The Ecology of Community Solar Gardening: A ‘Companion Planting’ Guide

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- Hon. Betty Ann Kane, Chairman, Public Service Commission of the District of Columbia;
- Jill Cliburn representing the U.S. DOE-sponsored Community Solar Value Project;
- Lee Gabler, Xcel Energy Company, Senior Director of Customer Strategy and Solutions; and,
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Any errors are the authors' responsibility. As always, we welcome communications from readers about corrections or additions for this work, and ideas for future research.

– Tom Stanton and Kathryn Kline, NRRI

Executive Summary

This NRRI research paper provides an overview of community solar (CS) activities around the country. It reports on the rapid expansion of community solar projects under two different rubrics:

1. States that are implementing laws and rules that govern CS, currently underway in 15 states and the District of Columbia;* and,

2. In other states as well those above, individual utility companies are obtaining approvals from their state regulatory authorities, or for non-state-regulated utilities from their governing boards or commissions, for CS programs.

Part I introduces the concept of community solar.

Part II presents a working definition for CS, explains how certain CS program designs can lower costs by avoiding state and federal securities regulations and IRS treatment of customer benefits as taxable income. The definition used for this report is solar electricity generating projects with multiple, unrelated, utility customers who either own or lease a portion of the project and who receive economic benefits based on the amount of electricity generated, most often in the form of volumetric utility bill credits. Part II also briefly compares CS to other utility- and non-utility program options that are at least tangentially related, where interested customers might also act on their preferences for receiving additional percentages or all of their power from solar or other selected energy resources or invest in solar energy.

Part III reviews many important reasons why CS is important, from the standpoint of customers, utilities, the solar industry, and the regulatory community. It includes a brief discussion about why the idea of companion planting can be an apt analogy for community solar. In gardening or agriculture, companion planting means growing two or more different kinds of crops in close proximity to one another to produce mutual benefits such as pest control and suppression, increased productivity, and hedging against various kinds of disruptions. Similarly, this paper begins to explore ideas about how community solar can play an important role in the larger contexts facing the electric utility industry, including the ongoing efforts in many states to either enhance or replace net metering tariffs, ideas about future business models for utilities, and possible beneficial roles for all kinds of market-based solutions and distributed energy resources.

Part IV summarizes state laws and rules about CS programs, presents examples of the major similarities and differences in CS regulations, and compares how the programs address more than a dozen major program design aspects. Part IV reviews legislative and regulatory actions in the 15 states and the District of Columbia, that have already taken action to authorize community solar. A timeline is presented, showing those actions from 2006 to the present, and

* The list includes California, Colorado, Delaware, District of Columbia, Hawaii, Illinois, Maine, Massachusetts, Minnesota, New Hampshire, Oregon, Rhode Island, Vermont, and Washington . In addition, Connecticut and Maryland are initiating pilot programs in response to their respective state legislations and New York's program is authorized by a NY Public Service Commission order, rather than state legislation.

indicating a couple of states that have already put in place mechanisms to review and make decisions about the status of community solar in the future. State laws and rules are reviewed to identify over a dozen substantive features of the state programs, and provide a sampling of some of the many similarities and differences among the programs.

Categories included in that review include:

- program and project capacity limits;
- customer eligibility requirements, along with minimum and maximum limits for customer participation and special provisions for including low- and moderate-income participation;
- location requirements for both project siting and for participating customers;
- customer disclosures, education, and protection;
- participant bill credits;
- participant rates and terms;
- portability and transfer of participation;
- project ownership;
- program evaluations;
- renewable energy certificate (REC) treatment;
- treatment of unsubscribed energy;
- utility cost recovery; and.
- other provisions.

Part V explores some regulatory considerations and preliminary ideas about approaches that policy makers might consider for CS programs, and presents some brief ideas about future research related to CS. The regulatory considerations include:

- efforts to regulate CS as a means of simulating the performance of fully competitive markets;
- deciding about CS cost allocation and utility cost recovery;
- expanding the value of CS;
- CS as a gateway to all cost-effective distributed energy resources (DER); and,
- Evaluating CS.

The preliminary recommendations for future research include:

- Exploring non-utility-regulatory barriers to community solar, to better understand them and identify possible actions that might reduce or remove them;
- Reviewing possibilities for standardizing community solar offerings;
- Gaining a deeper understanding of how customers might be fully engaged to act as partners in the development of all kinds of distributed energy resources; and,
- Identifying strategies for all interested parties to best manage a transition to a utility sector that will deploy many more distributed energy resources.

Lastly, Part VI provides a brief summary of this paper.

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I. Introduction

This paper reviews the current status of state actions on community solar (CS) and strives to identify qualities commissions might look for, when identifying best practices in CS programs and projects. Particular issues include:

- Are there basic criteria and minimum standards that can be applied, without which state utility regulatory commission approvals should be withheld?
- What are the opportunities for expanding or maximizing the benefits of CS, so that CS systems provide the greatest value to all participants, and for society as a whole? And,
- How can low- and moderate-income customers benefit from CS projects, and what is known about best practices to encourage their participation?

Companion planting is an apt analogy in this context because it represents a particular kind of mutual support, based on *a priori* knowledge of mechanisms that add value: In gardening, companion planting means growing two or more different kinds of crops in close proximity to one another or even inter-planting multiple crops in one area, to produce mutual benefits such as pest control and suppression, increased productivity, and hedging against various kinds of disruptions (McClure and Roth 1994). Similarly, CS might contribute towards solutions to several of the pressing challenges facing utilities and regulators today, such as the design of enhancements to or replacements for NEM, future utility business models, and possible roles for market-based solutions and distributed energy resources (DER). CS provides an important opportunity for early learning about beneficial utility involvement in a way that can produce and deliver important system and societal benefits while both satisfying some of the explicit desires of participating customers and holding harmless non-participating customers (Campbell and Mahrer 2016; Funkhouser, Blackburn, et al. 2015a and 2015b; Marcacci 2016; Pareg and Sovacool 2016; Pyper 2016b and 2016c). On the other hand, inadequate regulatory oversight could lead to unintended consequences, including the possibilities of monopoly rents, reduced benefits for all concerned, and higher costs for participating customers.[1]

[1] Economists use the term "monopoly rents" to refer to a situation where the price of a product or service can be set higher than marginal costs because a producer lacks a fear of market entry by competitors. Participating CS customers could have only a single choice, controlled by their monopoly utility, that uniquely provides the benefit of value receivable in the form of utility bill credits. In that situation, the provider might not maximize the value of CS installations and could give participating customers a less than fair share of the CS system benefits. See, for example, Teece, David J., *Monopoly Rents,* in Palgrave Encyclopedia of Strategic Management, DOI: 10.1057/9781137294678.0435.

II. Defining Community Solar

For purposes of this research, community solar (CS) is characterized as solar electricity generating projects with multiple, unrelated, utility customers who either own or lease a portion of the project and who receive economic benefits based on the amount of electricity generated, most often in the form of volumetric utility bill credits. Although there can be many variations in basic program design, the aspects that define CS, for the purposes of this report, are the fact that the owners or subscribers are multiple unrelated customers, that they receive benefits that represent their fractional shares of the energy output generated by a particular CS project, and that the CS generator is located remotely, off-site, from all, or at least most, of the participating customers.[2]

IREC (2012, pp. 3, 5) refers to "multiple, dispersed energy consumers" receiving "tangible economic benefits on their utility bills." IREC explains:

> Shared renewable energy programs enable multiple customers to share the economic benefits from one renewable energy system via their individual utility bills. Participants purchase an interest in generation from a common renewable energy system, and directly receive the benefits of their participation on their utility bills.

In a similar vein, Feldman, Brockway, et al. (2015, p. v) define 'shared solar' as "PV systems… that allocate the electricity of a jointly-owned or third-party-owned system to offset multiple individual businesses' or households' consumption."

US-DOE (2016) describes CS with an emphasis on the participating customers, who want to obtain benefits of solar energy without having a solar installation on their premises:

> Shared solar projects allow customers that do not have sufficient solar resource, that rent their homes, or that are otherwise unable or unwilling to install solar on their residences or commercial buildings, to buy or lease a portion of a shared solar system. The subscriber's share of the electricity generated by the project is credited to their electricity bill, as if the solar system were located at the home or business.

As this DOE definition implies, on-bill credits can generally be thought of as a form of virtual net energy metering (VNEM). As explained in Part II of this report, several states have begun implementing community solar programs that are explicitly being regulated as variations of VNEM. However, depending on each program's design, the bill credits for CS projects are often different from, usually less than, the credits that would be associated with an individual customer's net-metered, on-site generation.

Furthermore, not all programs operate using a VNEM model: There are many different ways to design CS programs, including for example models where the customer buys their share

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[2] Many projects are off-site, with none of the participating customers located adjacent to the CS project site. In some instances, though, there can be one host facility served directly by a CS project on-site, and even behind-the-meter, with participants other than the host facility entitled to a share of revenues based on the metered CS project output.

of CS output at a fixed price and that portion of the customer's regular monthly utility bill is charged at the CS price rather than the standard tariff price. Or, a kind of buy-all, sell-all model might be used, where participating customers buy all of their utility service under a standard tariff and then receive a bill credit based on their share of output from a CS generator, with that output purchased by the utility under a power purchase agreement (PPA).

In fact, some CS vendors and utilities prefer that regulators and participating customers do not think of these relationships as net metering variations: Even though there are a lot of variations in the different state net metering program rules and standards, many observers might still assume that net metering always involves generation credits based on the participating customer's full retail rate. With the recent controversies about net metering and many states already engaged in proceedings to establish changes to or replacements for net metering, many interests prefer that CS will be thought of as a different kind of program.

Importantly, the benefits to participating customers can include various combinations of:

(1) a hedge against future electricity cost increases, because the participating customers lock in a long-term fixed rate for their solar energy purchase.

(2) lower electric bills from the outset, because the per unit bill credit is greater than the per unit cost of the community solar subscription; and,

(3) long-term financial benefits, where the fixed-price of the customer's share of a solar production facility, including any carrying costs, is expected to be repaid, with interest, through the customer's aggregated bill credits.

Remuneration by way of utility bill credits is particularly important because it differentiates community shared programs from other forms of renewable energy investments, and thus, depending on program design details, can entitle the project developers and participating customers to special treatment under securities rules and tax codes. The Securities and Exchange Commission (SEC) can determine that the shares purchased or subscribed to by participating customers do not have to be treated as an offering of securities subject to federal regulation. Unfortunately, for the time being, there is no clear, comprehensively stated policy on the relevant SEC or Internal Revenue Service (IRS) rules, but community solar projects can be designed in ways that are most likely to receive favorable SEC and IRS treatment.

The IRS, by individual letter rulings, has acknowledged that when customer benefits constitute a simple exchange of energy like individual net metering, with the bill credits subject to annual caps closely related to the customer's annual energy usage, the benefits do not have to be included in calculating gross income.

In addition, programs can be designed so that participating customers can benefit from the federal investment tax credit for their expenditure for qualifying solar electric property (IRS 2015). Projects can be structured so that each participating customer can claim the federal ITC. Or, more often, the developer or a project tax equity partner monetizes the tax credits and conveys much of that benefit to subscribers through any combination of a reduction in costs or an increase in benefits.

Community solar project costs and financial implications would be markedly different if the ITC benefits were not available, if securities laws were implicated, and if each customer's share of production were treated as a sale of electricity, subject to income taxes: Payback periods would be lengthened and participant benefits lowered, reflecting the added costs of obtaining all regulatory approvals and paying all of the applicable federal, state, and local income taxes. That is one reason why CS projects can offer participating customers something unique: Other means of investing in solar projects might not enjoy the same benefits.

