What Would Expand Utility-Led Community Solar in the Southeastern US?

Disclaimer: This 2021 student paper was prepared in partial completion of the graduation requirements for the Master of Public Policy Program at the Sanford School of Public Policy at Duke University. The research, analysis, and policy alternatives and recommendations contained in this paper are the work of the student who authored the document, and do not represent the official or unofficial views of the Sanford School of Public Policy or of Duke University. Without the specific permission of its author, this paper may not be used or cited for any purpose other than to inform the client organization about the subject matter. The author relied in many instances on data provided by the client and related organizations and makes no independent representations as to the accuracy of the data.
EXECUTIVE SUMMARY

Community solar (CS) expands access to the benefits of solar energy by overcoming many of the challenges associated with residential solar ownership. Installing rooftop solar is not an option for an estimated 77 percent of the U.S. population. For many households, rooftop solar is impossible due to homeownership status (renting versus owning), installation restrictions, or credit requirements. For others, rooftop solar would not be economical due to limited rooftop space, a lack of sun exposure, or inadequate state incentives. The CS model allows individuals and businesses to own or subscribe to a portion of an off-site solar facility, thus avoiding large upfront costs and the hassle of home installation.

In addition to expanding solar access to homeowners, CS also offers advantages to utility stakeholders. Utilities who offer CS may increase customer satisfaction by expanding customer energy choice. If residential customers choose CS over rooftop installation, it could help stabilize residential demand (and revenue) for the utility. Furthermore, CS benefits from economies of scale (low cost per kW) and preferred project siting (high production per kW).

CS is similar to the Community Supported Agriculture (CSA) model, but instead of subscribing to a share of a local farm’s produce, customers subscribe to a share of a solar farm’s energy output.


Electric Membership Cooperatives (EMCs) and municipal utilities (munis) have a unique opportunity to advance CS development. These consumer-owned utilities (“local utilities”) provide electricity to nearly half of the Southeastern population. Nevertheless, much of the existing research on CS focuses on investor-owned utilities (IOUs). Unlike IOUs, EMCs and munis are democratic entities which are accountable to their constituents, not to shareholders. Thus, consumer demand should play a larger role in driving CS development at local utilities than at IOUs. Whether consumer demand does play a larger role, however, is a question that has been largely unexplored.

Despite all of its benefits, CS is not widely available to local utility members. Only 15 percent of local utilities offer CS (exposing only 30 percent of EMC and muni customers to CS). State policies may restrict CS development or curtail potential economic gains. Compared to other areas, electricity is relatively inexpensive in the Southeast, limiting the incentive for distribution utilities to search for alternatives to buying energy from their power providers. Additionally, utilities may be unfamiliar with CS since it is a relatively new model.

The Southern Environmental Law Center is interested in understanding the contributing factors behind CS development at EMCs and municipal utilities in the Southeast and how the decision to offer (or not offer) CS relates to a utility’s approach to residential solar tariffs. The organization’s goal is to make solar accessible for all Southerners, and CS is one component of this mission.

What factors explain why only some EMCs and municipal utilities in the Southeastern U.S. developed community solar programs?

**Limited financial incentive for subscribers.**

Many utility-led CS programs in the Southeast region do not generate positive returns for member-subscribers. None of the five distribution utilities interviewed for this research have replicable CS models with meaningful, positive returns for subscribers. Anecdotally, the interviewees also reported that lackluster returns were common for most of the region’s CS programs. The generation and transmission (G&T) cooperative for Georgia’s 38 distribution cooperatives corroborated this finding. A Smart Electric Power Alliance (SEPA) survey found that upfront consumer savings were the primary driver of high CS subscription

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4 Defined in this report as the states my client operates in (Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia).


8 In this report, “utility-led” only refers to electric cooperatives or municipal utilities.
rates. Without the financial motivation, subscription levels depend on consumer preferences for non-market benefits (e.g., personal satisfaction from environmental contribution). Therefore, nominal subscriber returns deter initial CS development as utilities don’t want to risk low subscriber uptake.

