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Distributed Generation Valuation and Compensation

White Paper

February 2018

AC Orrell
JS Homer
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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
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Executive Summary

This white paper can help guide a state as it considers issues associated with distributed generation valuation and compensation. States may address a common set of questions and issues in the valuation process, but differences in market expectations, policy priorities, and regulations result in different responses. Key issues include the following.

- Context is important. Valuations and compensation strategies will vary based on goals and objectives they are being designed to achieve. Goals and objectives should be made clear up front and will drive the perspective used in performing valuations and how outcomes are applied.
- An important early step in performing valuations is to survey the different value components and their associated costs and benefits that could be used as the valuation building blocks. Examples of valuation building blocks include avoided costs associated with fuel, generation capacity, transmission capacity, reserve capacity, distribution capacity, fixed and variable operations, and maintenance and environmental compliance and/or impacts.
- Utilities and stakeholders can have different interpretations of how value elements should be calculated. In some states, the objective of standardized calculators and methods is to reduce ambiguity and inconsistencies in how valuations are performed.
- Certain value elements are difficult or impossible to quantify and most efforts to establish workable value of solar or value of distributed energy resource tariffs are emerging and nascent. Assessing locational and temporal value of distributed generation and applying that in compensation schemes is a new and emerging field of study being explored by a handful of research organizations and advanced states and utilities.
- The most advanced states, such as California, are using demonstration projects to test valuation and compensation methodologies or are applying valuation and compensation strategies to a subset of customer projects, such as for community solar projects (e.g., Oregon and New York), before rolling out programs to the full customer base.
- A variety of states are moving away from full net metering, in many cases substituting avoided cost rates (sometimes with an adder) in lieu of full retail rate compensation, instead of pursuing valuation of distributed energy resource approaches. For example, in Indiana a 25% adder is applied to average wholesale electricity prices and in Mississippi a 2.5 cents/kWh adder is applied to avoided cost rates. These adders appear to have been established through policy directives rather than comprehensive cost of service valuations.

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Acronyms and Abbreviations

CGS	Customer grid-supply
CPR	Clean Power Research
CPUC	California Public Utilities Commission
CSS	Customer self-supply
DER	Distributed energy resource
DRP	Distribution Resource Plans
DRV	Demand reduction value
ERCOT	Electric Reliability Council of Texas
FEJA	Future Energy Jobs Act
FIT	feed-in tariff
HECO	Hawaiian Electric Company
ICC	Illinois Commerce Commission
IOU	Investor-owned utilities
LBMP	Locational Based Marginal Price
LCOE	Levelized cost of energy
LNBA	Locational Net Benefits Analysis
LSRV	Locational system relief value
MCOS	Marginal cost of service
NARUC	National Association of Regulatory Utility Commissioners
NEM	Net energy metering
NYPSC	New York Public Service Commission
OPUC	Oregon Public Utilities Commission
PUC	Public Utilities Commission
PURPA	Public Utility Regulatory Policies Act
REC	Renewable energy certificate
RGGI	Regional Greenhouse Gas Initiative
RVOS	Resource value of solar
SETO	Solar Energy Technology Office
TOU	Time-of-use
VOST	Value of solar tariff

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1.0 Introduction

The adoption of distributed generation has different implications for system owners, utilities, utility customers (including both participating customers who have distributed generation and non-participating customers), and the overall society. As a result, distributed generation can be valued differently by stakeholders. Valuation calculations or processes can be tied to distributed generation compensation mechanisms, such as value of solar tariffs or distributed generation rebates.

In a value of distributed generation calculation, all values, both positive (i.e., benefits) and negative (i.e., costs), are considered to achieve a net value. This allows for a well-designed compensation mechanism to be achieved that mitigates negative effects, reinforces positive effects, and supports the full and fair value of distributed generation to all stakeholders (NREL 2017).

1.1 Report Purpose

This white paper can help guide a state in determining its goals and objectives for distributed generation valuation and compensation. States may address a common set of questions and issues in the valuation process, but differences in system contexts, market expectations, policy priorities, and regulations result in different responses (NREL 2013). This report highlights what some states are doing, and their current challenges, to show how distributed generation valuation and compensation are currently being considered.

1.2 Background

Valuation and compensation of distributed generation has changed over the years to keep pace with the evolution of distributed generation. The primary compensation mechanisms in the United States have included payments per the Public Utility Regulatory Policies Act (PURPA), net energy metering (NEM) programs, and next generation programs, such as value of solar tariffs and successor NEM programs.

PURPA, enacted in 1978, was designed to encourage energy conservation and to support domestic renewable energy sources (Warren 2017). PURPA requires utilities to purchase electricity from renewable energy generating facilities of 80 MW or less (FERC 2017) at the utility's avoided cost rate, the incremental cost equal to or less than what a utility would have to pay for electricity from a traditional power plant.

Because PURPA requires utilities to allow customers to self-generate electricity and be compensated for it, PURPA essentially laid the foundation for future NEM programs (Freeing the Grid 2015) and feed-in tariffs. While PURPA is a federally mandated compensation policy, NEM is a state policy that compensates generation at retail electricity rates, not avoided cost rates.

Thirty-eight states have mandated NEM rules as of November 2017, but many states are scaling back their NEM requirements, or introducing replacement programs, such as value of solar tariffs, buy-all, sell-all, or net billing programs, as discussed in Section 3.0. Even with these next generation programs that are moving away from valuing compensation at the retail electricity rate, PURPA still provides a minimum level of distributed generation compensation protection.