Without the significant expense of obtaining prior rulings from federal and possibly also state or local regulators, program developers cannot be absolutely certain that any particular program design detail might not convert their projects into renewable energy investments subject to securities regulations and with participant benefits treated as income for tax purposes. For the present, it appears that CS programs can avoid unfavorable treatment as long as customer benefits are provided by utility bill credit and are at least fairly closely aligned with the customer's expected annual utility charges. (Coughlin, Grove, et al. 2010, Sections 4-5; Feldman, Brockway, et al. 2015, pp. 13-20; US-DOE 2016). It is uncertain whether the SEC and IRS might extend the same treatment to CS projects installed and operated entirely behind the meter, with bill credits delivered by a third party and no direct utility involvement.[3]

A. Programs implemented under state authorizing laws

These are the programs that are described in more detail in Part II of this report. Most of those states have initiated actions to provide some standardization for CS offerings, while developing competitive markets for project developers. Of the jurisdictions where the enabling laws have passed, 11 states plus the District of Columbia are restructured, so that regulated utilities will have more limited roles in CS projects. Although these programs are in the early stages of development, many of the state laws do appear to be opening up markets that are attracting CS developers: As much as 90% of all CS applications in the near future are predicted for those states with enabling legislation, and nearly 3/4 of the growth is projected for the few states that have the most attractive rules and regulations for developers, including California, Colorado, Massachusetts, and Minnesota. (Honeyman 2015; Trabish 2015b).

B. Programs implemented based on utility applications

In many other states, regulated utilities have sought and obtained approval from their state regulatory authority for projects of the utility's own design, or in other instances non-state-regulated utilities, acting on their own authority, have developed projects. Participating utilities are most likely to use competitive bidding procedures to select contractors to design, build, and possibly even operate and maintain the CS projects. The utilities themselves are almost always the ones siting the facilities and designing the programs.

Although these should be considered only anecdotal observations at this early stage of development:

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[3] Personal communications with Mark Clevey, Ann Arbor Energy Commission, and Erica S. McConnell, representing the Interstate Renewable Energy Council, June 2016.

- Often, these early utility projects are much smaller in scale, some measured in only the tens of kilowatts, compared to the projects in states with enabling legislation, that are sometimes a megawatt or larger;

- Many utility projects are being developed in small increments for customers who pre-enroll, rather than starting with a larger project and then enrolling customers over a longer period of time; and,

- In an effort to make sure that CS projects do not result in cost-shifting to non-participants, utility designed projects often have benefit streams with longer paybacks for participants, compared to the developer-led projects in the states with enabling legislation. (Schaefer 2016; Stumo-Langer 2016).

Several other states have taken actions that promote CS or closely-related multi-customer shared solar generating facilities, but they fall short of establishing state-wide programs. This is not a comprehensive listing, but selected recent examples include:

- **Georgia's** Public Service Commission approved Georgia Power's Integrated Resource Plan on July 27, 2016, which includes a provision for 3MW of self-build community solar (Docket No. 40161, Document Filing #164778 and Docket No. 40162, Document Filing #164738).

- **Illinois** passed legislation (220 ILCS 5 §16-107.5(l)) which allows electric providers to consider adopting measures to support meter aggregation targeting two groups: (1) "properties owned or leased by multiple customers that contribute to the operation of an eligible renewable electrical generating facility" and (2) "individual units, apartments, or properties owned or leased by multiple customers and collectively served by a common eligible renewable electrical generating facility, such as an apartment building served by photovoltaic panels on the roof."

- **Mississippi** Public Service Commission included in its Order Adopting Net Metering Rule a mandate to all electric utilities subject to the Commission's jurisdiction to file a report including information on the feasibility and potential cost-effectiveness of community solar along with other options that may "broaden solar choice to a wider group of customers" by July 1, 2016 (document 2016-UN-31).

- **Pennsylvania** amended its Alternative Energy Portfolio Standards Act (2007 Act 35) to authorize virtual metering aggregation so that a customer can act as a group host for other customers if customers are within a two-mile radius of the customer generator's property and within a single electric distribution company's service territory.

- **West Virginia** allows virtual meter aggregation (150 C.S.R. Series 33) on properties owned or leased and operated by a customer-generator as long as active meters are located within two miles of the property boundaries, and within the service territory of a single electric utility.

C. Comparing community solar to other customer choice options

There are several other utility- and non-utility-program types that are similar, in some ways, to CS (Feldman, Brockway, et al. 2015, p. v). IREC (2012, p. 5-6) differentiates CS programs from renewable energy investments, donation-based contributions to renewable energy projects, and other forms of net energy metering (NEM) which apply to individual customers only, and to NEM meter aggregation programs that allow participation for multiple meters only if they are on the same or contiguous properties. Another NEM variety available in some states is aggregation among multiple meters on multiple separate properties, where the participating customers are all related through one organizational structure. An example might be a single school district with NEM meter aggregation across multiple properties, all of which belong to the school district.

In addition to those NEM variations, there are other program types that are tangential to but different from CS. These include group purchasing, sometimes known as "Solarize" programs, and green pricing programs, also known as green marketing, green rate, or green tariff programs. Group purchasing programs are similar because they try to achieve economies of scale by purchasing larger quantities of solar equipment and services for multiple customers, but they are different because the installations that result are separate, individual systems, located on each customer's property (Goodward, Massaro, et al. 2011; Irvine, Sawyer, and Grove 2012). Green pricing in regulated utility markets, also known as green marketing in competitive markets, generally means rate offerings that enable customers to purchase a larger percentage or all of their electricity from specific types of clean or renewable electric generation. Green rates are similar to CS, because they allow customers to select service offerings that include larger percentages of clean or renewable energy, but they are different because they seldom produce direct financial benefits for participating customers. In most of these programs, a utility or competitive supplier might purchase RECs, either bundled with the supply of electricity or unbundled, and then charge participating customers a price premium for the product, retiring the RECs on behalf of participating customers. (Bird, Swezey, and Cory 2008; US-DOE 2016c).

Another rapidly emerging kind of green power customer choice is the option for large utility customers to enter into direct contracts for purchasing clean energy. Many of the world's largest corporations are already working towards meeting publicly announced commitments to reduce their greenhouse gas emissions, and some are explicitly working towards sourcing all of their power from renewable resources (Healy 2016; Heeter 2014; Maloney 2016a; Romm 2016; Tweed 2016). In addition to these large corporate interests, the federal government is also engaged in major efforts to procure additional renewable power for its facilities (US-DOE 2016b). And, many U.S. Department of Defense facilities all over the country are developing microgrids with the capability to power critical facilities in the event of a grid outage. Many communities around the country are similarly working towards what are commonly called public purpose microgrids that will be capable of providing extra high reliability of service for critical infrastructure facilities first responders. (Stanton 2012). Some of these customers might also have a keen interest in on-site or contiguous solar power. These kinds of customer-choices could be harbingers of the future for even more utility customers (Shannon 2016). As Blank, Goodman, and Palazzi (2016) explain, CS is one means available to increasing numbers of customers who wish to customize their utility service to meet personal needs and desires.

Two other related ways that customers can express their support for green energy are: (1) by making donations to support specific renewable energy installations or more generally to support organizations that are helping to develop renewable energy; and (2) through direct investments in renewable energy projects. A prominent example of donation-based funding are projects developed through RE-Volv (2016), a non-profit organization. RE-Volv basically promises donors that the proceeds from each successful solar installation will be reinvested "to fund more worthy solar energy projects." Another donation-based approach is described by Richardson (2016). Mosaic and SolarCity are perhaps the best known providers of opportunities for individuals to make small investments in solar projects, with the dual intent of supporting solar projects while also earning returns (Kelly-Detwiler 2013; SolarCity 2016).

Depending on individual circumstances, specific consumers might find any one or more of these approaches attractive, including on-site solar or participation in any utility or non-utility CS program.

III. Why Community Solar is Important

Community solar projects are proliferating in many states (Blank, Goodman, and Palazzi 2016; EPRI 2015; Feldman, Brockway, et al. 2015; Honeyman 2015; Pyper 2016c; Roberts 2016; SEPA 2016a; US-DOE 2016). The Institute for Local Self-Reliance (2016) has a map showing the locations of CS projects and IREC (2016b) has a database listing projects through the first half of 2015. The IREC database indicates which projects are operating under state CS laws; presumably all of the other projects listed are operating under the second approach.

By early 2016, the Interstate Renewable Energy Council and Smart Electric Power Alliance (IREC 2016b) had cataloged 89 different announced utility community solar projects in 29 states. Similarly, the Smart Electric Power Alliance (Edge, Myers et al. 2016) identified 83 active projects as of the end of 2015, with a similar number of new projects expected to become operational in 2016 and nearly 90 percent of utilities responding to a solar market survey indicating they are already considering, researching, or planning community solar programs. Altogether, when completed, the identified projects will represent at least 500MW of installed solar capacity (Honeyman 2015; IREC 2016b). The U.S. Department of Energy forecasts that by 2020 community solar capacity could equal anywhere from a third to nearly half of all installed distributed solar (Feldman, Brockway et al. 2015; National Community Solar Partnership 2016).

Such projects take different forms, variously called community solar, shared solar, or solar gardens (Blank, Goodman, and Palazzi 2016; Chwastyk and Sterling 2015; IREC 2012). Similar concepts are also spreading to other community-shared renewable energy projects, such as wind generators, and community-shared energy storage (Dennis 2016; EPRI 2015; McMurtry and Lipp 2015).

There are several major reasons why CS is important for customers, utilities, the solar industry, and the regulatory community. For example, Feldman, Brockway, et al. (2015, p 4) list:

- Access for customers without suitable land or a rooftop where an individual solar system could be located;
- Lower financial and technical barriers to entry for participating customers;
- Professional operations and maintenance provided by a qualified system manager, rather than by individual customers;
- Portability or transferability of shares for customers who might relocate, either within or outside of the utility service territory, or for those that might experience a major change in financial circumstances;
- Lower hard- and soft-costs for PV systems, due to important economies of scale;
- More flexibility in siting, with the possibility of more beneficial or even optimal grid integration; and,
- Increased community support, based on locational or other affinity relationships.

A. Importance for customers

Recent survey research shows that nearly half of all residential customers show interest in community solar, once they have a basic understanding of the opportunity, and fully one-third of residential customers report being seriously interested (Shelton Group 2016; Szaro 2016). For customers, CS represents one meaningful option, perhaps the most economical one, for selecting additional green energy. Many customers do not have opportunities for installing on-site solar, because they are renters, or they lack roof space that is unshaded and properly oriented towards the prevailing angles of incidence for solar radiation. Also, many customers prefer CS because it offers combinations of lower risks, no ongoing responsibilities for maintenance and operations, and more flexibility in financial options and terms. (IREC 2012, pp. 2-3; Shelton Group 2016; Szaro 2016). The National Renewable Energy Laboratory estimates that nearly half of all residential and business customers, for various reasons, have properties that are not good locations for on-site solar installations (Feldman, Brockway, et al. 2015, p. v). Even larger numbers of customers will find on-site installations out-of-reach because of other issues, such as credit requirements, a lack of attractive net metering terms, local or neighborhood association siting restrictions, and the like (Shelton Group 2016; Trabish 2015b).