**Likelihood of member engagement.**

The novel quantitative analysis conducted for this research found a positive relationship between a more educated customer base and an increased likelihood of the local utility offering CS. One explanation for this correlation is that education acts as a proxy for civic involvement. Extensive research has found a causal relationship between more education and increased levels of civic engagement. Engaged citizens are more likely to make their preferences known to their local utility, which can put pressure on utility leaders to respond to consumer demand. The interviews and survey results reinforce this finding. Conclusions from NC Clean Energy Technology Center’s four-year project – “Community Solar for the Southeast” – also reaffirm the relationship with community activism, citing the benefit of “local champions” at spurring CS.

**Access to low-risk CS opportunities.**

Proactive external support advances CS development at local utilities. The majority of the utilities interviewed did not actively pursue CS development. Rather, they accepted a low-risk CS opportunity. In North Carolina and Georgia, the state-wide G&T cooperatives play a pivotal role in supporting CS adoption by initiating CS discussions, providing information, and financing development. In many instances, the G&T cooperatives also bear the initial economic burden, since they often own the CS facilities. These types of collective action agencies may contribute to CS variation by state and utility type (EMC versus muni).

**Desire to provide an alternative to rooftop solar.**

Results from the quantitative analysis revealed that local utilities with CS programs are 14 percent more likely to charge a monthly fee on residential solar compared to local utilities without CS. This finding suggests that utility-led CS is often deployed to substitute residential solar versus simply to expand access to the benefits of solar. Interviews and survey responses support this finding. Advocates should recognize that not all CS programs share the same motivations and that, in some instances, CS may come at the expense of residential solar development.

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RESEARCH APPROACH
Through a mixed-method approach of interviews, surveys, and novel statistical analysis, this report explores how customer, utility, and environmental attributes predict CS development at local utilities in the Southeast. The simplified diagram below illustrates the theory of change driving the investigation. Most studies assert that customer interest is the primary motivator for CS development at local utilities since they are democratic entities, overseen by officials elected by their consumer-owners. However, customer demand is only one consideration among many CS factors.

The relationships and factors depicted in the theory of change diagram are drastically simplified. For example, customer interest in CS shows up in environmental concerns and customer retention (not just customer satisfaction).

12 Funkhouser et al., "Emerging Landscape of US Community Solar.", Lenhart et al., "Municipal utilities and electric cooperatives in the United States: Interpretive frames, strategic actions, and place-specific transitions."

Figure 2. Theory of Change (Parsonnet, 2021)
Other elements – both observable and unobservable – factor into a utility’s decision to offer CS. Upfront costs and accessible financing, for example, are often barriers of CS adoption. On the other hand, utilities may be incentivized to offer CS if they have concerns about losing customers to rooftop solar or to other utilities (in areas of choice). Net savings from power providers in the form of lower peak demand costs (kW) or avoided energy purchases (kWh) may also incentivize development. In all cases, utilities will need the financial and technical skills to successfully deploy a CS program.

To untangle the complexities of CS considerations, the survey and the interviews explicitly inquired about the factors behind initial CS development and the current success of CS programs. For the quantitative component, the hypothesized CS factors were approximated when available and readily measurable. For example, customer preference was estimated by analyzing observable characteristics such as race, income, housing status, and education (estimated at the utility level).

**FINDINGS**

Results from the Quantitative Analysis

**EMCs are significantly more likely to offer CS programs compared to municipal utilities.**

The type of local utility – municipal versus electric cooperative – has a strong, statistically significant association with CS development. Holding other explanatory variables constant, munis are 33 percent less likely to offer CS to customers compared to EMCs. The variation could be due to differences in internal and external oversight. Munis are subject to more local regulation and public scrutiny compared to EMCs, potentially making it difficult to initiate new ventures like CS. Furthermore, EMCs and munis have different support networks. Cooperative networks like NRECA and numerous state organizations like NCEMC, have intentionally focused on developing renewable energy resources. Municipal utilities seem to lack comparable support systems that encourage renewable energy adoption.