In contrast to NEM, a feed-in tariff (FIT) compensates generation at a set FIT rate that is typically higher than the retail rate (EIA 2013). A FIT is typically designed and implemented to achieve overarching policy goals such as accelerating renewable energy investment and/or reducing greenhouse gas emissions.

Feed-in tariff programs are not common in the United States, but are used in many European countries and Japan.





1.3 Importance of Context

A state's goals for what it is ultimately trying to achieve with a program, tariff, incentive, or rebate will impact its valuation calculations. Goals can include reducing state carbon emissions, replacing net metering, encouraging renewable energy development, encouraging market participation from a variety of resources, encouraging only cost-effective renewable energy development, or some combination of factors. This context can come from state legislation, executive goals, and/or state commission actions. As a state moves toward developing valuation and compensation schemes for distributed generation, it is important they have a clear understanding and statement of the goals and objectives the programs are being designed to achieve.

Context therefore drives the valuation process and the perspective used in the valuation. Three different perspectives are typically considered—that of the participating customer, the utility (and thus the utility customer), or society as a whole. The views of other stakeholders, primarily the non-participating customer, but also the distributed generation industry and the policy maker, can also be considered as they relate to the three main perspectives.

As noted by the consulting firm Energy and Environmental Economics, Inc. (E3), improvement in environmental quality is a value for society. Improvement in the environment can be quantified or assessed in different ways—one such way is to apply the social cost of carbon in the valuation and another is to ensure that the costs of complying with environmental laws or renewable portfolio standards (RPS) are included.

Selecting a primary perspective will determine which elements should be considered and how they should be included in a valuation calculation. Figure 1 (from Rocky Mountain Institute) summarizes these perspectives.

stakeholder perspective		factors affecting value
PV CUSTOMER 	<p>"I want to have a predictable return on my investment, and I want to be compensated for benefits I provide."</p>	<p>Benefits include the reduction in the customer's utility bill, any incentive paid by the utility or other third parties, and any federal, state, or local tax credit received. Costs include cost of the equipment and materials purchased (inc. tax & installation), ongoing O&M, removal costs, and the customer's time in arranging the installation.</p>
OTHER CUSTOMERS 	<p>"I want reliable power at lowest cost."</p>	<p>Benefits include reduction in transmission, distribution, and generation, capacity costs; energy costs and grid support services. Costs include administrative costs, rebates/incentives, and decreased utility revenue that is offset by increased rates.</p>
UTILITY 	<p>"I want to serve my customers reliably and safely at the lowest cost, provide shareholder value and meet regulatory requirements."</p>	<p>Benefits include reduction in transmission, distribution, and generation, capacity costs; energy costs and grid support services. Costs include administrative costs, rebates/incentives, decreased revenue, integration & interconnection costs.</p>
SOCIETY 	<p>"We want improved air/water quality as well as an improved economy."</p>	<p>The sum of the benefits and costs to all stakeholder, plus any additional societal and environmental benefits or costs that accrue to society at large rather than any individual stakeholder.</p>

Photos courtesy of Shutterstock

Figure 1. Stakeholder Perspectives (RMI 2013)

1.4 Illinois Context

As the Illinois Commerce Commission (ICC) considers the valuation process for a distributed generation rebate (referred to by some as the smart inverter rebate), different perspectives will need to be accounted for and a determination made as to how to interpret existing policies, directions, and legislation, namely the context provided in the directions and language of the Future Energy Jobs Act (FEJA) (Public Act 099-0906).

The FEJA declares that the state should encourage “the adoption and deployment of cost-effective distributed energy resource technologies and devices...which can...stimulate economic growth, enhance the continued diversification of Illinois' energy resource mix, and protect the Illinois environment;...which should benefit all citizens of the State, including low-income households...” (Illinois 2017). These ideas indicate a desire for the valuation to achieve many goals from economic development to environmental protection.

The FEJA covers other related topics as well, including expanding net metering to include community-owned (typically solar) projects. The FEJA refers to the credit for owners of or subscribers to these types of projects as the “energy supply rate”—there was disagreement among stakeholders on how to value the energy supply rate. The ICC issued an order concluding that only the value of the electricity produced should be energy supply rate (and transmission service or other charges should not be bundled with the electricity charge) (ICC 2017). This rate is applicable to just community-owned projects, as defined in the FEJA, and differs from the net metering policy for individual distributed generation owners.

In addition to these high-level objectives and language, the FEJA also makes specific mandates. It specifies that the valuation “must reflect the value of the distributed generation, consider geographic, time-based, and performance-based benefits, as well as present and future grid needs” and “be grounded in a technical knowledge of how distributed energy systems impact the distribution network and the grid in general.” It also declares that “the social cost of carbon is an appropriate valuation of the environmental benefits provided by zero emission facilities” (Illinois 2017).

Related to these geographic and time-based requirements, the FEJA requires rebate recipients to have their distributed generation interconnected to the utility’s grid with a smart inverter—the utility will be allowed to operate and control the smart inverter with the intent of preserving distribution system reliability (Illinois 2017). Any compensation from the utility to the distributed generation owner for this control and use of the smart inverter is separate from the distributed generation rebate.

Finally, the FEJA states, “An electric utility shall recover from its retail customers all of the costs of the rebates made under a tariff or tariffs...including, but not limited to, the value of the rebates and all costs incurred by the utility to comply with and implement...” the valuation requirements set forth in the FEJA (Illinois 2017).

Besides the distributed generation rebate, the FEJA is also the impetus for the NextGrid initiative. NextGrid, kicked off in March 2017 by the ICC, is a consumer-focused study on topics such as leveraging the state’s restructured energy market, investment in smart grid technology, and recent laws expanding renewable energy and efficiency (Homer et al. 2017). NextGrid working groups may be a source of additional input in the rebate valuation process.

