CB 119516 - SUMMARY ATT 2 – NATIONAL TRENDS IN NET ELECTRIC METERING AND DISTRIBUTION GENERATION VALUATION METHODS

PREPARED FOR SEATTLE CITY LIGHT

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Executive Summary

Nationally, distributed generation compensation programs like Net Electric Metering have begun shifting from simple, static designs to more evaluative and integrated methods. As renewable generation has risen in utility service territories from fraction of a percent to over 30% of total generation for some California utilities[1], the necessity for compensation methods incorporating the characteristics of each utilities unique operating environment has similar grown in importance.

To accomplish this, many states[2] have developed or began development of evaluative frameworks for estimating the overall cost and benefits of distributed generation. Through these processes, a better understanding of the value of distributed generation has steadily shifted compensation methodologies from static values and program limits towards more reactive price-based programmatic constraints. Generally, evolving distributed generation valuation methodologies have grown to reflect, and incorporated in, best practices from Integrated Resource and System Planning processes.

Applying lessons learned nationally to City Lights own efforts, this report recommends adopting a multi-phased process in developing a distributed energy compensation policy. Such an approach allows for an initial program implementation with the understanding that more granular valuation methodologies will be implemented once more data is available. With proper data and program design, a distributed generation compensation policy should exist without program limits and individual system limits, relying on price signals to ensure an equitable exchange between utility and customer generators.

[1] December 2018 California Energy Commission Renewable Energy Tracking Progress.

[2] 20 States and DC completed or began Solar Valuation or Net Metering Studies by end of Q4 2018 according to NC Clean Energy Technology Center.

Introduction

The last decade has seen both a rapid decrease in cost for solar photovoltaic systems and a subsequent increase of installed solar capacity. While this trend is more prolific nationally, there has been a significant increase in installed capacity within Washington State and Seattle City Light territory.[3] As solar has become more widely adopted, 43 states and DC took action related to solar policy or rate design as of 2017. (NCCETC, 2018).

While there are a range of local, state, and federal policies pertaining to solar energy technologies, the purpose of this report is to provide an overview of current solar policies as Seattle City Light explores and finalizes a commercial scale solar export rate. In order to provide context, this report will focus on 100kW+ net electric metering (NEM) and net electric metering successor tariffs. To assist City Light, this report will attempt to answer the following questions:

- What approaches are states, utilities, and regulators taking to address the solar market, especially the large solar market?
- What changes to traditional net metering policies are emerging?
- What are the lessons learned?

[3] Between 2007 and 2017, installed capacity increased by over 5000% in Washington State and 4000% in the Seattle City Light territory, EIA Form EIA-861M.

Seattle City Light Net Metering Policy

Adopted originally in 1998[4], Washington State's NEM law requires electrical utilities to offer net metering to all customers until a cumulative NEM generating capacity for each utility reaches 0.5% of their peak 1996 energy demand. Currently, Washington State's NEM policy compensates customer generators monthly at the retail rate for any exported generation with any remaining credits at the end of the typical 12-month billing cycle being forfeit to the interconnected utility. Systems of 100kW and below are eligible for participation in Washington State's NEM policy.

Additionally, Washington State's NEM policy requires electrical companies to provide meter aggregation upon customer request. For City Light[5], this means applying accumulated net metering credits to all meters owned by the customer owning the interconnected net metered system regardless of location in respect to the solar system. Net metering credits will be applied to aggregated meters at their unique rate rather than the rate of the meter directly interconnected to the solar system. Seattle City Light is further required to provide on-bill accounting of "banked" kWh credits from a customer-generators net metering production on the subsequent bill.

[4] Revised Code of Washington 80.60
[5] Seattle Municipal Code 21.49.082 (D)

Approach

This report will explore various case studies selected for the national perspective on current trends in commercial NEM policies they provide. First, NEM participation and policy design is not directly dependent on a utility's generating assets and operating environment. Second, while NEM policy design has recently begun to diverge national, traditional retail-rate NEM policies followed a single methodology.[6] Third, recently adopted NEM successor tariffs, while individually unique in design, are developed using the same underling principles and a short list of valuation inputs. (IREC, 2015), (LBNL, 2012) The states and utilities included in this section were selected for:

- Similarities in resource mix and regulatory structures;
- Ability to provide lessons learned;
- Either developing, or in the proceedings for, a NEM successor tariff.