Plus, many customers who support solar energy might prefer to make a smaller investment, compared to the relatively large expense of installing a system on their own property. A CS investment can be much smaller; there are sometimes options for purchasing the output from only a single solar panel, on the order of a few hundred watts. Customers might balk at an investment on the order of many thousands of dollars to install a complete home-scale system, but might welcome the opportunity to buy a smaller share of output from a CS system for an investment of one thousand dollars or less. And, if on-bill financing is offered, customers could find that their participation will generate positive cash flow from the outset. Low- and moderate-income customers, especially, might find other solar options impossibly out of reach but could have a realistic opportunity to participate in a CS project. The White House is explicitly supporting this option with its new *Clean Energy Savings for All Americans Initiative* (White House 2016). That effort includes plans for:

- "Convening banks and regulators to expand access to financing for community solar projects for low- and moderate- income households;"
- Grant awards of up to $100,000 each for communities that "develop innovative models to increase solar deployment and cut communities' energy bills;" and,
- Greatly expanding the DOE-sponsored National Community Solar Partnership.

Another major factor for both consumers and for other CS project partners is that larger solar installations benefit from important economies of scale, notably in engineering, procurement, construction, operations, and maintenance: CS systems could be ten, 100, or even 1,000 times larger than typical home-scale systems of only a few kilowatts, and might cost half or less per unit of delivered energy (Stanton et al. 2014; Trabish 2016c; Tsuchida, Sergici, et al. 2015). That means that the participant's economic benefit from a community solar project could be substantially higher compared to an individual system, even after accounting for the added costs associated with program administration and specialized billing systems. In some locations, depending on the available solar resource, the maturity of solar markets, and the economies of scale in community-based systems, CS can be cost-effective at current prices while individual systems are not (Blank, Goodman, and Palazzi 2016).

In addition, as discussed below, CS projects often convey special treatment from the federal and state securities officials which allows small, non-accredited investors to participate. And, bill credits typically avoid having the IRS treat the value of CS solar output as income for tax purposes. Plus, carefully designed programs can also convey to participating customers the benefits of the federal investment tax credit that is still available for solar equipment. A customer could find there are few renewable energy program options, or perhaps even only one utility-sponsored choice, that can provide those specific benefits.

B. Importance for utilities

For utilities, CS can be an important mechanism for building brand loyalty and customer satisfaction: It can be a simple matter of giving certain customers what they want. Early CS consumer survey research shows a near-even split between some customers who prefer that their utility company will play a lead role in, or maybe even run the CS program, as opposed to other customers who prefer that their utility company not be involved at all (Szaro 2016).

Because CS can involve rather long-term investments, it can be, as Blank, Goodman, and Palazzi (2016) note, a potential tool "to bind customers to their company and reduce customer churn." That effect could imply that CS customers will tend to stick with their competitive supplier because of a long-term commitment to a CS project. Or, in a fully-regulated market served by vertically integrated monopoly utilities, CS participation could help to reduce or prevent load and grid defection on the part of regulated utility customers (Bronski, Creyts, et al. 2015; Kantamneni, Winkler, et al. 2016).[4] CS could even be seen as introducing a long-term, positive relationship that will encourage customers to buy additional products and services from their CS supplier (Trabish 2015b).

Utilities can also use CS projects as opportunities to gain experience with all of the important planning and operational characteristics of solar energy and other DER. For those utilities that are already well-versed in DER deployment, CS projects can be designed to maximize locational values and CS can be optimized for the maximum solar output and matching to peak demands by careful siting and attention to tilt angle or with variable axis tracking mounts (Tsuchida, Sergici, et al. 2015). For other utilities with less experience, CS offers important opportunities for learning about beneficial siting and for testing advanced operating functions, such as the ability of solar systems with smart inverters to provide valuable grid services (Flores-Espino 2015, p. 27; Frader-Thompson 2016; IREC 2012, p. 3; Reiter, Adani, et al. 2015). The U.S. DOE sponsored Community Solar Value Project is developing resources about how best to maximize the value of CS through distribution integrated resource planning, coordination with demand response and other DER, and the provision of ancillary services (see Community Solar Value Project 2016; Huffaker and Powers 2016; Trabish 2016a and 2016b). Whether vertically integrated or restructured, all utilities are likely to have some role in enabling or managing at least some of these potential value-creating approaches.

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[4] Load defection happens when a customer starts to supply some of their own power on-site, thereby reducing purchases from the electric grid. Grid defection happens if a customer completely disconnects from the electric grid, or never connects in the first place, because they opt for the alternative of on-site self-generation, typically coupled with battery storage. See Bronski, Creyts, et al. 2015.

CS is also a mechanism that utilities can use to expand customer access to solar power that does not involve cost-shifting between participants and non-participants and does not require any rate-funded subsidies.

In addition, utilities can look towards CS as an early means of gaining experience with inviting private and public interests to co-fund new utility infrastructure, viewing customers as potential investors and partners in grid modernization (Braun and Hazelroth 2015; Frader-Thompson 2016).

C. Importance for the solar industry

For the solar industry, CS represents an important growth market and greatly expands the audience for potential investors and off-takers for the solar generation. CS can help reduce soft costs by standardizing mid- to large-scale installations (CERTS 2016). CS can magnify the market pull that is helping to reduce the cost of distributed photovoltaics (DPV) so that solar can be more rapidly introduced as a cost-effective resource in more applications and more utility service territories.

CS could also prove to be an early point of entry for much broader markets for all kinds of DER: The same customers interested in CS might also be early adopters of other services that have similar potential for customized utility services that support cost-savings and clean power. Primary examples might include extensive energy efficiency retrofits, and aggregated demand-response and load management. (Trabish 2016a and 2015).

In addition, solar industry participants are acutely aware that the clock is ticking on federal financial support: The investment tax credit (ITC) for solar PV equipment is slated to remain at the current 30 percent for projects commencing construction through 2019. The credit then steps down to 26 percent in 2020, then 22 percent in 2021. After 2023, the residential credit drops to zero while the commercial and utility credit drops to what is now slated to be a permanent ten percent. (SEIA 2016; Trabish 2016c). Thus, the solar industry is motivated to do as much as possible in the next few years to reduce costs and demonstrate the cost-effectiveness of solar applications with reducing and eventually phased-out federal incentives.

D. Importance to the regulatory community

In approving community solar programs, state utility regulatory commissions must grapple with the issues of appropriate roles for regulated utility companies, utility cost recovery, reasonable economic benefits for CS owners and operators, plus rate design, including appropriate protections for both participating and non-participating customers. Feldman, Brockway, et al. (2015, p. 5) highlight several important regulatory challenges and obstacles:

1. Are new laws or regulations needed to enable CS?
2. Is there presently a lack of uniformity in offerings and standard contracts, and how can CS offerings be designed to avoid SEC regulations and ensure that the benefits of federal tax credits can be applied?

3. What new capabilities, if any, might be needed to enable utilities or third parties to process billing credits?
4. Might CS create unquantified benefits, that are not equitably shared with those responsible for producing those benefits?
5. Might CS create unquantified costs that are not equitably borne by those responsible for causing those costs to be incurred?

When programs are carefully designed and implemented, CS offers the potential to expand clean solar energy production without adding costs to non-participating customers; however, achieving that goal requires full awareness of and attention to both the costs and benefits that CS projects can produce. Early on in CS project development, program designers attentive to prevent cost shifting to non-participants could be erring on the side of trying to quantify and account for all known costs without making an equally diligent effort to identify, quantify, capture, and then equitably share all of the potential benefits.

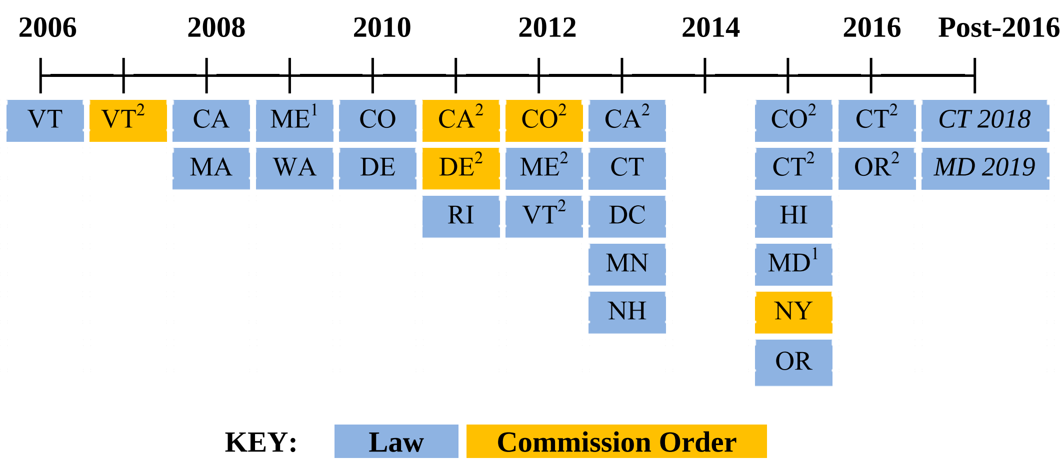
In this context, the essential role of the regulator is to simulate, as best it can, the effects of competition (Lazar 2011, p. 5). As McCraw explains (1984, p. 308), "[R]egulators should always exploit the natural incentives of regulated interests to serve particular goals that the regulators themselves have carefully defined in advance."

In addition, regulations can bring stability and consistency to what might otherwise develop in a haphazard or chaotic way. Flores-Espino (2015, pp. vi-vii) points out that regulatory uncertainty is bad for business. He explains, "The ripple effects of regulatory uncertainty are difficult to measure and could include constraints to the expansion of the solar industry, higher costs of capital, and reduced investment." Thus, he calls for "deliberate and transparent mechanisms that balance the interests of all relevant stakeholders… [to] help maximize benefits system-wide."

IV. Review of State Actions on Community Solar

Figure 1 shows a timeline for the 15 states and the District of Columbia that have already adopted CS legislation or rules.

Figure 1: Timeline of States Adopting Community Solar Programs



Notes: [1] Pilot program
[2] Indicates additional state legislative or regulatory actions, subsequent to the enabling laws or rules.
Source: Authors' construct using sources listed in Table 1, plus DSIRE 2016, IREC 2015, Durkay 2014, and Stanton and Phelan 2013.

At least half of the states listed in Figure 1 took their CS actions in the context of their state's pre-existing net energy metering (NEM) programs, implementing CS as a form of remote or virtual net energy metering (VNEM). These include Colorado, Delaware, District of Columbia, Illinois, Maryland, Massachusetts, New York, Rhode Island, and Vermont. CS bill credits are often different from, usually less than, credits awarded for on-site, single-customer NEM, but the NEM rules typically provide several of the other relevant parameters for CS programs. In the other states, formal linkages between CS and NEM are not explicitly described, but the two program types are likely to share at least some similarities. Those include California, Connecticut, Hawaii, Maine, Minnesota, New Hampshire, Oregon, and Washington.

Table 1 provides an overview of some of the important similarities and differences among these state programs. As Table 1 shows, six of these jurisdictions remain vertically integrated and the rest are restructured. Typically, restructuring means the local distribution companies will be enablers of CS programs, but will not be owners or operators of CS projects. Programs currently defined for Connecticut and Maryland are specifically described as pilot projects, subject to additional analysis and legislative reviews.

As shown in Table 1 in the following pages, most of the states with CS legislation and rules establish:

- maximum total CS program capacity limits;[5]
- maximum capacity limits for each participating CS project;[6]
- minimum number of participants in each CS project;
- maximum amount of energy to be generated per participant, usually expressed in terms of a percentage of the participant's annual average energy use; and,
- location requirements, both for the siting of each CS project and for the participating customers of the respective project.