2.0 Distributed Generation Valuation and Compensation

This section summarizes more considerations for a valuation methodology, including market types, common valuation building blocks, and valuation challenges.

2.1 Market Types

The three main perspectives that can influence a valuation calculation are those of the participating customer, the utility, and society. The resulting program, tariff, incentive, or rebate then impacts the distributed generation market. Market environments have been characterized as either a price-support market, a transitional market, or a price-competitive market (Taylor et al. 2015).

In a price-support market, the value of distributed generation rate is not sufficient to fully recover the levelized cost of energy (LCOE) of distributed solar photovoltaic (PV) or other generation systems; additional incentives can be used to bridge this gap. In a transitional market, the value of distributed generation rate is nearly equal to the LCOE of the distributed solar PV and limited additional incentives may be needed to sustain the market. In a price-competitive market, the rate is greater than the LCOE, meaning the market is self-sustaining.

A state can consider which of these different market types exist in their jurisdiction, including existing or planned incentives and/or tax credits, when translating valuation calculations to program design.

2.2 Value of Resource and Value of Service

A recent National Association of Regulatory Utility Commissioners (NARUC) report provides a manual for rate design and distributed energy resources (DER) compensation policies (NARUC 2016). The report explores characterizing valuation methodologies as either a value of resource or value of service method. Most value of distributed generation calculations focus on value of resource components and some attempt to address value of service components as well.

Value of resource studies evaluate saved or additional energy costs, transmission capacity costs, and administration costs associated with a specific type of DER. With a value of resource methodology, a value of solar or other distributed generation rate is determined through a bottom-up calculation of all the benefits and costs that distributed generation provides to or imposes on the electricity system. These value streams (e.g., avoided transmission capacity, administration costs) are added together to create a single rate, expressed in cents per kilowatt-hour (kWh), at which customers are compensated for their distributed generation (Taylor et al. 2015).

A value of service approach attempts to identify services that distributed generation can provide, independent of the type of resource, such as providing resource adequacy and grid reliability through voltage support or black start capabilities (NARUC 2016). There is overlap between value of resource and value of service characterizations, including ancillary services that may include voltage or reactive power support. The different components are presented in Section 2.3 and the complexity of valuing service and some other components is discussed in Section 2.4.

2.3 Valuation Building Blocks

The first step in typical value of distributed generation calculations is to survey the different value components, and their associated costs and benefits, that could be used as the valuation building blocks. States include different elements in their calculations based on state-specific policy goals or legislation, as discussed in Section 1.2, and market types, as discussed in Section 2.1. Even when value elements are agreed upon, there are different interpretations of how they should be calculated. For this reason, some states develop standard methods or calculators to reduce ambiguity and promote consistency.

Table 1 presents a list of potential valuation elements from an analysis report completed for the Advanced Energy Economy Institute (Wolf et al. 2014). Another approach to viewing valuation building blocks is presented in Appendix A (from the Rocky Mountain Institute).

Table 1. Potential Value Calculation Elements (Wolf et al. 2014)¹

	BENEFITS		COSTS	
	Category	Examples	Category	Examples
Impacts on All Customers	1 Load Reduction & Avoided Energy Costs	Avoided energy generation and line losses, price suppression	1 Program Administration Costs	Program marketing, administration, evaluation; incentives to customers
	2 Demand Reduction & Avoided Capacity Costs	Avoided transmission, distribution, and generation capacity costs, price suppression	2 Utility System Costs	Integration capital costs, increased ancillary services costs
	3 Avoided Compliance Costs	Avoided renewable energy compliance costs, avoided power plant retrofits	3 DSP Costs	Transactional platform costs
	4 Ancillary Services	Regulation, reserves, energy imbalance		
	5 Utility Operations	Reduced financial and accounting costs, lower customer service costs		
	6 Market Efficiency	Reduction in market power, market animation, customer empowerment		
	7 Risk	Project risk, portfolio risk, and resiliency		
Participant Impacts	1 Participant Non-Energy Benefits	Health and safety, comfort, tax credits	1 Participant Direct Costs	Contribution to measure cost, transaction costs, O&M costs
	2 Participant Resource Benefits	Water, sewer, and other fuels savings	2 Other Participant Impacts	Increased heating or cooling costs, value of lost service, decreased comfort
Societal Impacts	1 Public Benefits	Economic development, reduced tax burden	1 Public Costs	Tax credits
	2 Environmental Benefits	Avoided air emissions and reduced impacts on other natural resources	2 Environmental Costs	Emissions and other environmental impacts

¹ DSP is distribution system platform.

While this list attempts to be comprehensive of all the possible elements, not all elements have equal weight in a valuation. For example, the relative weights of the elements used in the Minnesota value of solar calculation are shown in Figure 2 and are presented in more detail in Section 3.4.