Table 1: Case Studies Reviewed

UTILITY OR STATE	POLICY INCLUDED
Austin Energy (TX)	Value of Solar rate
Minnesota	NEM and Value of Solar rate
New York State	"Value Stack" – VDER rate
California	NEM 2.0, Developing NEM Successor Tariff
Oregon	NEM w/ Value of Solar Rate in Development

Case Studies

While details outlined below were accurate at the writing of this paper, many of the policies and proceedings are in deliberation and subject to change.

[6] Interstate Renewable Energy Council. *2010 Updates and Trends.*

Austin Energy

Implemented in 2012, Austin Energy's residential Value of Solar tariff[7] (VOST) was the first of its kind in the nation. Austin Energy's primary goal with their VOST was to compensate customers with solar installations fairly and prevent cost-shifting between solar and non-solar customers.

Austin Energy's net metering policy compensates customers at the retail rate for any excess generation sold back to the utility. Under their VOST, customers are billed at the retail rate for all imported electricity usage and receive a separate credit for each kilowatt-hour (kWh) exported to the utility. In 2017, Austin Energy announced a commercial VOST. A summary of Austin Energy's current rate structure for VOST is provided in Table 2.

Table 2: VOS Rates at Austin Energy (2018)

CUSTOMER TYPE	VOS RATE ($/kWh)
Residential and Commercial Non-Demand	$0.97
Commercial Demand (Solar capacity < 1,000 kW - ac)	$0.067
Commercial Demand Solar capacity ≥ 1,000 kW -ac)	$0.047

Several key value inputs are used in Austin Energy's VOST calculation. These components include: line loss savings, avoided fuel costs, avoided cost of installing new generation capacity, fuel price hedge value, avoided transmission and distribution expenses, and environmental benefits (DSIRE, 2015). When combined, these costs reflect the real value of the electricity provided by solar installations to the electric grid (Taylor, et al., 2015). Currently, Austin Energy updates the commercial VOST rate every 4-5 years as part of its cost of service study. (Austin Energy, 2018)

[7] For the purpose of this report, "tariff" and "rate" are used interchangeably for NEM policies.

Minnesota

As of 2013, Minnesota is the only state where utilities have the choice of offering the current version of the state's NEM policy or developing a value of solar tariff using the valuation framework developed by the Minnesota Department of Commerce. Despite this, Minnesota's VOS rate is only being offered as the compensation rate for Xcel Energy's Community Solar Garden Program. (Eleff, 2017)

Minnesota Community Solar Gardens Program

Minnesota enacted a separate policy giving direction to utilities establishing Community Solar programs. Except in the case of the state's largest utility, Xcel Energy, utility participation is voluntary. There are numerous participant requirements ensuring the program captures only local and equitable customer participation. Except for Xcel Energy customers, subscribers receive bill credits for energy produced equal to their specific retail rate with added eligibility to participate in separate performance-based incentive programs within the state. Xcel Energy compensates Solar Garden participants at the state established VOS rate. Community solar projects are limited in size from 1kW to 1mW with a limit of 5 cumulative mW's per site. As of the end of 2016, there were 18 established voluntary community solar programs in Minnesota.

Minnesota's NEM policy was enacted in 1983 under MN Statute 216B.164[8] (with updated language in 2013) and follows a traditional framework by offering a kWh credit for excess energy generated (net of energy consumed – energy produced) throughout a monthly billing cycle. This bill credit is applied to subsequent billing cycles for exported renewable generation within a 12-month period. Commercial NEM customers have the option of being compensated at the interconnected utilities avoided cost rate[9] or with a kWh credit to be applied to subsequent bills (Minnesota, 2014). For large NEM customers, any remaining kWh credits at the end of a calendar year are compensated at the avoided cost rate for IOU's and are forfeit for public utilities customers.

[8] Minnesota Statute 216B.164, Cogeneration and Small Power Production
[9] As defined under Code of Federal Regulations, title 18, section 292.101 and section 292.304.

Virtual Net Metering and Meter Aggregation:

Public utilities in Minnesota are required to provide meter aggregation by customer upon request. To qualify, customers requesting meter aggregation must own all interconnected meters, with all aggregated meters being located on contiguous property to the interconnected NEM meter.