Table 1 also notes which utilities are covered by the rules. Often, it is all of the utilities regulated by the state's utility regulatory commission. In some cases, the state laws also apply to utilities that are not state-regulated. The last column in Table 1 includes links to the relevant state laws or rules for implementing CS.

Additional review of the individual state programs reflects many details that are sometimes but not always included. The information that follows, about features of the individual state programs, represents only a sampling of the provisions in selected states; it is not based on a comprehensive review. Because all of these programs must fit within the unique context of each state's pre-existing utility rules and regulations, there are sometimes also specific features that might not be easily translated to other states. Important similarities and differences among the state programs are described here, including:

A. Consumer disclosures, education, and protection;
B. Eligible participants;
C. Participant bill credits;
D. Participant rates and terms;
E. Portability of and transfer of participation;
F. Project ownership;
G. Project siting;
H. Program evaluations;
I. REC treatment;
J. Treatment of unsubscribed energy;
K. Utility cost recovery; and,
L. Other provisions.

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[5] As noted in Table 1, the provisions in Illinois, Massachusetts, and Vermont laws refer to each state's overall NEM cap, instead of a separate cap for CS projects.

[6] Here, the word "project" is used to refer to a CS system or facility and the word "participant" is used to refer to a CS project customer; depending on program designs, participants might otherwise be called subscribers to or part-owners of a project.

Table 1: Summary of Community Solar Laws and Rules by State

State (R) means restructured	**Program maximum**	**Project maximum capacity**[*,1]	**Minimum number of participants**	**Participant maximum** (% of annual use)	**LMI provisions**	**Basis for bill credits**	**Project and participant location requirements**	**Utilities included** (V) means voluntary	**Enabling law / rule**
California[2] Enhanced Community Renewables Project	600 MW	20 MW	3	100	Utilities shall actively market to LMI customers[3]	Avoided cost of generation credit based on average generation rate	Within 10 miles, or same county[4]	IOUs	SB 43
Colorado	6 MW for first 3 years; afterwards, CO-PSC determines ceiling.	2 MW	10	120	Commission shall implement policies to encourage ownership by LMI customers	Variable retail energy minus delivery charge, integration fee, & admin. fee	Utility service territory, in the same or an adjacent county	IOUs	C.R.S. 40-2-127 / 4 CCR 723-3665
Connecticut (pilot) (R)	6 MW	2 MW	2	--	--	CT PURA shall determine billing credit based on proposals	Utility service territory	IOUs	PA 16-116
Delaware (R)	--	Both capacity limits total per meter and aggregate consumption	2	110[5]	--	Full retail rate if customers and project are on the same feeder, minus distribution charge if different feeders	Utility service territory, projects can be behind the meter	All Utilities	DE Rule 26 : 3001 § 8.1.1.1-3 and 8.7
District of Columbia (R)	--	5 MW	2	120	Developers should promote participation among LMI customers	Standard offer service rate minus distribution charge	Utility service territory	All Utilities	B20-0057
Hawaii	Utilities will propose tariffs, and program details will be decided through tariffs approved by the Hawaii PUC.							All Utilities	HRS 0269-27.4 / Docket No. 2015- 0389
* See all table notes at the end of the table.									

Table 1 (continued): Community Solar Laws and Rules by State

State (R) means restructured	**Program maximum**	**Project maximum capacity**[*,1]	**Minimum number of participants**	**Participant maximum** (% of annual use)	**LMI provisions**	**Basis for bill credits**	**Project and participant location requirements**	**Utilities included** (V) means voluntary	**Enabling law / rule**
Maine (R) (expired pilot program)	50MW	10 MW	2 minimum, maximum of 10	--	--	Commission set credit at 10¢/kWh, plus 1.5 RECs per MWh	Utility service territory	IOUs, Munis & Coops (V)	Ch. 325 / Order in Docket No. 2009-363
Maine (R)	1% of peak[6,7]	660 kW for IOUs 100 kW for muni's and co-ops	No minimum, maximum of 10	--	--	Carried over as kWh credit for 1 year, after which credit expires	Utility service territory	IOUs, Munis & Coops (V)	407c313 / Ch. 20 HP 272—LD 336
Maryland (pilot) (R)	220MW	2 MW	2	200	Developers should promote participation among LMI customers	No less than the value if applied to a subscriber's bill as a reduction in metered kWh	Utility service territory	All Utilities	§7-306.2 / COMAR 20.62, proposed rules
Massachusetts (R) Green Communities	6% of peak[8]	2 MW [10 MW]	10	--	--	Full retail rate	Utility service territory & ISO load zone	IOUs, Munis (V)	SB 2768 §138 / 220 CMR 18.00
Massachusetts (R) Neighborhood Net Metering	6% of peak[8]	10 MW	10	--	--	Energy plus transmission and transition charges, minus distribution charge	Within service Territory of 1 distribution company & ISO zone	IOUs	22 CMR 1800
Minnesota	--	1 MW	5[9]	120[10]	--	Full retail rate; VOS for Xcel after 2018.	Utility service territory	Largest IOU	MS 216B.1641
New Hampshire (R)	--	1 MW	--	--	--	--	Utility service territory	All Utilities	SB 98

* See all table notes at the end of the table.

Table 1 (continued): Community Solar Laws and Rules by State

State (R) means restructured	**Program maximum**	**Project maximum capacity**[*,1]	**Minimum number of participants**	**Participant maximum** (% of annual use)	**LMI provisions**	**Basis for bill credits**	**Project and participant location requirements**	**Utilities included** (V) means voluntary	**Enabling law / rule**
New York (R)	--	2 MW	10	100	PSC staff-led collaborative to develop means to encourage LMI participants	Phase 1: full retail rate for selected zones and 20% LMI participants	Utility service territory, with DG development zones identified by utility	All Utilities	Case 15-E-0082
Oregon[11] (R)[12]	--	--	--	100	Commission shall establish methodology for 10% of CS generation to be made available to low-income customers	Credit reflects the resource value of solar (determined by commission)	Utility service territory	--	SB 1547 / UM 1746
Rhode Island (R) Comm. Remote NEM System	30MW	10 MW	1 minimum, 50 maximum	125	LMI participants eligible for CS credits	Standard offer service charge	--	--	S 2450 Substitute B / Docket No. 4589
Rhode Island (R) Shared Solar Facility	--	--	3	100% of prior 3-year average	--	Distribution plus transition plus transmission plus standard offer supply rate	Facility and accounts must be in the same municipality	--	S 2450 Substitute B / Docket No. 4589
Rhode Island (R) Community Remote Distributed Generation System	To be set based on goals for annual RI Renewable Energy Growth Program	--	2 minimum, 50 maximum	100% of prior 3-year average	LMI "housing eligible credit recipient"	Standard offer service, plus distribution, transmission, and transition kWh charges. NEG at lower avoided-cost.	--	--	S 2450 Substitute B / Docket No. 4589

* See all table notes at the end of the table.

Table 1 (continued): Community Solar Laws and Rules by State

State (R) means restructured	**Program maximum**	**Project maximum capacity**[*,1]	**Minimum number of participants**	**Participant maximum** (% of annual use)	**LMI provisions**	**Basis for bill credits**	**Project and participant location requirements**	**Utilities included** (V) means voluntary	**Enabling law / rule**
Vermont	15% of peak	500 kW [2.2 MW]	2	--	--	Full retail rate	Utility service territory	All Utilities	H.475
Washington	0.5% of peak	75 kW or less	--	--	--	--	Utility service territory	All Utilities	HB 1301

Notes:

[1] California does not describe its program as a pilot, but the enabling legislation (PUC Code §2834) states the law is "in effect only until January 1, 2019, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2019, deletes or extends that date."

[2] Items in square brackets ("[…]") indicate a different maximum capacity standard for government-owned or military shared renewable facilities.

[3] California's law also provides for 100 MW of capacity set aside for facilities no more than 1 MW each, located in California EPA-designated "most impacted and disadvantaged communities," including "areas with socioeconomic vulnerability" (PUC Code §2833(d)).

[4] Prior to project approval, the subscribers and project must meet these criteria. Once a project is approved, subscribers and project can be anywhere within the same utility service territory. (CA-PUC Decision 15-01-051, 29 January 2015, pp. 67-69)

[5] Calculations are based on the most recent 24-months average usage in Delaware and 3-year average usage in Rhode Island.

[6] Maine's program also includes a 2MW set-aside for small systems, each less than 100kW of capacity.

[7] No single subscriber is allowed to have more than a 40% interest in a shared solar facility.

[8] These program limits refer to the state's total NEM program, which includes CS.

[9] Minnesota's program also includes a minimum subscription amount, which is 200 Watts.

[10] Any member demanding more than 25kW can not constitute more than 40% of facility output.

[11] Oregon information source: October 26, 2015 letter to state legislative committees, Re: Attributes for the design of a Community Solar Program, from Oregon Public Utility Commission. (See UM 1746 docket.)

[12] Oregon provides for choice in electric suppliers for customers with demands greater than 30kW. Smaller customers have some tariff choices, but are served by regulated monopoly service providers.

Sources: Authors' construct, using information from laws and rules as indicated in right-hand column, plus:

Durkay, Jocelyn. (2014). "Net Metering: Policy Overview and State Legislative Updates" [Electronic Article], *National Conference of State Legislatures,* 18 Dec 2014. http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx

Shared Renewables HQ. (2016). *Community Energy Projects* [Web Page, retrieved 6 June 2016]. http://www.sharedrenewables.org/community-energy-projects/

A. Consumer disclosures, education, and protection

Some states are already making provisions for consumer disclosures, education, and protection. They include Connecticut (PA15-113(6)(c)), DC, Maryland (§7–306.2(e)), and Minnesota (216B.1641(e)(5)). In Maryland, consumer protection policies are included in the proposed Commission rules; among other things, those rules cover advertising, consumer disclosures, prohibitions against discrimination, minimum contract requirements, and dispute resolution (COMAR 20.62.05).

In Connecticut, the Department of Energy and Environmental Protection (CT-DEEP)[7] is assigned with developing "consumer protections for subscribers and potential subscribers… including, but not limited to, disclosures to be made when [project developers are] selling or reselling a subscription." (CT Public Act No. 15-113 §(6)(c)).

The Minnesota Commission is initiating consumer protections, including provisions for standard contracts that will include a statement about disclosures from CS operators (17 September 2014 Order in Docket E-001/M-13-867, pg. 16-17). Minnesota's consumer education effort is already well underway (CERTS 2016a).

In Maryland, the PSC staff is working with a Net Metering Working Group including utility representatives, to develop a model utility tariff and CS participant contract form. The PSC is also preparing a web page to provide information for both consumers and project developers.[8]

These consumer information efforts are particularly important because at least some of the targeted consumers could have a difficult time weighing the different solar-investing options that are available to them (Alexander and Briesemeister 2016, pp. 12-16; SEIA 2016). And, CS programs sponsored by utilities imply an imprimatur from the state utility regulatory authority: Customers considering participation are likely to assume, correctly or not, that the deal they are offered has been considered by the regulatory authority and found fair enough to be authorized. Equally important, the IRS treats net metering credits as a simple exchange of energy, not taxable income (see pp. 8-9). But, that means each utility customer has a limited opportunity and perhaps few available choices for participating in a CS project that will convey that important benefit. Consumer education and consumer protection policies can go a long way towards helping to ensure that participants have access to all of the facts they need in order to make an informed decision.