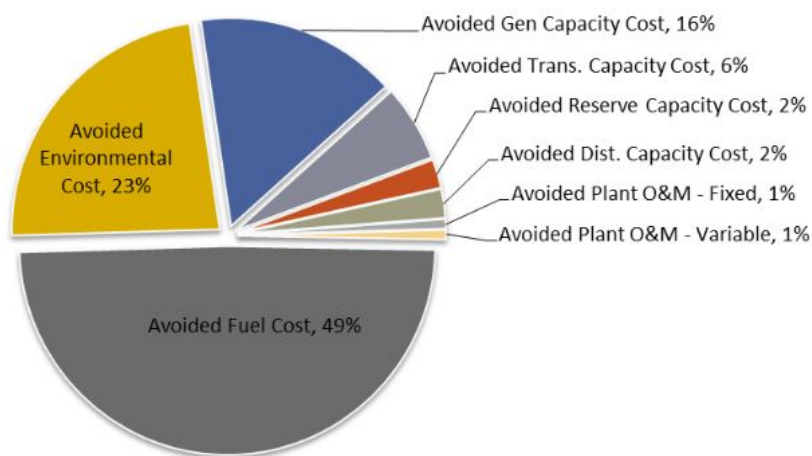


Figure 2. Relative Weights of Minnesota Value of Solar Components (Flores-Espino 2015)

2.4 Valuation Challenges

Some elements of value can be difficult to quantify because the value of distributed generation approach is a relatively new practice. In addition, stakeholders, particularly different utilities, have diverse business expenses and different interpretations of elements and how to calculate them that can result in widely varying valuations. Monetizing some elements, such as social value or the value of meeting state policy directives around employment or low income customers, can be difficult or impossible to quantify.

A Rocky Mountain Institute review of solar PV benefit and cost studies noted a significant range of estimated values across studies, driven primarily by differences in local context, input assumptions, and methodologies (RMI 2013). With respect to local context, solar PV generation may provide a significant generation capacity deferral value in certain regions, but in other regions the avoided generation capacity value could be significantly lower (OPUC 2015). In addition, input assumptions are influenced by the valuation perspective, and different methodologies can be used to estimate elements such as the market price response.

Some of the more challenging elements include grid support services, RPS and environmental compliance, financial market elements (e.g., market price response), and social value (e.g., economic development benefits). As an example, while NEM does not account for time or locational differences in costs or energy value, a value of distributed generation tariff or rebate may be able to account for these elements; however, existing efforts to characterize temporal and locational value and translate them into a rate or incentive are limited and nascent. A value of distributed generation calculation could monetize the benefit of grid support services to maintain distribution grid stability and reliability, but these services need to be defined and would require technology investments by both the distributed generation owner and the utility to implement (NARUC 2016).

Determining how the value elements vary through time and at different locations across the utility service territory is a nascent field of study, currently limited to research organizations and some of the more advanced utilities and states. Section 3.0 describes examples of states, such as California and New York

that are moving in that direction and have relatively new demonstration projects or programs to do so, but the practice and results are not well established.

3.0 State Approaches

Multiple states have implemented, or are in the process of implementing, various distributed generation valuation approaches that consider the building blocks described in Section 2.0. Other states provide examples of approaches that are essentially scaled back net metering programs, reducing the compensation amount for distributed generation. The following are examples of states that have or are studying, adopting, implementing, amending, or discontinuing policies associated with distributed solar PV valuation and/or compensation; however, it is not a comprehensive list.¹

3.1 California

In recognition that traditional distribution system planning is limited in its ability to support state policies on DERs and emerging technologies, the California legislature passed Assembly Bill (AB) 327 in 2013, requiring utilities to file Distribution Resource Plans (DRPs) with the California Public Utilities Commission (CPUC 2015a). DRP proposals, the first of which were filed by July 1, 2015, included an evaluation of locational benefits and costs of DERs on the distribution system (CPUC 2015b). Evaluations were based on reductions or increases in local generation capacity needs, avoided or increased investments in distribution infrastructure, safety benefits, reliability benefits, and any other savings the distributed resources provide to the electric grid or costs to customers.

The three large investor-owned utilities (IOUs) in California (Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison) jointly engaged the consulting firm Energy and Environmental Economics, Inc. (E3) to develop a technology-agnostic Excel tool for estimating location-specific avoided costs of DER for a Locational Net Benefits Analysis (LNBA) demonstration project. As shown in Figure 3, the LNBA tool has two major parts—a project deferral benefit module, which calculates the values of deferring a specific capital project, and a system-level avoided cost module, which estimates the system-level avoided costs given a user-defined DER solution. The summation of the quantitative results provided by the two modules provides an estimate of the total achievable avoidable cost for a given DER solution at a specific location.

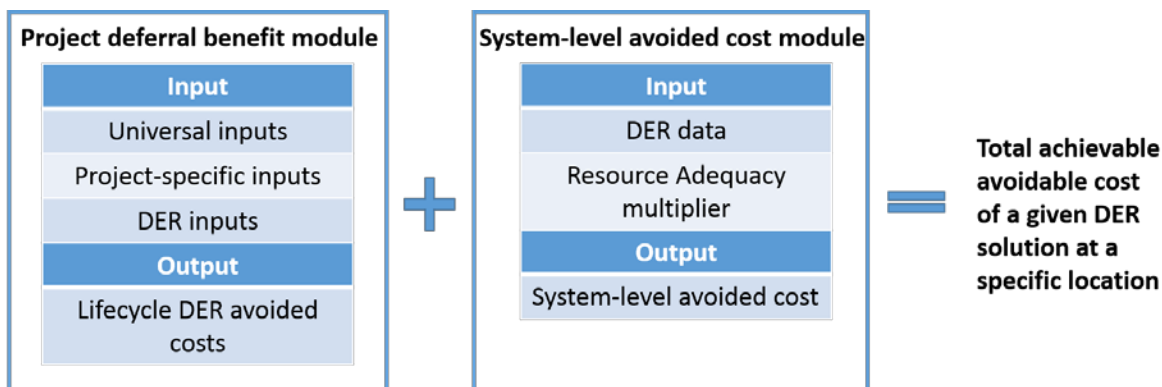


Figure 3. Components of LNBA Tool

¹ The North Carolina Clean Energy Technology Center's quarterly *50 States of Solar* report does comprehensively track solar PV policies for each state.