Dissimilar to traditional virtual net metering policies, Minnesota's mandates aggregated meters be compensated on a ranked order basis, with kWh production credits being distributed to aggregated meters sequentially as each meter's monthly energy consumption is offset.

Fees and Standby Charges

Like most states, Minnesota's guidance on how utilities are to recover costs associated with the interconnection[10] of customer generators follow national best practices established by FERC Or. No. 792. Minnesota diverges from national trends in its treatment and calculation of allowable standby charges for large customer generators.

After disagreements arose in 2013 regarding statuary changes to "standby service tariffs", the Minnesota PUC convened a stakeholder proceeding to develop a mutually acceptable framework for parties involved. The root of the issue being the introduction of language allowing utilities to charge "standby service tariffs" to 100kW+ customer generators (including solar power) without providing a clear framework for how these fees would be established. Census was reached in late 2016 that IOU's would file standby service tariffs following mythologies developed by the Minnesota PUC. Public utilities agreed to use IOU tariff filings as a guide for their own deliberations over developing standby service tariffs. As of 2014, Xcel Energy charges systems over 100kW a fee of $5.15 per kW of installed capacity when a system is offline longer than 964 hours. (Minnesota, 2014)

[10] Specifically, utilities cannot charge customer generators interconnection fees different to what it charges non-customer generators with similar load characteristics. Public utilities can collect additional fee to recover fixed costs (i.e. production meter) not covered through an existing billing arrangement.

Individual System Capacity Caps

Minnesota's limit for commercial NEM systems is set between 40kW and 1mW. In addition to this broader limit is an additional deviation from traditional NEM policies in that Minnesota allows qualifying facilities to produce and be compensated for annual energy production up to 120% of a customer's historical on-site annual energy consumption.

It is worth reiterating here that Xcel Energy is required as part of its Community Solar Gardens program to allow aggregated systems up to 5mW's per site. There has been additional legislation passed since 2014 limiting the proximity of community solar gardens to each other to mitigate potential impacts to the transmission and distribution (T&D) infrastructure.

Program Capacity Caps

Minnesota utilities must petition the Minnesota Public Utilities Commission to limit additional NEM qualify facilities when the cumulative NEM generation within a utility's service territory reaches 4% of annual retail energy sales. In a petition, a utility must demonstrate that additional net metering facilities would cause significant rate impacts, require significant reliability measures or raise significant technical issues for the Public Commission to consider limiting net metering capacity.

Contract Lengths

Like Washington State's NEM policy, Minnesota does not require utilities to offer a specific contract length to customers NEM. By omission, contract length for NEM customer is indefinite until a superseding policy is established. The exception is Xcel Energy's required 25-year contract lengths for its Community Solar Garden participants.

New York

New York State recently began transitioning away from traditional net energy metering as part of the State's Reforming the Energy Vision. In 2017, the New York State Public Service Commission introduced the initial phase of this transition from net metering in its *Order on Net Energy Metering Transition, Phase One of Value of Distributed Energy Resources, and Related Matters* (the "VDER Order"). Part of New York's VDER Order is the establishment of the "Value Stack", a valuation framework for adopting a value-based compensation structure for solar. Similar to Minnesota's motivation for developing a Value of Solar tariff, New York's Value Stack is meant to mitigate any cost shifting between solar and non-solar customers by compensating customer generators for the value a solar system provides to the grid both temporally and spatially.

For each utility, The "Value Stack" accounts for the price of energy, the avoided carbon emissions, the cost savings to both the utility and its customers, and other savings from avoided capital investments. Some elements are dependent on locational and temporal factors, meaning that any kWh produced in heavy load locations on a utilities distribution grid during peak demand time will be compensated at a greater rate than low load hours in a rural area (NYSERDA, 2018).

In mid-2017, New York State's investor-owned utilities began to apply the "Value Stack" to demand-metered commercial, community distributed generation, and remote net metering customers (NYSERDA, 2018). "Value Stack" customers receive compensation for any electricity delivered to the grid that is not consumed onsite on an hourly basis. Excess credits carry over to the next billing period.

As part of phase one, any current net metering customers or residential and small commercial customers that install solar prior to 2020, will not be affected by the new "Value Stock" framework for 20 years. Any customers Phase One Value Stack will be guaranteed compensation under the program's valuation structure for 25 years.