Commissions might consider whether existing state consumer protection provisions are sufficient, especially for contracts between consumers and third-party developers, or whether any additional rules or regulations are needed, perhaps especially for those projects where a regulated utility company plays a major role. Alexander and Briesemeister (2016, pp. 4-5, 26-36) recommend oversight by a state agency combined with requirements for "key disclosures, fair contract terms, and… penalties for violating state laws and regulations." A recent Federal Trade

[7] The Connecticut Public Utilities Regulatory Authority (PURA) is housed within DEEP, but many of the legislative assignments for the pilot program are to the Department itself.

[8] Personal communications with Tori Leonard, Maryland PSC Staff, 18 July 2016.

Commission workshop highlights some of the many contentious issues and divergent opinions involved (Maloney 2016b).

B. Eligible participants

Many of the state laws explicitly refer to the idea of extending the benefits of NEM to customers who could not otherwise participate, such as renters, homeowners with shaded roofs, and so forth.

California seeks to expand access to renewable resources "to all ratepayers who are currently unable to access the benefits of onsite generation" (PUC Code §2831b). California's legislature notes the difficulties that "many large energy users" have in meeting renewable energy goals because of "rooftop or land space limitations, or size limits on net energy metering" (PUC Code §2831(f)). The District of Columbia program goals include enabling CS service for "renters and low- to moderate-income retail electric customers…while prioritizing those persons most sensitive to market barriers (B20-0057§101a (3)). The New York PSC says one objective of its program "is to open participation in renewable energy to those previously foreclosed to entry" (17 July 2015 Order in Case No. 15-E-0082, p. 2).

In addition, Delaware and Massachusetts define what it means for customers to have a "community" affiliation. Delaware states that participating customers must "shar[e] a unique set of interests" (Title 26 3001: 8.7.1). And, Massachusetts describes one of its programs as "neighborhood net metering," defining the idea of "neighborhood," which "is recognized by the residents as including a unique community of interests" (220 CMR 18.00, Appendix B).

Some restructured states are restricting participation to customers receiving standard offer service (SOS). Those include New Hampshire, where a "group host" facility can be a CS project location, with the host customer served behind the meter. In that situation, the law says the participating customers "shall be default service customers of the same electric distribution utility as the host" (RSA 362-A:9.XIV(a)).

In the District of Columbia participating customers can be served by either the SOS supplier or a competitive provider (DC Law 20-47(b)(4) and DC Code §34–1518(m)). And, Maryland's program is also open, so that participation in any CS project can include both standard offer customers and customers of electricity suppliers (§7–306.2.(d)(3)).

Some of the state laws, as indicated in Table 1, also have specific goals for including low- and moderate-income (LMI) consumers in CS projects. For example, Colorado's legislation directs:

> Each qualifying retail utility shall set forth in its plan for acquisition of renewable resources a proposal for including low-income customers as subscribers to a community solar garden. The utility may give preference to community solar gardens that have low-income subscribers. (C.R.S. 40-2-127(5)(e)).

Another kind of provision regarding participation is found in multiple states that cap either minimums or maximums of the amount of any one project that can be dedicated to a single customer. Some of these criteria are included in Table 1. In Colorado minimum subscriptions are set at 1kW of capacity and no subscriber can own more than a 40 percent share (C.R.S. 40-2-127(2), 4 CCR 723-3665(a)(1)(A)).

C. Participant bill credits

The essence of a CS offering to participants is captured by this topic and the following one. This topic covers how much credit is offered to participating customers and how the credits are calculated, and the following topic covers how much it costs for customers to become and remain participants.

Bill credits for CS production are not necessarily the same as credits for customer on-site generation participating in NEM. Some observers might assume that NEM customers always receive a full retail cost credit for each kWh produced and used on-site and for surplus energy exported to the grid, called net excess generation (NEG): That is not always the case for individual on-site NEM and the same is true for CS programs. In reviewing bill credit mechanisms, care should be taken to ascertain whether the credits are the same for CS production which displaces monthly usage, as opposed to credits for NEG. It is common for net metering programs to distinguish between the two, often with credit based on the retail rate or retail rate minus certain specific charges until solar production equals billing period usage, and then credit for billing period NEG at a lower rate. Another important variation can be whether NEG credits are simply carried over from month to month, or if customers are entitled to payment for NEG either on a monthly or annual basis or sometimes when NEG exceeds some minimum threshold level (Proudlove, Daniel, et al. 2016, pp. 13-14; Stanton and Phelan 2013).

Examples of states that are providing lower bill credits for CS participants, as compared to customers with on-site NEM, include Colorado and Massachusetts. In Colorado, the credit is defined as the on-site NEM credit,

> …minus a reasonable charge as determined by the commission to cover the utility's costs of delivering to the subscriber's premises the electricity generated by the community solar garden, integrating the solar generation with the utility's system, and administering the community solar garden's contracts and net metering credits (CRS 40-2-127(5)(b)(II)).

Some states have also pegged CS bill credits to the rates charged for standard offer service. Those include the District of Columbia (§ 34–1518(j)).

In Colorado, excess generation credits roll forward indefinitely until the customer terminates service from the utility, at which point the utility will absorb any remaining credits (3 CRR 723-3665(c)(III)). In Massachusetts, CS customers will receive nearly the full retail rate for all measured usage during each billing period. If there is excess generation, customers will receive a lower “market net metering credit” equal to about 60 percent of the retail rate, calculated as the default service charge, plus variable T&D charges (220 CMR 18.04(1)(b)).

In Rhode Island, credits for NEG will be at an avoided cost rate that is defined as the rate for standard offer service, differentiated both by rate class and by time of use (39-26.4-2(7)).

California sets bill credits equal to the retail class average generation cost, as reflected in the utility's tariff, plus an adjustment based on the time of delivery profile of both the renewable generator and the customer class receiving the generation (§2831(k)). Delaware's program is a variation of NEM service, with bill credits generally based on supply service charges, with some differences based on whether the participant is on the same or a different distribution feeder as the generator, and further differences depending on whether there is a host facility that uses CS energy behind its meter, or if the host is a stand-alone generator (Title 26 3001: 8.4–8.5). Minnesota directs the PUC to approve bill credits (216B.1641(g)). The Minnesota PUC issued a July 21, 2016 Order in Case No. E002/M-13-867, directing Xcel Energy to provide credits based on the state's value of solar calculation, for CS projects entering operations after 2018.

D. Participant subscription or investment rates and terms

The subscription or investment rate is what a participant pays in order to become entitled to a share of a community solar project. Sometimes this comes in the form of an outright purchase of a solar panel, so many dollars for a panel with nameplate rating of so many Watts. For example a typical offering might be for customers to buy one 300W panel for $1,000 ($3.33 per Watt). In other cases, the offer could be for participants to purchase or lease a percentage share of output.

Consumer survey work for the Smart Electric Power Alliance (Szaro 2016) finds most customers interested in CS participation favor a lease term on the order of 5-10 years, as opposed to longer. Many utility programs, however, have been designed with a term of 20 to 25 years, based generally on the warranty periods that manufacturers offer for their PV panels or integrated DPV systems.

There are many variations on the project design details and whether the participants are leasing or owning their share of the project. What is most important is the amount of cash needed to participate. If financing terms are provided then the important questions are whether on-bill financing is available, the interest rate being charged, and the relationship between monthly payments and expected monthly credits. Low- and moderate-income customers, in particular, might find it impossible to come up with a lump-sum payment to purchase a share outright, but if financing terms are reasonable and monthly bill savings are expected to offset payments, that could enable LMI customer participation.

State-regulated programs under the laws reviewed for Table 1 typically leave it to markets to establish these terms. Some require competitive bidding procedures to select CS projects for development. The Colorado legislation directs the PUC to adopt rules to "facilitate the financing of subscriber-owned community solar gardens" and "encourage… community solar gardens with attributes that the commission finds result in lower overall total costs for the qualifying retail utility's customers" (C.R.S. 40-2-127(3)). But, at the same time, Colorado rules make clear that the PUC does not regulate the "prices paid for subscriptions" (3 CRR 723-3665(a)(II)(F)).

E. Portability and transfer of participation

CS participants are generally willing to make a fairly long-term commitment to a project, but it helps greatly if rules are in place to govern how benefits can be reassigned from one utility account to another, in the event that a participant moves from one location to another within the area eligible for participation in the same CS project, which is most often defined as within the service territory of the same utility. And, for those customers that might move outside of the area, provisions for transferring their ownership or subscription without penalty are also important.

Portability and transferability are included in the CS programs in District of Columbia (B20-0057§101a (3)(B)), Colorado (C.R.S. 40-2-127(1)), and Maryland (COMAR 20.62.05.09).

F. Project ownership

Another important consideration is whether utility companies will be acting as project owners and operators, or whether those functions will be assumed by third party developers. This question and the appropriate CS program roles for utilities and third parties is being explored in many jurisdictions (Shallenberger 2016). Some jurisdictions, including Colorado, Minnesota, and Oregon, appear to allow participation by both utilities and third-parties.[9] In those cases, protections could be necessary to make sure that competition does not unfairly advantage any particular providers.

CS project ownership decisions are likely to be different for states with vertically integrated monopoly utilities than for states with restructured utilities that are wires-only companies, having divested their previously-owned power generation assets. Utility ownership would appear more likely in states with vertically integrated utilities.

At least some of the restructured states restrict or prohibit utility ownership of distributed generation assets, and there it could be necessary to examine the appropriate roles for both utilities and competitive service providers. California is a relevant example, where California utilities will use Commission-approved procurement mechanisms for CS projects (PUC Code §2833(c)). California's law directs the PUC to require that regulated utilities administer an approved green tariff shared renewables program, but also notes that community choice aggregators are not prohibited from offering their own voluntary renewable energy programs (PUC Code §2833(a) and §2833(w)).

G. Project siting

Project siting in many states is a joint responsibility of state and local units of government. As indicated in Table 1, most of the state programs require the projects and participating customers to be in the same utility service territory and a few states have additional provisions, including California, Colorado, Delaware, Massachusetts, and Rhode Island. Not all

[9] Personal communications with Charlie Coggeshall of Clean Energy Collective, 29 July 2016.

of the enabling laws or rules include additional siting requirements, but a few that do vary widely in the content of their siting requirements.

California states that projects should be both "located in reasonable proximity to enrolled participants" (§2833(e)) and describes as an objective to "facilitate projects located close to the source of demand" (§2833(o)).

Maryland's program directs electric companies to "make reasonable attempts to assist pilot program applicants with identifying means to locate and operate community energy generation facilities in a manner that minimizes adverse effects or maximizes distribution system benefits at locations identified by applicants" (COMAR *20.62.04.02*).

New York is engaging in a concerted effort to support siting where the projects will be most beneficial to the utility grid. NY-PSC is directing the state's regulated utilities to identify "Community Distributed Generation Opportunity Zones," encompassing at least 40 percent of each utility's service territory, and publish the maps in GIS format. This project will combine promising locations for distributed generation that are being identified for various New York programs including NY Prize, NY Sun, and REV proceedings. Presumably, the maps will help project developers in their prospecting for good sites. The Commission's stated objective for the mapping exercise is "achieving a more precise articulation of the full value of the benefits of DER… a solid foundation from which to adopt a more precise method of valuing benefits and costs to the distribution system, including locational benefits." (17 July 2015 Order in Case No. 15-E-0082, p. 24).