Table 2 lists the components of avoided costs to be calculated by the LNBA in California, as required by CPUC. The transmission and distribution (T&D) avoided costs in the table are the central focus of the LNBA demonstration project, since they are the LNBA components most sensitive to locations. Most of the non-T&D components of the LNBA are borrowed from or are extensions of an existing DER Avoided Cost calculator (DERAC) that was developed previously by E3 for the CPUC as part of demand side cost effectiveness proceedings (Zach 2017).

Table 2. LNBA Avoided Cost Components (PG&E 2016)

Note		Components of Avoided Costs	Proposed LNBA Elements in IOU Fillings
Central Focus		Avoided T&D	Sub-transmission/substation/feeder
			Distribution voltage/power quality
			Distribution reliability/resiliency
			Transmission
System-Level Avoided Costs	Use DERAC Values	Avoided generation capacity	System and local resource adequacy
		Avoided energy	Flexible resource adequacy
			Use locational marginal prices to determine
		Avoided GHG	Incorporated into avoided energy
		Avoided RPS	Methodology outlined in DERAC
		Avoided ancillary services	Methodology outlined in DERAC
	Additional to DERAC	-	Renewable integration costs
			Societal avoided costs
			Public safety costs

3.2 New York

In order to maximize benefits and value to customers, DER supplies, the electric system, and society, and to ensure clean generation, the State of New York Public Service Commission (NYPSC) directed utilities to develop implementation proposals to calculate value of DER (VDER) tariffs in 2017. New York's VDER tariffs, also referred to as value stack tariffs, are intended to replace net metering for larger-scale community solar PV projects in the short term, and will eventually be applied to all DERs across the grid.

VDER proposals have been reviewed and approved by the NYPSC, and each utility will move to full implementation in early 2018. The components of VDER are listed in Table 3 (NYPSC 2017).

Table 3. New York's VDER Components

Component	Calculation Based On
Energy value	Day-ahead hourly Locational Based Marginal Price (LBMP) grossed up for losses (eventually moving to subzonal prices)
Capacity value – market value	Monthly NY Independent System Operator auction price
Capacity value – out of market value	The difference between the market value and the total generating capacity payments made to value stack customers
Environmental value – market value	Higher of Tier 1 renewable energy certificate (REC) price per kWh, or social cost of carbon per kWh less

	Regional Greenhouse Gas Initiative (RGGI); customers who want to retain RECs will not receive compensation
Environmental value – out of market value	Difference between compensation and market will be recovered from customers within the same service class as the customers receiving benefits from the DER
Demand reduction value	Compensation based on marginal cost of service studies and eligible DER performance during 10 highest usage hours at \$ per kw-year value
Locational system relief value	Compensation based on marginal cost of service studies and static rate per kW-year value applied to net injected kW
Market transition credit	Static rate per kWh applied to net injected kWh; steps down by tranche

Some stakeholder groups have expressed concern that the proposed VDER tariff methodologies result in significantly different utility VDER tariffs because utilities are allowed to have notably different calculations for the utility marginal cost of service (MCOS) value (the base measure of what it costs for utilities to serve customers at different points on the grid) (St. John 2017). The MCOS in turn is used to derive two important values in the VDER tariff—the demand reduction value (DRV) and the locational system relief value (LSRV). Because of different calculation approaches, the VDER for ConEdison is \$226/kW and for Central Hudson is \$15/kW.

Another complaint associated with New York’s VDER is that some value components can change, so there is no long-term financial certainty of the overall VDER, which will make obtaining financing more difficult. The DRV and LSRV calculations can be changed every three years, so the rate established for year 1 is not guaranteed for a fixed amount of time (i.e., 10 years straight). As a result, financing parties are likely to zero out these values in the value stack when evaluating projects, thereby lowering the overall VDER in their own due diligence/project valuation calculations.

Changing component values is not unique to New York’s methodology. All valuation calculations include some level of annual or biannual adjustments, or placeholder or proxy values that will change in the future.

3.3 Oregon

Oregon Senate Bill 1547, signed into law in March 2016, requires Oregon utilities to eliminate coal as an electricity supply source, increases the state’s RPS target to 50% renewables by 2040, and addresses new programs to help meet these requirements (SB1547 2016). One such program is for community solar projects. The law states that an electric company shall credit an owner of or subscriber to a community solar project in a manner that reflects the resource value of solar energy, to be determined by the Oregon Public Utility Commission (OPUC). Therefore, the implication is that a resource value of solar (RVOS) compensation is intended for community solar gardens, and not as a replacement for NEM, as is the case for Minnesota and Austin Energy.

OPUC retained E3 to develop and demonstrate a methodology for calculating the RVOS every two years that could then be used by Oregon’s IOUs (OPUC 2015) for community solar. The OPUC’s Investigation to Determine the Resource Value of Solar docket is ongoing.

With the decision to pursue a valuation from the utility customer perspective, OPUC has directed the utilities to include the following values in their RVOS calculations.

- Elements determined using existing avoided cost studies
 - Energy
 - Generation capacity
 - Line losses
 - Transmission & distribution capacity
 - Integration
 - Administration
- Elements determined after workshops or later
 - Hedging costs (assigned proxy values for the initial filing)
 - Market price response (assigned proxy values for the initial filing)
 - Environmental compliance
- Elements valued at zero initially
 - RPS compliance
 - Grid services.

As noted in Section 2.4, certain elements are more difficult to monetize. In the case of Oregon, the difficulty in valuing RPS compliance and grid services means that those elements are valued at zero initially. Workshops will be required to determine hedging costs, market price response, and environmental compliance valuation.

