaches to incorporating locational value into solar tariffs: California, Minnesota, and New York. It also includes a comparative analysis between the locational value of solar tariff programs.

Location Specific Avoided Transmission and Distribution Avoided Costs Using Probabilistic Forecasting and Planning Methods, NEXANT FOR CENTRAL HUDSON GAS & ELECTRIC, (June 2016): This is a location-specific avoided transmission and distribution cost study methodology relies on probabilistic analysis and quantifies the option quantifies the option value of reducing peak demand, https://www.cesa.org/assets/SEIN-Team-Page/Nexant-Central-Hudson-Locational-Avoided-TD-Cost.PDF.

Locational Value of DER Is Essential to Grid Planning. So Why Hasn't Anyone Found It?, UTILITY DIVE (November 2018): This article includes an overview of various state efforts related to locational DER valuation and covers considerations such as reliability and mitigating risk of non-wires alternatives, https://www.utilitydive.com/news/locational-value-of-der-is-essential-to-grid-planning-so-why-hasnt-anyone/541946/.

Non-Wire Alternatives: Case Studies from Leading U.S. Projects, SMART ELECTRIC POWER ALLIANCE, (November 2018): This SEPA and Peak Load Management Alliance (PLMA) report provides information on ten non-wires alternative projects from across the country and shares lessons that have been gleaned from developing these projects, https://sepapower.org/resource/non-wires-alternatives-case-studies-from-leading-u-s-projects/.

Non-Wires Solutions Implementation Playbook, ROCKY MOUNTAIN INSTITUTE (December 2018): This report is designed to help regulators and developers implement non-wires solutions and includes best practices and implementation guidelines, https://rmi.org/insight/non-wires-solutions-playbook/.

The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices, CONVERGE STRATEGIES (April 2019): Prepared for the National Association of Regulatory Utility Commissioners (NARUC), this paper reviews methodologies that have been used by state regulators for calculating the value of resilience. It explores both regulatory and non-regulatory value of resilience calculations and groups the methodological approaches used, https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198.