H. Program evaluations

A few of the states make provisions for program evaluations. These include Connecticut and Maryland for their pilot programs, and Maine, New York, and Rhode Island where programs are not described as pilots.

Connecticut terms its effort a two-year pilot program, which falls under the auspices of CT-DEEP. The Connecticut law requires CT-DEEP to file a report with the General Assembly (CT Public Act No. 15-113 §(6)(e)):

> (1) analyzing the success of the shared clean energy pilot program, (2) identifying and analyzing the success of programs in other states that allow facilities similar to a shared clean energy facility, and (3) recommending whether a permanent program should be established in this state and, if so, any necessary legislation.

Maryland's pilot program rules include provisions for data to be collected and reported to the Commission by both electric companies and CS companies. Included will be a named contact person at the electric company, from whom the relevant information can be obtained. The data includes pilot subscriber data, including information about household income, credit rating, and CS project design details. "Commission Staff shall report annually on electric companies' billing accuracy, interconnection complaints, and consumer complaints related to the program." (COMAR 20.62.04).

The Rhode Island PUC is directed to "conduct a study examining the cost to all customers of the inclusion of the distribution charge as a part of the net-metering calculation" by mid-2019 (39-26.4-3 (a)(1)(ii)).

I. REC treatment

A few of the state laws include provisions about the treatment of renewable energy certificates (RECs). At the heart of the issue about appropriate REC treatment for CS is whether CS should always be in addition to, or could be included as part of, a utility's obligations under a state mandatory renewable portfolio standard and any applicable distributed generation or solar energy carve-out. Some observers advocate for CS to be additional, based on two main ideas, that: (1) the participating customers wish to procure a larger percentage or all of their usage from the solar generator; and (2) mandatory requirements should be fulfilled by generation that is funded by all ratepayers (Romankiewicz 2016).

Either way, the value of RECs should be considered when analyzing the costs and benefits of CS installations. From a customer protection standpoint, disclosure requirements can ensure that REC ownership is clearly explained in marketing materials and participation forms.

In California, utilities will retire RECs "utilized by a participating customer" on behalf of the participating customers, and any "not utilized" RECs can be counted towards the utility's RPS requirement (PUC Code §2833(r)). Colorado enables contracts for the utility to purchase RECs from CS projects, at which point the utility and solar garden owner "shall agree" whether each subscriber receives REC compensation on their bill or if REC compensation goes to the owner (3 CRR 723-3665(c)(IV)). In both Delaware (Title 26 3001: 8.7.11) and DC (B20-0057§118b(5)(D)), the RECs are retained by system owners or subscriber organizations, unless they are transferred contractually.

J. Treatment of unsubscribed energy

Some of the state laws include provisions about unsubscribed energy; this is energy produced by a CS generator but not allocated to a participating customer. Unsubscribed energy could be produced when a project is still in its start-up phases and initial subscribers are being sought, or in any billing period when one or more customers might have relinquished their subscription due to a move or because their financial circumstances changed. The general purpose for unsubscribed energy provisions is to prevent any project costs from accruing to non-participating customers, while also making sure that project operators have an incentive to keep subscriptions full. Therefore, unsubscribed energy, if any, is usually credited to a CS project owner at a lower, avoided cost rate.

Colorado directs utilities to purchase unsubscribed energy at the "retail utility's average hourly incremental cost of electricity supply over the immediately preceding calendar year" (C.R.S. 40-2-127(5)(d)).

The DC law says (§ 34-1518.01 (h)(i)):

> If the electrical capacity of a community renewable energy facility is not fully subscribed, the SOS administrator shall purchase the energy associated with the unsubscribed capacity at the PJM Locational Marginal Price for the PEPCO zone, adjusted for ancillary service charges.

Maryland's law will treat unsubscribed energy as a purchase from a PURPA qualifying facility (QF) (§7–306.2.(d)(7)). Oregon's law directs purchasing utilities to apply the value of unsubscribed energy "in support of low-income residential customers" (SB1547B, §22(5)(b)).

K. Utility cost recovery

An important factor to be addressed in CS programs is cost recovery for utility expenses incurred. This means billing system reprogramming costs for tracking CS customers and calculating and presenting their bill credits, but it can also mean any costs associated with interconnections, with utility development of CS facilities if that is the case, with CS facility O&M, and with any incremental operating costs incurred to manage the variability of solar output. Unless the laws or rules state otherwise, Commissions will have to determine which if any costs will benefit and thus will be collected from all ratepayers and which will be assigned only to the participating customers. A long-term view could identify at least some specific utility expenditures for systems and functions that can serve multiple needs, in addition to CS, in which case it would be fair to collect costs from all ratepayers.

California's law states:

> A participating utility shall track and account for all revenues and costs to ensure that the utility recovers the actual costs of the utility's green tariff shared renewables program and that all costs and revenues are fully transparent and auditable (PUC Code §2833(q)).

Colorado's law explicitly directs the PUC to "ensure that this charge does not reflect costs that are already recovered by the utility from the subscriber through other charges" (C.R.S. 40-2-127(5)(b)(II)).

In the District of Columbia, the enabling legislation says that electric companies can seek cost recovery in a base rate case, but it also states, "Any recovery of the net costs by the electric company approved by the Commission shall occur solely through a rate assessment of the subscribers" (B20-0057§122).

New York PSC states:

> Since Community DG is initially structured under a net metering paradigm, insofar as utilities and Community DG project sponsors interact, the program does not raise implementation cost issues at this time that distinguish it from other forms of net metering sufficient to justify singling it out for fees and charges not imposed on other participants in net metering. Consequently, the utilities shall initially implement

> Community DG as a form of net metering in conformance with existing net metering policies… (17 July 2015 Order in Case No. 15-E-0082, p. 27).

L. Other provisions

A couple of other miscellaneous provisions are noteworthy because they reflect on other specific issues that will eventually need the attention of interested parties. One is from Delaware, where the law explicitly states that a utility can require all of a CS project's participants to have their meters read on the same billing cycle (Title 26 3001: 8.7.9). That seems like a practical idea: It is complicated enough to think about measuring the output of a solar generator, converting the energy production into dollars at a prescribed rate, and then dividing it into proportional shares for bill credits for large numbers of customers. Though it might not be impossible to perform such a calculation accurately with different billing cycles for different participants, it would surely add to the complexity.

Rhode Island's law lists some criteria to be considered in adopting "appropriate and reasonable" property tax rates (H 8354 Substitute A, pp. 32-34). This applies not only to CS properties, but more generally to all renewable energy facilities. The law states that renewable energy resources and associated equipment will be taxed in accordance with rules to be established by the state's office of energy resources, in consultation with the division of taxation. It says, "The rules will provide consistent and foreseeable tax treatment of renewable energy to facilitate and promote installation of grid-connected generation of renewable energy… ." And the law lists criteria to be considered in developing those rules, including $5.00 per kilowatt of nameplate capacity as one benchmark for consideration.

These two legislative criteria are noteworthy not so much because of their specific content, but because they highlight just how complex some of the issues are that CS inevitably raises. In Delaware's case, it shows a complexity in integrating CS into pre-existing utility operations. And, in Rhode Island's case, it shows complexity in solar energy markets and solar project business models (see Stanton and Phelan 2013, pp. 33-35).

In addition, interconnection rules, standards, and practices play a major role in CS programs, even though they are more generally applicable to all small generators, not only CS. Experience in Minnesota and New York, for example, shows that interconnection queues can be overwhelmed if utility companies are not fully prepared for what can be a major influx of CS proposals (Key, Rogers, et al. 2015; Trabish 2015a).

V. Regulatory Considerations

A. Introduction

CS programs are in the early stages of implementation. As Part II explains, not far from half of all the states have already taken action to enable CS projects, at least on a pilot-program basis. And, many other states are enabling CS as a result of both state-regulated and non-state-regulated utility company applications. Where legislation provides a framework, state commissions are typically charged with rulemaking responsibilities and must flesh out many details. This creates a situation where all interested parties can watch and learn from the progress in different jurisdictions. What follows here are some general, preliminary ideas for regulatory consideration. The discussion is divided into five main topics:

1. Regulating CS to simulate competitive markets;
2. Deciding about cost allocation and recovery for CS;
3. Expanding the value of CS;
4. Enabling CS as a gateway to all cost-effective DER; and
5. Evaluating CS programs and projects, and making progressive changes based on those evaluations.

B. Regulating CS to simulate competitive markets

One of the long-standing, broad concepts that applies to the economic regulation of monopolies is that the regulation can create a second-best situation, where the best outcome is thought to result from fully competitive markets but in the absence of such markets the regulator emulates the function of a competitive market by limiting the potential for the exercise of monopoly power (Nilleson and Pollitt 2008).

Of course, some CS markets are already more competitive than others. For example, as reviewed in Part II, state government agencies are conducting requests for proposals to select projects in Connecticut. And, in Minnesota, multiple local governments have combined efforts to seek competitive bids (Schaffer 2016). Projects in those states can provide benchmarks, against which monopoly utility programs can be compared, in a form of what is called yardstick regulation (Primeaux 1986, pp. 42-48). Even though the various state programs differ from one another in many respects, some could be similar enough to provide at least a general point of comparison for identifying major differences between offerings (see Speiser 2013). And, investments in solar projects outside of the realm of community solar can also provide something of a benchmark (e.g., SolarCity 2016; Stoker 2016). It could be possible to benchmark projects even within a state, comparing CS projects to other DPV applications, and if the CS programs allow it, directly comparing utility and competitive supplier CS projects. It could also prove helpful to benchmark regulated utility offerings compared to non-state-regulated municipal or cooperative utility offerings.

If a project will not prove fully cost-effective because its costs outweigh its benefits to participants, then participation would be limited to only the small percentage of customers who have both the financial means and the philosophical predisposition to be solar supporters. The idea that small numbers of innovators and early adopters might be willing to support solar energy even though it is not really cost-effective has been prevalent since the earliest days of solar power. That reality could be starting to fade into obscurity, though, as solar equipment performance and cost effectiveness continues to improve. Now, at least many areas of the country are reaching the point where CS can be cost-effective, as long as projects are well-designed and excessive program costs are not added on.[10]

There have already been multiple efforts to identify standards that could apply to CS programs (Chwastyk and Sterling 2015; IREC and Vote Solar 2013). And, another effort is presently underway, on the part of a group of CS trade allies.[11] The main points of comparison among customer offerings might boil down essentially to monthly or annual customer cost savings, simple payback period, and return on investment: In a competitive market, theory holds that consumers would lean towards CS projects offering the best combinations of low cost and high returns. In part, the market response to offerings can serve as a barometer of success. That could be particularly true for projects that have specific goals for LMI customer participation.

Regulating to simulate competition will require a long-term perspective, tied closely to the lessons that can be learned from ongoing program and project evaluations. The essence of the task at hand will be to keep a close eye on progress in mid-size solar projects, watching for those projects that achieve something like best-in-class performance in maximizing value and minimizing costs.

C. Community solar cost allocation and utility cost recovery

At first glance, it seems axiomatic that costs associated with CS are being caused by the CS programs' participating customers, and thus should be assigned to and collected from those customers, with none being assigned to non-participants. As discussed in Part II.K, some state laws explicitly state that all costs associated with CS should be recovered only from participants; however, commissions could determine that certain costs are incurred for the benefit of all customers. One example might be changes to a utility billing system that can accommodate multiple kinds of on-bill financing and bill credit mechanisms, not only CS. And, utility advertising, marketing, and customer acquisition costs warrant review to ensure that utility spending is not excessive, and expenditures serving functions such as building and maintaining brand identity and community good-will can be separated from those that serve narrower functions exclusively for the support of the CS program and projects.