In November 2017, utilities provided an initial RVOS filing for OPUC’s review. As discussed in Section 2.4, utilities can have different costs to input into the valuation calculation, but they can also have different interpretations of the valuation components, resulting in widely varying valuations. Oregon provides another example of differing utility interpretations as it is still in the process of its RVOS investigation. In Idaho Power’s initial filing, the utility assumed a high administration cost (or negative value), which resulted in a low net RVOS of \$1.61/MWh. This compares to PacifiCorp’s initial RVOS of \$49.72/MWh.

3.4 Minnesota

Minnesota is an early value of solar tariff (VOST) adopter, but no IOUs have implemented a VOST at this time. One report suggests that VOST policies would be less expensive for utilities in the long run, but Minnesota IOUs have determined that VOST policies are less favorable than net metering in the short term (Harari and Kaufman 2017).

In 2013, Minnesota passed legislation to allow IOUs to apply to the Minnesota Public Utility Commission for a voluntary VOST as an alternative to net metering. In turn, the Minnesota Department of Commerce retained the consulting firm Clean Power Research (CPR) to develop a VOST methodology (CPR 2014).

Like Oregon, Minnesota’s valuation approach is from the utility customers’ perspective. CPR’s methodology report states, “If the value of solar is set correctly, it will account for the real value of the PV-generated electricity, and the utility and its ratepayers would be indifferent to whether the electricity is supplied from customer-owned PV or from comparable conventional means. Thus, a VOST eliminates the net energy metering cross-subsidization concerns” (CPR 2014).

The legislation mandated that the value of solar methodology consider the following values.

- Energy and its delivery
- Generation capacity
- Transmission capacity
- T&D line losses
- Environmental value.

These values are in turn captured in the Value of Solar Calculation Table components (see Figure 4). The valuation calculation uses the Value of Solar Calculation Table and the Value of Solar Data Table (see Figure 5) to create a levelized value of solar that would be paid over a 25-year contract and must be calculated annually. Avoided voltage control cost and solar integration cost in the Value of Solar Calculation Table are placeholders for future year calculations; they do not currently have calculation formulas associated with them.

Xcel Energy, a large IOU in Minnesota, has questioned the avoided fuel cost calculation methodology developed by the consultant, which is the largest component of the VOST (Harari and Kaufman 2017). This disagreement is likely a reason why Xcel Energy and other IOUs have not yet established a VOST for any customer.

25 Year Levelized Value								
	Gross Value	×	Load Match Factor	×	(1 +	Loss Savings Factor) =	Distributed PV Value
	(\$/kWh)		(%)			(%)		(\$/kWh)
Avoided Fuel Cost	GV1					LSF-Energy		V1
Avoided Plant O&M - Fixed	GV2					LSF-Energy		V2
Avoided Plant O&M - Variable	GV3					LSF-Energy		V3
Avoided Gen Capacity Cost	GV4		ELCC			LSF-ELCC		V4
Avoided Reserve Capacity Cost	GV5		ELCC			LSF-ELCC		V5
Avoided Trans. Capacity Cost	GV6		ELCC			LSF-ELCC		V6
Avoided Dist. Capacity Cost	GV7		PLR			LSF-PLR		V7
Avoided Environmental Cost	GV8					LSF-Energy		V8
Avoided Voltage Control Cost								
Solar Integration Cost								
Value of Solar								

Figure 4. Minnesota Value of Solar Calculation Table (CPR 2014)

Table 5. VOS Data Table (EXAMPLE DATA) — required format showing example parameters used in the example calculations.

Input Data		Units	Input Data		Units
Economic Factors			Power Generation		
Start Year for VOS applicability	2014		Peaking CT, simple cycle		
Discount rate (WACC)	8.00%	per year	Installed cost	900	\$/kW
			Heat rate	9,500	BTU/kWh
Load Match Analysis (see calculation method)			Intermediate peaking CCGT		
ELCC (no loss)	40%	% of rating	Installed cost	1,200	\$/kW
PLR (no loss)	30%	% of rating	Heat rate	6,500	BTU/kWh
Loss Savings - Energy	8%	% of PV output	Other		
Loss Savings - PLR	5%	% of PV output	Solar-weighted heat rate (see calc. method)	8000	BTU per kWh
Loss Savings - ELCC	9%	% of PV output	Fuel Price Overhead	\$0.50	\$ per MMBtu
PV Energy (see calculation method)			Generation life	50	years
First year annual energy	1800	kWh per kW-AC	Heat rate degradation	0.100%	per year
			O&M cost (first Year) - Fixed	\$5.00	per kW-yr
Transmission (see calculation method)			O&M cost (first Year) - Variable	\$0.0010	\$ per kWh
Capacity-related transmission capital cost	\$33	\$ per kW-yr	O&M cost escalation rate	2.00%	per year
			Reserve planning margin	15%	
			Distribution		
			Capacity-related distribution capital cost	\$200	\$ per kW
			Distribution capital cost escalation	2.00%	per year
			Peak load	5000	MW
			Peak load growth rate	1.00%	per year

Figure 5. Minnesota Example Value of Solar Data Table (CPR 2014)

3.5 Austin Energy

In 2012, Austin Energy, the municipal utility serving Austin, Texas, became the first utility to offer a VOST to its residential customers in place of net metering for systems up through 20 kW in size (DSIRE 2015a). Like Oregon and Minnesota, the goal of the VOST was to create a value for distributed solar energy at which the utility is economically neutral to whether it supplies such a unit of energy itself or obtains it from the residential customer (DSIRE 2015a).

The VOST calculation, also created by CPR, was designed to consider the following values (DSIRE 2015).

- Line loss savings
- Avoided fuel costs
- Avoided costs of installing new generation capacity
- Fuel price hedge value
- Avoided T&D expenses
- Environmental benefits.