Oregon

Oregon's current NEM policy closely mirrors traditional retail rate NEM policies. Enacted in 1999 under Oregon Revised Statute (ORS) 757.300, Oregon's NEM policy requires public utilities to offer an avoided cost kWh credit to be carried over to a subsequent billing cycles for a 12-month period. After which, any remaining credits are forfeited to the interconnected utility. Oregon's two larger IOU's are required to compensate NEM credits for at a retail rate rather than an avoided cost rate. Like many NEM policies, Oregon's intention is for solar customers to offset customer load with generation.

Oregon Resource Value of Solar

The Oregon legislature passed SB 1547 covering a wide range of topics pertaining to public utilities. A section of this bill provided guidance on Oregon's Community Solar Projects program. Section 22(6)(a) directs the Oregon Public Utilities Commission (PUC) to determine a "resource value of solar" (RVOS) electrical companies will credit system owners for capacity generated for respective shares in a community solar project. The Oregon PUC completed Phase 1 outlining how utilities should calculate a resource value of solar in late 2017. While the language in SB 1547 only pertains to how utilities compensate community solar projects, the Oregon PUC goes as far to state they "find that there could be many potential policy and ratemaking uses for the resource value of solar, and in this order we are not prejudging potential future uses." (OPUC, 2015)

Meter Aggregation

Oregon's NEM policy allows meter aggregation for IOU customers with no limit on the number of aggregated meters given that the capacity of all aggregated meters on a customer's contiguous property does not exceed the applicable capacity limit. Aggregation of meters on different rate schedules is permitted.

Fees and Standby Charges

PV systems of 25kW's and greater qualify as level 2 (up to 2mW's) & 3 under ORS 860-039 dependent on the complexity of a PV system interconnection requirements for a utility. Allowed fees for level 2 and 3 interconnection reviews for IOU's are:

Table 3 Allowed Interconnection Fees

	Onetime Fee Limit	$/installed kW	Allowed hourly Engineer Rates
Level 2	$ 50.00	$ 1.00	$ 100.00
Level 3	$ 100.00	$ 2.00	$ 100.00

Individual System Capacity Caps

As of its most recent revision in 2017, Oregon Revised Code 757.300(8) requires all electric utilities to provide net metering to facilities with a generating capacity of 25kW or less with exception for potential higher capacity limits for customers of IOU's. In 2007[11], the Oregon PUC required the two larger of its three IOU's (excluding Idaho Power) to provide net metering to systems up to 2mW's.

Program Capacity Caps

Utilities are required to provide Net Metering to customers up to 0.5% of "historic single-hour peak load" (Oregon, 2018). After this threshold has been reached, a utility can petition the Oregon PUC to limit Net Metering participation given that the utility can prove continued participation in the program will have detrimental consequences to its broader retail customer base. To date, no utility has petitioned to limit Net Metering participation in its service territory.

Contract lengths

While ORS does not specify any required contract length, Oregon PUC Chapter 860.084.0240 establishes standard contract requirements for Net Metering. The minimum required contract is set at 15 years. After the 15-year contract term, utilities can pay their prevailing avoided cost rate for energy generated by solar PV systems. Despite this, neither Portland Gas & Electric and PacificCorp specify a Net Metering contract term in their interconnection agreements.

[11] Oregon Public Utilities Commission. *Or. No. 07-319: Rulemaking to Adopt Rules Related to Net Metering.*

California

California has long been the nation's leader in installed solar capacity with over 17.7 gigawatts of solar installed as of late-2018.[12] In 2016, the California Public Utilities Commission (CPUC) announced, once individual capacity cap for the original NEM (NEM1) program is reached, a NEM Successor (NEM 2.0) program would replace it. Currently, this cap has been reached by all utilities. As a result, all new net metering customers of California IOU's are enrolled in NEM 2.0. Existing NEM1 customers who want to switch may also take service under NEM 2.0 (PG&E, 2018)

NEM1 was a traditional retail rate net metering program. NEM 2.0 is very similar to NEM1 in that any exported solar generation is credited at the current retail rate. However, there are three notable differences between NEM1 and NEM 2.0:

- All NEM 2.0 customers must participate in a time-of-use (TOU) rate,
- All NEM 2.0 customers must pay a one-time "interconnection fee" to connect their solar panels to the electric grid. Fees range from $45-145. (CPUC, 2018)
- All NEM 2.0 customers must now pay non-bypassable charges for each kWh delivered by a utility.