Overall, a paramount utility company concern is to make certain that its costs will be recoverable (Satchwell, Mills, and Barbose 2015). For a CS project, costs will be associated with at least: (a) the solar installation itself, including operations and maintenance; (b) costs for advertising, marketing, and customer acquisition; and (c) accounting, calculating and managing

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[10] Cost effectiveness can be predicated on local, state, and federal actions to promote solar energy, including subsidies if any. Typical examples include tax credits or exemptions, grant and loan programs, and the like. See Stanton and Phelan 2013 and Stanton et al. 2014.

[11] Personal communications with Laurel Passera of the Coalition for Community Solar Access Policy Team, 18 July 2016. http://www.communitysolaraccess.org/

bill credits, and managing any customer turnover, with the possibility of reduced revenues because there could be a portion of unsubscribed energy production from month to month. Plus, costs might be incurred for data collection and analysis and program and project evaluation. And, a utility, conceivably, could incur added costs needed to manage the variable output of solar energy being delivered to its grid.

Depending on the ownership structure and the roles of utilities as opposed to project developers, some of those costs will accrue to each entity and only some will be utility costs. A common design has utility roles in administrating a CS program, while developers build and manage CS projects. Regulatory commissions will most often make determinations about cost-recovery for program costs, while project costs will be accounted for either by additions to subscriber charges or subtractions from bill credits.

These are not new issues for the regulatory community. They are regularly raised in the context of other utility activities, such as energy efficiency and green pricing programs. They do deserve attention, though, and it could be helpful to address them sooner rather than later, as CS programs grow and as the offerings to specific customer segments might begin to proliferate, as some observers expect, perhaps starting soon with electric vehicles incorporating vehicle-to-grid capabilities and other forms of energy storage (Deign 2016; Dennis 2016; Frader-Thompson 2016; Huffaker and Powers 2016).

In addition, because many of the CS programs are presently tied to state NEM programs, all stakeholders should be thinking about what happens as more states make major changes to or create replacements for their current NEM programs. As described in a previous NRRI report (Stanton 2015), those discussions have started in many states already. In that context, it will be helpful to model how proposed changes might affect both the cost-effectiveness of different kinds of distributed generation and utility cost recovery. Already, multiple researchers are exploring how CS programs can be designed to bypass at least some of the rate design challenges that are causing so much concern with current NEM approaches (Campbell and Mahrer 2016; Chapman 2016; EQ Research Staff 2016; Flores-Espino 2015; Perez, Rabago, et al. 2016; Pyper 2016a; Revesz and Unel 2016; Satchwell, Mills, and Barbose 2015; Woolf, Whited, et al. 2014).

D. Expanding the value of community solar

Simply stated, it is possible that carefully planned and implemented CS projects could provide grid and societal benefits far in excess of the energy value ascribed to participating customers. This is a key benefit of CS, that projects can be developed and operated so that they deliver important system benefits. Capturing and monetizing those benefits, however, will require concerted efforts on the part of utilities and project developers, and could eventually also engage CS participants themselves. Regulators can try to ensure that as many of these benefits as practical are produced.

The Rocky Mountain Institute review of over a dozen different solar value studies shows that the energy value alone averages from about 75 percent to as little as 25 percent of the total value analyzed (RMI 2013, p. 22). And, those studies represent utility system averages: Even more benefits can be achieved if distributed photovoltaics (DPV) siting and operations are designed to maximize system value. The Community Solar Value Project (2016) and SolarGrid Engineering (2016) represent early efforts to identify the potential sources of value and develop methods for achieving them. For example, if geo-targeting is used to site DPV where it can help reinforce the existing grid, DPV can play an important role in developing non-transmission and non-distribution alternatives (Stanton 2015b and 2015c). Advanced inverters and control systems can facilitate DPV for delivering valuable ancillary services (Reiter, Ardani, et al. 2015). Other important ideas for increasing the value of DPV include integrating CS with demand-response, energy efficiency offerings, energy storage, and public purpose microgrids (Community Solar Value Project 2016; Powers and Huffaker 2016; Stanton 2012). Coordinating CS with energy efficiency in participants' homes and businesses could be especially helpful for promoting LMI participation and could even become a criteria for participation, similar to how some jurisdictions have combined energy efficiency services with utility financial assistance.

Other potential sources of value could come from siting DPV systems on brownfield sites and at publicly owned facilities (US-EPA 2016b). There are also a range of potential benefits that can be developed in the design and layout of DPV systems. For example, one of the first CS projects in Wisconsin hosts a herd of goats to assist with vegetation control and an early CS projects in Minnesota is being designed, with input from the Minnesota Department of Natural Resources, to provide healthy habitat for pollinator species, effectively channel surface water into the aquifer, build topsoil and reduce erosion (McDonald 2016; Styx 2016).

Modeling and planning for DPV should incorporate such locational and operational values. There has been much recent progress in computer modeling techniques, including geographic information systems fully integrated with power flow models that can be used for this purpose (Stanton 2016a and 2015c). However, all parties need to recognize that at the outset the distribution utility company is the only entity that has access to much of the data required to complete these kinds of analysis. Two New York examples highlight the kind of disclosures that can be considered, for facilitating CS applications designed to produce important system benefits. One example is the NY PSC order directing utilities to publish service territory maps indicating specific areas most amenable to CS applications (17 July 2015 Order in Case No. 15-E-0082, p. 24), and another is the announcement from New York State Electric & Gas Company, seeking proposals for DER alternatives for the area served by a particular substation (NYSEG 2016).

E. Community solar as a gateway to all cost-effective DER

Customers have long demonstrated a willingness to invest in products and services that bring them value and produce utility system benefits. Any product or service that passes both a utility cost test and participant cost test might attract customer support (Woolf, Whited, et al. 2014). And, proven financing mechanisms such as property-assessed clean energy (PACE) and pay as you save (PAYS®) are making it easier for customers to access the resources necessary to participate (Stanton 2016b).

As the regulatory community learns how best to implement CS, those lessons can readily be applied to many emerging options that can be thought of as companion planting options, which will provide both system and customer benefits. CS is proving sufficiently attractive to enough customers that it is producing a major market pull, but CS is not the only option available that might prove capable of attracting financial support from growing numbers of customers. Other examples that are immediately ready for deployment in at least some locations in some markets include automated demand-response and load control, energy storage, and small combined heat and power systems. Market research about CS participants will help all interested parties to understand customer motivations and preferences for DER products and services (for example, Shelton Group 2016).

With so much of the existing public utility infrastructure ripe for modernization and replacement in the near future, now is the time to develop the tools and techniques needed to engage customers and communities in ways that will encourage customers to rapidly adopt more and more innovations (Brehm, Bronski, et al. 2016; Braun and Hazelroth 2015; Huffaker and Powers 2016). Many visions for the future of electric utilities anticipate widely expanding DER, notably DPV. As Welton points out (2016, pp. 11-14), comprehensive revisions of utility business models and associated regulations are being contemplated in California, Hawaii, Maryland, Massachusetts, Minnesota, and New York. CS is just one of the ways that customers might become more active participants or even partners in shaping the utility of the future.

As the future roles of utilities, customers, and third-party service providers are being considered, CS could be viewed as an important first step, a special opportunity for learning valuable lessons. Attention will be needed in each jurisdiction to reconcile the appropriate roles for customers, utilities, and third party developers, so it is helpful that CS is bringing these issues to the fore. A major objective could be to explore all of the opportunities where customer needs and wants are poised to support utility system needs, and then develop the capabilities to facilitate those investments using minimum funding from non-participating customers and making it as attractive as practical for investments by participating customers.

F. Evaluating community solar

There is still much to learn about how best to implement CS in order to maximize the value for all participants. A variety of potential concerns with early CS programs have already been identified (Chapman 2016; Enger 2016). Klein and Grego (2016) are working on an open source platform to identify potential criteria for comparing CS projects, and have already identified a few dozen parameters that could be considered by program evaluators.[12] And, multiple efforts are underway to identify best-practices and evaluation protocols for solar, generally, or for CS in particular (Keyes and Rabago 2013; IREC 2016a; IREC and Vote Solar 2013; ME-PUC 2016; Strategen Consulting 2016; Woolf, Whited et al. 2014). In addition, 15 states are engaged in proceedings now to examine the value of DPV and consider updates or replacements for NEM (Proudlove, Daniel, et al. 2016, pp. 25-28).

As CS programs are initiated in more and more jurisdictions, concerted evaluation efforts are warranted. There is a need for multiple case studies that include detailed benefit-cost analyses, comparing projects to determine best practices. Policy makers might look for opportunities to encourage flexibility in early program efforts, including the possibility of

[12] Personal communications with Prof. Sharon Klein, University of Maine, and Vito Grego, Elevate Energy, 12 May 2016.

true-up mechanisms to ensure that the early-adopter participants are not disadvantaged by projects with bill credits based on overly conservative estimates of CS production value.

As discussed in Part II, several states are preparing for high level reviews of CS programs. One of the goals expressed by the Oregon PUC is that CS "[p]rograms should allow for adaptations as we gain experience" (26 October 2015 letter from OR-PUC to Legislature, in Docket UM 1746, p. 2). Oregon PUC is particularly focusing is review on:

1. Total program benefits minus costs;
2. Share of total benefits accruing to participating customers;
3. Participation by low and middle income consumers;
4. Flexibility for customer participation; and
5. Subsidies and cross subsidies.

The experience with regulated customer-facing, ratepayer funded energy efficiency programs provides a template: Parties have regularly worked together to achieve continuous improvements in program cost-effectiveness and outcomes, through long-standing evaluation protocols, independent program evaluators, and modest ratepayer expenditures on program evaluations. Early CS programs can be designed with evaluation in mind, making sure that plans are in place to collect, analyze, and report relevant information so that best-practices can be developed and spread rapidly.

G. Recommendations for future research

Here are some preliminary ideas about how future research into CS might provide additional insights and help all interested parties as CS moves forward. In a nutshell, the future research recommendations are to work on:

1. Understanding and then reducing or removing non-regulatory barriers to CS;
2. Standardizing CS offerings;
3. Exploring how customers might be fully engaged to act as partners in utility infrastructure development; and,
4. Identifying strategies for all interested parties to best manage a transition to a utility sector that will employ many more DER.

These ideas are focused on CS, but also apply more generally to all DER. What follows is a brief discussion of each of the four ideas.

1. Understanding and then reducing or removing non-regulatory barriers to CS

The U.S. Department of Energy's SunShot Initiative has been instrumental in highlighting the wide variety of so-called "soft costs" that add to the installed cost of solar and thereby slow market acceptance (US-DOE 2016e). The SunShot Initiative has been working to reduce soft-costs, funding a variety of projects since 2009. As some CS advocates have discovered, utility cooperation and CS standard practices are just one of many hurdles that need to be cleared if CS projects are going to develop rapidly to meet their full market potential. In addition to the utility regulatory issues, there are many issues that need to be considered in order to create and maintain what some refer to as "solar ready communities." Issues need to be addressed such as compliance for building, electrical, and fire safety codes, insurance company treatment, local siting and zoning issues, and tax treatment at all levels of government. Solar developers cannot lose sight of how important these concerns can be: Together such soft costs can easily account for half of the total cost involved with any given solar installation, and up to nearly 2/3 for small, home-scale systems.