These values are in turn reflected in these component calculations: guaranteed fuel value, plant operations and maintenance value, generation capacity value, avoided T&D capacity costs, and avoided environmental compliance costs (Harari and Kaufman 2017).

The value of solar rate changes annually, based on updated inputs to the components such as the natural gas price in the guaranteed fuel value calculation, but the rate customers receive is a five-year rolling average. The VOST rate appears on residential customers' monthly electric bills as a credit on electricity costs and customers still pay the retail rate for all of their electricity consumption (Harari and Kaufman 2017). This approach is considered a buy-all sell-all approach that separates the payments for the solar generation from the customer's electricity use (Taylor et al. 2015).

Two issues unique to Austin Energy's VOST are the utility's regulation and location within the Electric Reliability Council of Texas (ERCOT) (Harari and Kaufman 2017). As a municipal utility, Austin Energy is regulated by the elected members of the Austin City Council, rather than a state public utility commission. In addition, ERCOT's energy pricing market is open and available for review, while wholesale energy costs for utilities in other parts of the country are not accessible in the same way.

The City of Austin also provides a rebate for residential customers, on top of the VOST, to increase solar PV adoption by lowering the upfront cost of a system (Taylor et al. 2015). The value of the rebate declined over the years and is currently at \$1.10/W (DSIRE 2017d). For commercial customers not eligible for this rebate or the VOST, a production-based incentive of 9¢/kWh is available for a 10 year period (DSIRE 2015b). With a rebate and a VOST, Austin Energy has adopted the perspective of the participating customer, and has a price-support market, to make distributed generation cost effective for its customer owners.

3.6 Maine

In March 2017, the Maine Public Utilities Commission (PUC) issued an order replacing net metering with a buy-all, sell-all compensation structure (DSIRE 2017a). This change in policy was initiated by the 2014 Act to Support Solar Energy Development in Maine (Maine PUC 2015). Under the new structure, the distributed generation owner buys all of their electricity from the utility at the retail rate and then sells all the electricity produced by the DG system to the utility at a fixed rate (NREL 2017). In Maine's case, the fixed sell rate is the utility's avoided cost rate, rather than a value of solar rate like Austin Energy.

3.7 Hawaii

Through Docket 2014-0192, the Hawaii PUC intends to spur an electricity sector reform to support the sustainable growth of DERs. Order 33258, the first major Commission order in this docket, closed its NEM program for new applicants and created three new tariffs for solar PV owners—the customer self-supply (CSS) option, the customer grid-supply (CGS) option, and a time-of-use (TOU) tariff program similar to NEM, but at a reduced credit rate (HPUC 2015a, HPUC 2015b).

The CSS option is intended for customers who plan to consume all energy produced and do not need to export any to the grid. Hawaiian Electric Company (HECO) is considering CSS tariffs that encourage “scheduled” exports as needed for the DERs to provide critical grid services, as well as to encourage CSS customers to use grid-supplied energy during low-demand/high-supply periods of the day (10 a.m.–3 p.m.). The option also allows for an expedited (~30-day) interconnection review.

The CGS option is functionally similar to NEM. Customers export excess energy to the grid and receive a credit. The difference between NEM and CGS is that the CGS credit is set to approximate the relative value of the energy to the system and the credit does not need to be tied to retail rates. The net effect of the proposed CGS tariff is to reduce the solar credit that customers receive for self-generation from 30 cents/kilowatt-hour (kWh) under traditional net metering to ~15 cents/kWh, which is closer to

HECO's avoided cost compared to the least cost alternative generation resource. In addition, the minimum residential customer bill was increased from \$17 to \$25.

A third tariff option is a new, expanded TOU tariff that shifts energy demand to the middle of the day (HPUC 2014). Phase I of this docket (2014-0192) concluded in September 2016, after the Commission approved HECO's TOU pilot program for 5,000 customers.

In addition, Hawaii PUC and HECO are developing revised grid service tariffs that aim to more flexibly integrate controllable loads, generation, and storage resources into grid operations and to expand the ability of loads to provide key grid services that can help balance intermittent renewable resources and help address some of the concerns surrounding large-scale distributed generation PV and other renewable energy resources (HECO 2017). HECO has defined four major bulk services that demand response can provide, which HECO envisions implementing through four rate and incentive mechanisms: (1) capacity, (2) fast frequency response, (3) regulating reserve (regulating up and down), and (4) replacement reserve. The values for these four bulk services were based on avoided cost for each category of service, and were determined based on modeling.

3.8 Indiana

Similar to Maine, Indiana is phasing out its net metering program by July 2022 or when individual utilities reach 1.5% peak summer load caps, whichever is earlier. Under the new program, the compensation rate must equal 1.25 times the utility's average wholesale electricity price (DSIRE 2017b).

3.9 Mississippi

Under Mississippi's revised distributed generation program, only instantaneous electricity generation and use can be credited at the retail rate. Excess electricity exported to the utility grid is credited at the utility's avoided cost rate plus a 2.5¢/kWh premium (DSIRE 2016), an approach similar to Indiana's new compensation rate formula.

3.10 Arizona

As of December 2016, Arizona replaced its NEM program with a net billing program (DSIRE 2017c). In net billing, a distributed generation system owner consumes self-generated electricity in real time that displaces retail rate utility electricity; however, excess generation exported to the grid is valued at a non-retail, predetermined avoided cost rate (NREL 2017). Each utility will determine its specific avoided cost rate (DSIRE 2017c). Net billing is similar to NEM, but a net billing arrangement does not allow excess generation to be credited to the distributed generation owner's future utility bills; the excess generation is "sold" to the grid at the predetermined rate and that credit is applied to the billing cycle.