**CS is often paired with cost-prohibitive residential solar tariffs.**

Local utilities with CS programs are 14 percent more likely to charge a monthly fee on residential solar, even after for controlling for socioeconomic, geographic, and institutional factors. This finding indicates that utility-led CS is often deployed to substitute residential solar development instead of simply to expand solar access. However, the statistical analysis does not prove causation. In one scenario, a local utility may first develop

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16 Benefits of Public Power.
CS and then apply a rooftop solar fee. In another scenario, a local utility may have a rooftop solar fee in place and then develop CS to appease its solar-leaning customers. Either way, solar advocates should be wary of how utilities bundle distributed energy policies.

Local utilities with a higher percentage of customers with post-secondary degrees are more likely to develop CS.

Utility service areas with a larger percentage of adults with a Bachelor’s, Master’s or Doctorate degree are more likely to have CS programs. This seems to support the hypothesis that customer demand influences CS decisions. Extensive research has found a causal relationship between more education and increased levels of civic engagement. Engaged citizens are more likely to make their preferences known to their local utility, which can put pressure on utility leaders to respond to consumer demand.

### Table 1. MODEL INFO: OLS Linear Regression

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<tr>
<td>(F(13,375) = 13.23, p = 0.00)</td>
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<td>Adj. (R^2 = .29)</td>
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**Standard errors:** Robust, type = HC1

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Significance Codes: .001 = **** ; .01 = *** ; .05 = ** ; .1 = *

17 Mayer, “Does Education Increase Political Participation?.”
Results from the Expert Interviews

Proactive external support helps initial development.

The majority of the utilities interviewed did not actively pursue CS development, rather, they passively accepted a low-risk opportunity. EMCs in Georgia and North Carolina have a strong support system through their respective G&T cooperatives. In Georgia, Green Power EMC conducts cost analyses, handles the upfront financing, takes advantage of federal tax incentives, and helps operate and maintain the facility. NCEMC similarly helps its members. NCEMC prompted Roanoke EMC and Brunswick EMC to offer CS. External resources and support from collective action agencies likely varies by utility and state. Based in North Carolina, the NCCETC has partnered with government officials, nonprofits, and local utilities in an effort to expand regional CS through its “Community Solar for the Southeast” project.\(^\text{18}\)

Some of the situations surrounding initial CS development are not replicable. In Tennessee, BrightRidge appealed to TVA for permission to buy solar from a third-party. After gaining approval, Silicon Range (a Tennessee-based solar developer) approached them for the contract to build a solar facility. Though the details of the transaction are complicated, Silicon Ranch wound up donating 500 kW to BrightRidge as part of a larger solar development. BrightRidge saw an opportunity to provide value to its member-customers and used that “free” capacity for its CS program.

Customer preferences and ability to pay determine success of CS.

The majority of utility-led CS programs in the region generate nominal financial returns for member-subscribers. Of the five distribution utilities interviewed, only BrightRidge’s CS program, which was effectively given to them at no cost, had positive annual returns for subscribers. The G&T cooperative for Georgia’s 38 distribution cooperatives corroborated this finding.

CS programs can still be popular without positive financial returns. In most places, however, low financial returns curbs CS demand. Subscribers to Walton EMC’s program lose $5-6 annually per panel, yet the program is incredibly popular. Walton is developing its third CS farm after selling out 3.5 megawatts of CS. Green Power EMC continues to field requests about CS development from its members even though analysis shows just breakeven returns for subscribers. For the most part, Walton EMC is an outlier. Brunswick EMC’s program, which has a 22-year payback period for the subscription cost, has struggled to attract subscribers.


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North Carolina Electric Membership Corporation (NCEMC) is one of the largest G&T cooperatives in the U.S. It provides electricity to 25 EMCs in NC.