NEM 2.0 is scheduled to run until 2019, at which point the CPUC will launch a new program designed to account for the locational and time benefits of solar.

[12] October 2018 EIA Electric Power Monthly, Table 6.2.B

LADWP COMMERCIAL NEM POLICY:

Los Angeles Department of Water and Power is unique compared to other California utilities discussed here as it is not regulated by the California Public Utility commission, and thus not legally required to offer a commercial net metering program. Despite this, LADWP allows customer generators (up to 1mW AC) to net meter excess generation over a billing period and apply retail rate kWh credits to future billing periods indefinitely until a customer cancels their service. At that point, all excess generation balance is adjusted to zero without any compensation to the customer. LADWP provides all necessary metering equipment unless a PV system requires atypical metering equipment. All interconnection costs are covered by the customer generator.

Virtual Net Metering and Meter Aggregation:

Combined, California's NEM enabling legislation CPUC (D.) 16-01-044 and (SB) 594 allow for Virtual Net Metering and authorize NEM aggregation (NEMA). Virtual net metering and NEM aggregation participants are subject to all requirements regarding non-by-passable charges and interconnection costs as systems under NEM 2.0. NEMA systems are only eligible for customer-generators to aggregate electrical load from multiple attached, adjacent, or contiguous properties given the customer generator is the sole owner, lessee, or renter of the properties in question. [13]

Another aspect of CPUC's requirements under (D.) 16-01-044 for VNEM is that all virtual net metering participants must be associated with the property on which the renewable energy generation is sited. Specifically, California's VNEM "allows multi-meter property owners to allocate bill credits generated from the renewable generation system to multiple service accounts associated with the property."

[13] California AB 2466 which allows for Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) and applies only to governments and universities. It allows for the transfer accrued self-generation credits from a system on one building to be credited to billing accounts with other government/university owned properties.

Fees and Standby Charges

It is first worth noting parties developing NEM 2.0 agreed that imposition of standby charges to NEM participants was unreasonable due to standby charges historically being charged to self-generating customers using non-intermittent resources.
The reintroduction of non-bypassable fees into NEM 2.0's rate schedule was primarily to "recover costs that all customers pay in a fairer and more transparent way" compared with the previous NEM tariff. Current requirements for fees and standby charges under (D.) 16-01-044 for California IOU's are:

- Commercial NEM customers pay any demand charges, standby fees, or similar fixed charges part of the underlying rate for their customer class.
- Requires customers installing a customer-sited PV system to pay a reasonable interconnection fee. (2.14.1.1) This fee should be modest and not have noticeable impact on the economics of installing a Distributed Generation (DG) system. In calculating this fee, as per 16-01-044, utilities are only allowed to account for:
    - NEM processing and administrative costs;
    - Distribution engineering costs;
    - Metering installation/inspection and commissioning costs.
- Pay any non-bypassable charges levied on each kWh of electricity the customers receive from the interconnected utility in each billing interval. Netted kWh credits rolled over from previous billing cycles cannot be used for offsetting these costs. Typically, while different for each IOU, these fees add up to approximately 2-3 cents per kWh. For customer of CA's 3 IOU's, these fees are:
    - Public purpose program charge;
    - Nuclear decommissioning charge;
    - Competition transition charge;
    - And Department of Resources bond charges.

For systems under 1mW, California's three IOU's charge a one-time interconnection fee of $145 for PG&E; $75 for SCE; and $132 for SDG&E. Customer generators over 1 mW must pay a one-time $800 interconnection fee and pay for all related transmission and distribution system upgrades. It is worth noting here that interconnection requirements for systems over 1mW fall under the jurisdiction of California Rule 21.

As the implications and requirements of CA Rule 21 are as expansive as the NEM successor development process discussed here, this report will only provide a brief overview of the relevant aspects to the structure of a commercial NEM policy. Primarily, Rule 21 provides guidance on the allowable interconnection fees California's IOU's may charge for net metered systems above 1mW. Closely following categories established by

FERC, Rule 21 establishes two primary tracks (Fixed Price/Fast Track and Detailed Study options) for 1mW plus systems applying for interconnection.