3.11 New Jersey

New Jersey's NEM program is currently under review. Pending Senate Bill 2276 would establish the "New Jersey Solar Energy Study Commission" that would study all aspects of solar energy in the state (NCCETC 2017; State of New Jersey 2016). In September 2017, the New Jersey Board of Public Utilities initiated a generic proceeding on the state's solar market, but the filings within the proceeding are not public (NCCETC 2017; NJ BPU 2017).

4.0 Summary and Conclusions

As a state moves toward developing valuation and compensation schemes for distributed generation, it is important to have a clear understanding and statement of the goals and objectives the programs are being designed to achieve and what perspectives and market environments are desired.

An important step in performing valuations, after establishing overall goals and objectives, is to survey the different value components and their associated costs and benefits that could be used as the valuation building blocks. Examples of valuation building blocks include avoided costs associated with fuel, generation capacity, transmission capacity, reserve capacity, distribution capacity, fixed and variable operations, and maintenance and environmental compliance and/or impacts.

States include different value elements in their calculations based on state-specific policy goals or legislation. In addition, utilities and stakeholders can have different interpretations of how the same value elements are to be calculated. For this reason, standardized calculators and methods help reduce ambiguity and inconsistencies in how valuations are performed.

Some elements of value can be difficult to quantify because the value of distributed generation approach is a relatively new practice. Monetizing elements, such as social value or the value of meeting state policy directives around employment or low income customers, can be difficult to do. Determining how the value elements vary through time and at different locations across the utility service territory is a nascent field of study, currently limited to research organizations and some of the more advanced utilities and states.

States around the country are exploring value of solar and DER and are moving away from pure net metering. California, Oregon, New York, and Austin Energy have or are pursuing new distributed generation valuation and compensation mechanisms. Maine, Hawaii, Indiana, Mississippi, and Arizona have all transitioned away from full retail net metering, and in most instances, avoided costs are the basis of payments to customers for excess distributed generation rather than the full retail rate.

This white paper, along with learning what other states have accomplished, can help guide a state as it considers issues associated with distributed generation valuation and compensation.

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Appendix A

Valuation Elements Graphic

Appendix A

Valuation Elements Graphic

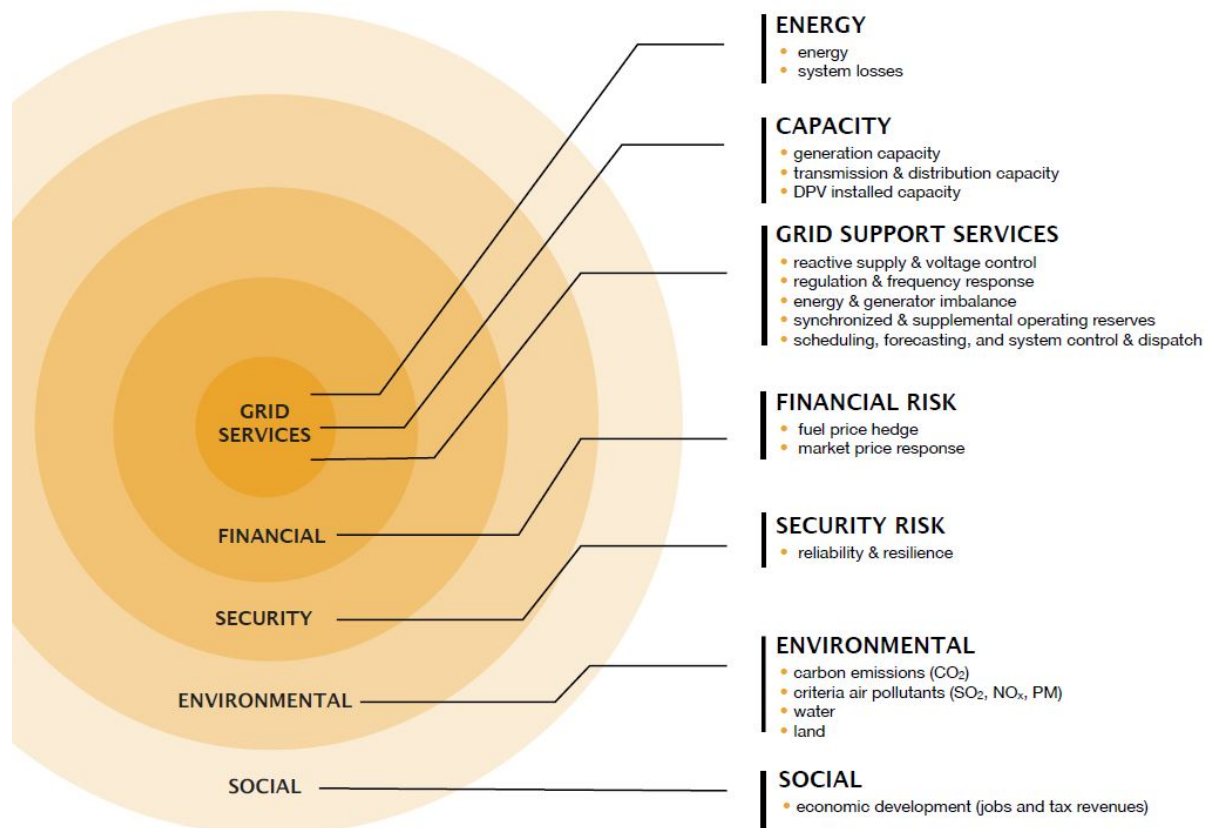


Figure A.1. Valuation Categories (RMI 2013)



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