A good start has already been established through a series of reports from a U.S. Department of Energy series called *On the Path to Sunshot* (US-DOE 2016d). Along with reports about utility operational issues, regulatory and business model reforms, that series already includes research about solar technical advances, possible manufacturing improvements, and opportunities and challenges in financing.

The point is not that all of the important problems have been completely addressed and issues solved. Rather, it is not to lose sight of the fact that making DPV and other DER fully cost-effective in more and more applications necessitates actions well beyond those that can be accomplished solely by utilities and their regulators.

2. Standardizing CS offerings

Feldman, Brockway et al. (2015) propose standardizing CS program designs in order to ensure consistent treatment by way of securities regulations and to clarify the enabling laws and rules that are needed to support CS. With the newly adopted federal rules for non-accredited investors, that kind of standardizing could smooth the path towards larger markets and lower soft costs for CS. Research about standardizing could also focus on how to combine CS with other DER, to maximize the value of the solar contribution. In addition, White (2015) and Revesz and Unel (2016) both consider a CS project design based on the sales under federal Public Utilities Regulatory Policy Act (PURPA) rules. If a workable project design can be developed that fits within the context of PURPA rules, that option might open more CS project opportunities and could be expandable to other PURPA qualifying facilities.

Having said that, however, it is important to recognize the healthy tension between innovations in program designs and standardization. More research is needed to determine which aspects of program design and rules are most amendable to standardization, and which should remain open to competition that can lead to the most beneficial approaches.

3. Exploring how customers might be fully engaged to act as partners in utility infrastructure development

Frader-Thompson (2016) asks, "What if [utilities] could incentivize customers to adopt DERs that provide valuable grid services, which would in turn create a reason for utilities to embrace these technologies?" He explains:

> Historically, utilities have seen such resources as a threat to their economic relationship with customers. But they should instead approach consumer adoption of DERs as a

> critical opportunity to partner with their customers to create shared value, leveraging customer resources to improve system reliability. … Customer-installed DERs — such as connected thermostats, smart inverters, electric vehicles, water heaters, and stationary batteries − allow utilities to reap the benefits of distributed energy technologies at a fraction of the cost of assets they might install themselves.

Interested parties will all benefit from more and better insights into customers and customer needs and desires. The utility industry historically, by and large, treated all customers as belonging to one of three major classifications, residential, commercial, and industrial. There has been little segmentation beyond some attention to large and small users in each class, and low-income customers' treatment as a special subgroup. Much, much more needs to be learned: Focusing on greater customer segmentation and increasing customer choices. Research is progressing now, but a great deal more needs to be learned about consumer education, motivations, and preferences. As one consumer research group puts it, there is a need for "high-definition detail" in understanding consumers, and another group says the differences include literally thousands of characteristics (Stanton and Kline 2016, pp. 9, 40-41).

CS early adopters represent important subgroups for study, because they are predisposed to want to take more control over their utility service, and are willing to invest their own dollars to support clean energy. Researchers might successfully learn from CS participants how best to design and market future utility service offerings with a focus on simultaneously increasing both customer and system value.

4. Identifying strategies for all interested parties to best manage a transition to a utility sector that will employ many more DER.

Sterling, Cory, et al. (2015, pp. 36-39) observe that this is an ideal time for utilities to consider all aspects of their operations, and identify "least regrets strategies" for managing the transition towards increased DER. Particularly important, these researchers suggest, are the needs for utilities to:

(a) "update planning and operations activities – before DER becomes an issue;"
(b) learn how to complete "localized analysis," using more comprehensive benefit-cost techniques to clearly and comprehensively understand DER system impacts; and,
(c) develop a "flexibility supply curve" based on which resources are associated with what specific valuable qualities that apply to grid operations and management.

Coleman, Wilson, and Chung (2016, p. 4-1) have a message:

> Utilities can no longer avoid the advance of DER technology adoption. The sooner utilities begin to implement a proactive DER planning process, the better prepared they will be to achieve the potential benefits and minimize the risks of the distributed energy future.

Several projects in different parts of the country demonstrate that there can be opportunities for DER to postpone or even replace expenditures that would otherwise be needed for more traditional utility assets, at lower cost (Stanton 2015b; Walton 2016). If those experiences prove to be both reliable and replicable, as their sponsors and developers predict, then important cost savings can be obtained as more and more utility companies get better at identifying such opportunities and then implementing DER solutions. These concepts represent a major cultural change for utilities, though: Most utilities are just beginning to focus more attention on distribution system integrated resource planning and the operational characteristics of multiple, integrated DER.

For the time being, there are many visions for the future of the electric grid and the appropriate roles for all industry players, with strongly held opinions competing for position (Kann 2016; Pyper 2016a; Scott 2016; Walton 2016). The Smart Electric Power Alliance's *51st State Initiative* is intended to provide a collaborative platform for such discussions (SEPA 2016b). There might be no immediate or easy answers to the questions being raised, but there seems no doubt that carefully constructed approaches are needed to:

- Re-imagine the role of public utilities in helping to support DER; and,
- Provide necessary changes to regulatory incentives that will motivate utilities to be partners in the rapid introduction of all cost-effective DER.

For the immediate future, the early experience with CS shows that customers have a pent-up demand for hundreds or even thousands of megawatts. There is ample evidence that CS can produce and deliver benefits in excess of costs. Therefore, it makes sense to open even more markets to well-designed programs. Regulators should ensure enough flexibility so that program evaluations and reviews can help determine best practices and then programs can be adjusted as necessary, increasing benefits while decreasing costs.

VI. Summary

The title of this paper includes "companion planting." That idea represents a particular kind of mutual support, based on *a priori* knowledge of mechanisms that add value: In gardening, companion planting means growing two or more different kinds of crops in close proximity, to produce mutual benefits. Similarly, CS might contribute towards solutions to several of the pressing challenges facing utilities and regulators today, such as the design of enhancements to or replacements for NEM, future utility business models, and possible roles for market-based solutions and DER. CS provides an important opportunity for early learning about beneficial utility involvement in a way that can produce and deliver important system and societal benefits while both satisfying some of the explicit desires of participating customers and holding harmless non-participating customers. On the other hand, inadequate regulatory oversight could lead to unintended consequences, including the possibilities of monopoly rents, reduced benefits for all concerned, and higher costs for participating customers.

CS programs are spreading rapidly through many states and utility service territories. Already 15 states have passed laws or issued regulatory commission rules or both, which open CS participation to customers of regulated utilities and sometimes set up the option for voluntary programs to be offered by utilities that are not state-regulated. In addition, many utilities in other states have sought regulatory approvals for CS projects, either from state regulatory commissions or for municipal or cooperative utilities from their boards of directors. Although these programs are in the early developmental stages, many of the state laws do appear to be opening up markets that are attracting CS developers: As much as 90% of all CS applications in the near future are predicted for the states with enabling legislation, and nearly 3/4 of the growth is projected for the few states that have the most attractive rules and regulations for developers, including California, Colorado, Massachusetts, and Minnesota. (Honeyman 2015; Trabish 2015b). With all of that growth, this paper is intended to assist state commissions with thinking about the many issues involved with designing and implementing CS programs so that mutual benefits can be achieved.

This paper defined CS as facilities that serve multiple, unrelated customers, who receive benefits that represent their fractional shares of the energy output generated by a particular CS generator, most often in the form of volumetric utility bill credits, and that the CS generator is located remotely, off-site, from all, or at least most, of the participating customers. Definitions from other organizations explicitly stress having benefits distributed to participating customers as credits on utility bills (IREC 2012, pp. 3, 5) and emphasize that participating customers will be those who favor solar energy but otherwise cannot take advantage of on-site solar or net metering (US-DOE 2016).

CS programs can be designed in many different ways, but careful attention to design details can enable CS projects to avoid: (a) having offerings treated as securities by federal, state, or local securities regulators, and (b) having the benefits treated as income by the federal internal revenue service. It appears that CS programs can avoid unfavorable treatment as long as customer benefits are provided by utility bill credit and are at least fairly closely aligned with the customer's expected annual utility charges. (Coughlin, Grove, et al. 2010, Sections 4-5; Feldman, Brockway, et al. 2015, pp. 13-20; US-DOE 2016).

CS can be thought of as similar to other utility- and non-utility program types, such as green pricing, large customer direct PPA contracts, and donation-based support or direct investment in renewable energy. All these are ways for customers to act on their preference for supporting renewable energy. CS is especially important because it can help customers to achieve their personal renewable energy goals while minimizing or eliminating any cost-shifting from participating to non-participating customers. And, depending how programs are designed, utilities might earn returns on at least some investments in CS. These benefits are helping CS to grow rapidly: Already identified projects will represent at least 500MW of installed solar capacity (Honeyman 2015; IREC 2016b), and US DOE forecasts that by 2020 community solar capacity could equal anywhere from a third to nearly half of all installed distributed solar (Feldman, Brockway et al. 2015; National Community Solar Partnership 2016).

A range of benefits have been identified for CS, including perspectives of customers, utilities, the solar industry, and the regulatory community. Those benefits were reviewed in Part III. For example, Feldman, Brockway, et al. (2015, p 4) list:

- Access for customers without suitable land or a rooftop where an individual solar system could be located;
- Lower financial and technical barriers to entry for participating customers;
- Professional operations and maintenance provided by a qualified system manager, rather than by individual customers;
- Portability or transferability of shares for customers who might relocate, either within or outside of the utility service territory, or for those that might experience a major change in financial circumstances;
- Lower hard- and soft-costs for PV systems, due to important economies of scale;
- More flexibility in siting, with the possibility of more beneficial or even optimal grid integration; and,
- Increased community support, based on CS facility location or sometimes affinity relationships for participating customers.

As discussed in Part IV, actions by states were reviewed, focusing on the 15 states plus the District of Columbia that have already adopted CS legislation or rules. A timeline, in Figure 1, shows the state actions that have taken place from 2006 to the present. The timeline also includes deadlines by which a couple of states, Connecticut and Maryland, are completing evaluation reports to help guide action on future programs.

The basic information about the programs for those states with legislation was presented in Table 1, including details about:

- maximum total CS program capacity limits;
- maximum capacity limits for each participating CS project;
- minimum number of participants in each CS project;
- maximum amount of energy to be generated per participant, usually expressed in terms of a percentage of the participant's annual average energy use; and,
- location requirements, both for the siting of each CS project and for the participating customers of the respective project.

In addition, Part IV presented a high-level review of similarities and differences in the state programs, including provisions for:

A. Consumer disclosures, education, and protection;
B. Eligible participants;
C. Participant bill credits;
D. Participant rates and terms;
E. Portability of and transfer of participation;
F. Project ownership;
G. Project siting;
H. Program evaluations;
I. REC treatment;
J. Treatment of unsubscribed energy;
K. Utility cost recovery; and,
L. Other provisions.

Some basic regulatory considerations were briefly explored in Part V, including:

1. Regulating CS to simulate competitive markets;
2. Deciding about cost allocation and recovery for CS;
3. Expanding the value of CS;
4. Enabling CS as a gateway to all cost-effective DER; and
5. Evaluating CS programs and projects, and making progressive changes based on those evaluations.

And lastly, some preliminary recommendations for future research related to CS were included at the end of Part V. Those include:

1. Understanding and then reducing or removing non-regulatory barriers to CS;
2. Standardizing CS offerings;
3. Exploring how customers might be fully engaged to act as partners in utility infrastructure development; and,
4. Identifying strategies for all interested parties to best manage a transition to a utility sector that will employ many more DER.

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