To provide guidance and transparency in estimating interconnect expenses for owners and developers of 1mW NEM systems, the CPUC developed a Cost Guide (CPUC, 2018) which CA's three IOU's most emulate in developing their own Cost Guide. Each utility's Cost Guide is to then serve as a pre-study cost estimate for a 5-year timeframe helping developers better estimate potentially larger interconnection costs under Rule 21 and the eventual NEM Successor Tariff.

Individual System Capacity Caps

NEM 2.0 has no individual system size limitation eligible for NEM compensation. Rather, (D.) 16-01-044 places restrictions on system size by requiring any NEM system to have no significant impact on the distribution grid and by requiring systems owners over 1 mW to pay for all interconnection costs under Rule 21. (CPUC, 2017)

Program Capacity Caps

Going forward, all utilities required to offer California's NEM 2.0 tariff will do so with no limit to the number of customers or generating capacity entitled to receive service under the new NEM contract. (CPUC, 2018) As this requirement is part of CA PUC code and not the current NEM 2.0 language, it will be applicable to any policy implemented in 2019 as part of the NEM successor tariff.

Contract lengths

Under CPUC D.14.03.041 Section 2.15, the CPUC followed requirements outlined in California's previous net metering policy that 20 years from the customer's initial interconnection was a reasonable period over which a customer taking service under the existing NEM tariff should be eligible to continue to take service under NEM 2.0. This contract length was selected to "allow customers to have a uniform and reliable expectation of stability of the NEM structure under which they decided to invest in their customer-sited renewable DG [or distributed generation] systems."[14]

[14] California Public Utility Commission D.14.03.041

Observations and Trends

Initial net electric metering policies implemented around the US followed a simple format of a full retail rate kWh for kWh exchange of power generated from participating systems. Increased solar penatration has put preasure on states, utilties, and policy makers to evaluate and implement successor tariffs that better align distributed generation export rates with the associated resource's costs and benefits. While there have been a range of compenstation methods developed recently, most share a number of core progromatic components. Following the scope of the evaluated case studies above, these progromatic components include:

- Meter Aggregation and Virtual Net Metering;
- Allowable fees and charges;
- Individual system capacity allowed;
- Program capacity limit;
- Valuation methodology;
- Compensation Mechanism.

Trends have emerged as public utility commissions and utilities have sought to balance their imperative to maintain reliable, equitable, and cost-effective service while valuing distributed generation in manner accounting for both the benefits and costs individual systems provide. The following sections discusses the trends identified from a review of the case studies above.

Additional charges for solar customers such as such as fixed charges and standby charges.

With the rapid decrease in equipment "hard" costs of the past decade, solar project "soft" costs (such as fixed/stand-by charges, permitting, and customer acquisition costs) for larger systems (100 kW+) currently account for around 25% of 100kW+ system costs. (Chung, 2015) In addition to one-time interconnection fees, fixed and standby charges were included as part of various initial NEM policies. Advocates of fixed charges such as the Edison Electric Institute (EEI, 2016) argue that implementing such charges reduces any cost-shifting to non-solar customers resulting from NEM. The counter argument to this, and the national trend regarding NEM, has been to move away from retail NEM towards more granular value of solar methodologies. During 2017, 31 states and Washington DC began or were in the process of developing distributed generation compensation policies. (NCCETC, 2018)

Due to the complexity and varying perspectives on fixed and standby charges, the Federal Energy Regulatory Commission readdressed Or. No. 792 in 2013 to "ensure interconnection time and costs for interconnection customers and transmission providers are just and reasonable".

Fixed charges

Examples of fixed charges implemented in rate cases include monthly Gird Access Charges and solar owner specific Meter Fees. Of the case studies reviewed, California is the only state to require system owners to pay "non-bypassable" fees on all imported kWh's. All other states reviewed follow similar practices to Oregon, which for commercial systems requires a base, one-time interconnection fee in addition to a $/kW installed fee of $1-2 depending on system size. City Light's current interconnection agreement for level 2-4 generators up to 20mW[15] allows City Light to collect a $1 per kW review fee plus a single $50 charge.

Standby charges

Standby service is the capability of a utility to meet system generation requirements typically provided by customer generation during periods of scheduled or unscheduled outages. As standby charges have historically been charged to self-generating customers with non-variable resources (CPUC, 2016), most NEM participants nationally do not pay standby charges. Of the case studies evaluated, only Minnesota's NEM policy allows public utilities to charge standby rates on 100kW+ distributed generation facilities. While currently allowed, the Minnesota PUC is exploring the continued allowance of utilities to charge standby fees on DG systems owners. (PUC, MN, 2017)

Valuation methodologies (components/methods)

As more utilities and states begin the transition from net metering, there is a wide range of methodologies in how utilities are compensating customers for energy delivered back to the grid. The most common approach is VOS. Many of the case studies in this report, Austin Energy, Minnesota, California, Oregon, and New York, have implemented or are in the process of developing some type of VOS methodology.

[15] Seattle City Light Department Policy & Procedure (DPP) 500 P III-305, Section 7.6.2

However, while the methodologies and components used remain similar, the representative values of the various components included in a VOS study can vary considerably from utility to utility. Some of the more commonly used benefit/cost tests (NREL, 2015) in developing a VOS rate include:

- Ratepayer Impact Measure (RIM);
- Program Administrator Cost Test (PACT);
- Total Resource Cost Test (TRCT);
- Societal Cost Test (SCT);
- Participant Cost Test (PCT);

Inputs for these various tests in National Renewable Energy Laboratories 2014 report on VOS include: (NREL, 2015)

- Energy
- Emissions
- T&D Cost Savings
- Generator Capacity
- T&D Capacity
- Ancillary Services
- Other costs and benefits, such as environmental impacts, hedging, diversity, market price suppression, O&M, integration, grid support services, and resiliency.

Trends

It is expected that as VOS rates continue to evolve, more utilities and PUC's will incorporate temporal and locational benefits into their calculations. Notably, New York's Phase One VDER rate does include elements that vary by time and location. Similarly, California's NEM 2.0 is intended to be implemented until 2019 when the California PUC's Distributed Energy Resource Planning process with the state's 3 main IOU's is scheduled to be completed.

> *At that time, [the California PUC] hope and expect that it will be possible to develop a valuation of exports from customer-sited renewable DG [distributed generation] that reflects the full location and temporal value of the services provided to the grid by those exports, as well to develop a more accurate valuation of the services provided by the grid when a customer-sited DG facility is importing from the grid.* (CPUC, 2016)

Given the variable nature of both distributed energy resources and distribution systems, current research contends that any valuation methodology used to compensate distributed solar also be variable. Further exploring the current revisions to New York's VDER rate (NY PUC, 2018), it is also recommended that any rate variability be predictable and consistent to maintain acceptable levels of risk for large-solar project development and financing.

Net metering policy considerations, including program caps, system size limits, and meter aggregation rules;

PROGRAM CAPS:

Most initial NEM programs were established with total capacity caps of .25%-1% of each utility's historical peak load. Washington State's current 0.5% of 1996 peak demand NEM program cap is tied for the second lowest program cap in the nation. (WSHFC, 2017) As installed capacity has reached and exceeded these limits, states and PUC's have begun to explore the rational for limiting program participation and, depending on regional circumstances, how to limit program participation.

Of the case studies evaluated, Oregon and Minnesota are the only states with enforceable % based capacity limits. For these limits to be enforced, a utility must petition their respective governing body with qualifying evidence that further NEM participation is detrimental to its larger customer base. As of the writing of this paper, no utility has petitioned their PUC for NEM participation limitation in either state. Other case studies evaluated here follow a similar trend requiring a heavier burdened of proof from utilities showing that net metering is negatively impacting the environment, non-NEM customer rates, grid reliability, technological advancement, and other regulatory requirements[16] (MN 216B.164).

Another recent trend has been the elimination of program capacity limits entirely by limiting NEM system capacity through price signals inherent in value of solar rate and distribution system limitations addressed in Distributed Energy Resource Capacity Hosting Analyses. (DOE, Sandia, NREL, 2016) Examples include California, Austin Energy, Hawaii, and NYSRDA. Such limitation of distributed solar capacity by locational and temporal parameters closely aligns with VOS valuation trends nationally.

[16] Minnesota Statute 216B.164

Individual system limits:

Currently, there are a range of allowable commercial system sizes under state NEM policies. Like many other aspects of a NEM policy, individual system limits have evolved as states have reached their initial program capacity cap.

Of examined case studies here, Minnesota[17] and LADWP have the smallest commercial NEM system limit of 1mW and Austin Energy's VOS program has the largest system limit of 10mW's (DSIRE, 2015). Most established national best practices recommend either eliminating system limits or setting NEM systems limits to exceed 2mW's (ACEEE, 2018). While there is a divergence in whether there should be static system limits, all case studies evaluated agree that NEM annual generation should be limited to the load a NEM system is offsetting and adhere to state and federal interconnection standards.

While these two limitations are implemented in various ways, emerging trends typically limit system sizes not through policy but rather by economics. One method of this is California's requirement that all systems above 1mW, in addition to causing "no significant impact on the distribution grid", pay all interconnection cost under Rule 21 including all utility costs. (CPUC, 2016) A more common practice, currently implemented in Washington State, Oregon, and Minnesota, is to either reimburse any remaining kWh credits at the end of a 12-month billing cycle at a utility's avoided cost rate or simply forfeit the credits to the utility.

Meter Aggregation:

As meter aggregation and VNEM has been addressed in previous reports, this paper will only touch on the topic briefly. All case studies in this report offer meter aggregation as part of the enabling statutes. The only differentiation in policies is how kWh credits is attributed to aggregated meters. Minnesota is unique in distributing accumulated credits in a sequential manner, zeroing out each aggregated meter billed hours in order until all generated kWh credits have been accounted for.

[17] While most of Minnesota's solar capacity is 1mW+ utility scale solar, all these systems are participants of Minnesota's Solar Community Garden Program.

What is worth noting here is that Virtual Net Metering and Community Solar program have become the more prevalent methodology for distributing generated kWh credits to other meters. This is due to the many similarities between VNEM/Community Solar policies and meter aggregation, and VNEM/Community Solar policies being much more flexible in their application. All case studies in this report either have an active VNEM or Community Solar program or one in development. As more emphasis has begun to be placed on developing more equitable solar access to consumers, VNEM and Community Solar programs are both seem as readymade programs to meet this need.

Net Metering and Rate Design Changes as Part of Broader Reforms (motivations/policy drivers)

As addressed earlier, the rapid cost declines of solar and renewable energy have led many states and public utility commissions to redesign net electric metering policies. While Net Metering is dually considered one of the most successful renewable energy policies in the United States and one of the most contentious. Many opponents of NEM policies assert traditional full retail rate NEM compensation structure shift utility fixed costs to other, non-solar customers. Increasing interest nationally for more granular value of solar tariffs is arguably a direct effort to prevent any potential cost shifting between utility customers.

Like evolving regulator frameworks developed for other aspects of utility operation like rate design and integrated resource planning, NEM successor tariff valuation methodologies have focused more on framework design rather than specific quantitative figures. This emphasis facilities the application of these frameworks across service territories with potentially drastic differences in utility operating environments and generating assets.

Conclusion

In developing a 100kW+ distributed generation rate that accurately reflects the value distributed generation provides, utilities, regulators, and policy makers are developing distributed generation rates that are:

- Fair and reasonable to all customers,
- Sustainable for both utilities and consumers,
- Reduce financial uncertainty for long-term distributed generation investments.

In pursuing these goals, states and utilities have begun to identify and collecting the data necessary to accurately value the inherent costs and benefits of distributed generation. Even California and New York, two states farthest along in designing distributed valuation methodologies, recognize current data gaps preventing an accurate valuation of distributed generation to their desired level of granularity. This has led to a multi-phased process in California, New York, and Oregon. Despite current information limitations, consensus has emerged that any value of distributed generation should be based on the inherent variable and locational properties of distributed generation. Such a valuation methodology helps insure transparent and equitable allocation of the associated costs and benefits of distributed generation.

This emphasis on providing specific energy values has led states and utilities to shift from traditional NEM policies to net billing. Such a shift allows utilities to recover any fixed or variable-fixed costs of providing service to customers while also compensating distributed generators for the specific value their resources provide. Specifying energy values to this degree has the dual purpose of assuring distributed generation provides benefits both to utilities and consumers while mitigating potential cost shifting to non-distributed generation customers.

Lastly, as the operating environment for both utilities and the renewable energy industry are far from static, any distributed generation compensation rate must be both flexible while providing enough financial stability to encourage the large investments necessary for scalable distributed generation.

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