North Carolina Clean Energy Technology Center (NCCETC)

Tennessee Valley Authority (TVA)

Rates of Solar Update

BrightRidge offers a CS program to its customers. The program is fully subscribed with a long waitlist.

Knoxville Utility Board is in the process of developing a CS program.

$\text{\textquoteleft\textquoteleft [It\textquoteleft s] just seemed like a no brainer to us. So, we looked at how we could get that back to customers and the Community Solar farm really took shape for us from there.\textquoteright\textquoteright}$

-BrightRidge on the origins of its CS program

“\text{\textit{It is like selling ice to an Eskimo.}}”

-Brunswick EMC on its CS

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The interviewees recognized the role of customer preferences and ability to pay in CS success. Some noted that CS was never intended to generate financial savings for customers. For these utilities, CS appears to be for members that (1) cannot afford the upfront costs or financing for rooftop solar, (2) have a minimum threshold of disposable income, and (3) are environmentally motivated.

Several issues for CS advocates arise. First, there appears to be a discrepancy in how advocates and researchers describe the benefits of CS and how CS developers and administrators in the region view CS benefits. Second, without subscriber savings, CS will have limited success in the Southeast. Financial savings are crucial to solar development. For residential solar, saving money on utility bills is the number one reason people consider installation.

Survey Results
The survey responses provided a snapshot of how some local utilities perceive CS development. Generally, the results align with findings from similar CS surveys. The survey results support findings from the expert interviews and the quantitative analysis but should not be generalized given the low response rate. See Appendix C for details on methods and survey analysis.

About the Survey Respondents
The survey received 11 responses out of 310 potential respondents; this is a 3.5 percent response rate. Of the 11 responses, eight were from munis and three were from cooperatives. Respondents varied geographically. There were five respondents from North Carolina, two from Georgia, two from Alabama, and two from Tennessee. No Virginia utilities responded to the survey.

CS Programs
Five out of the 11 responses (45 percent) reported offering a CS program. This is not representative of the region. In reality, only around 15 percent of local utilities have CS in the Southeast region.

Local Utilities Planning to Develop CS Programs
Shelby and Fayetteville reported plans to expand CS offerings and Lumbee River EMC reported plans to start offering CS.

Popularity of Current Programs
Similar to the interviews, the survey results on the status of current CS programs were mixed. Of the five utilities with an existing CS program, two noted their

Utility workers may still perceive their CS as successful despite low customer demand. Prior to COVID-19, representatives from Pee Dee Electric gave daily tours of their CS facility and noted that the educational component of the system made the project worthwhile. Pee Dee Electric’s CS program is at 25 percent capacity. Additional information from the survey responders may be needed to understand how their CS program is fairing overall.

Challenge Ranking
Utility representatives ranked a series of barriers to CS development. Results are shown in order of most challenging to least challenging.

Advantage Ranking
Conversely, some perceived barriers to CS can actually enable CS development (e.g., accessible, inexpensive financing). Respondents identified the below advantages as being helpful in the CS development process.

1. Availability of online resources
2. Accessible financing
3. Access to solar expertise
4. Customer interest
5. Innovative CS model & pricing structures

Appealing Aspects of Community Solar
Survey respondents indicated that the most appealing aspects of CS were customer satisfaction, environmental benefits, customer retention, and expanding access to solar for low-and-moderate income (LMI) customers.
Focus on Low-Income

Survey respondents who identified low-and-moderate income (LMI) customers as a contributing factor for CS development were presented with a list of common CS policies favorable to LMI customers. They were then asked to indicate how they plan to attract LMI households.

Most survey respondents did not seem to delineate special CS program accommodations for LMI subscribers. The top responses were (1) easy credit reassignment (in the event of a move) and (2) information campaigns, both of which are standard for any CS program. The sentiment in the surveys about CS for LMI customers aligns with the interview discussions – it is something utilities are interested in but have not put into practice. The City of Shelby in North Carolina offers guaranteed electric bill savings to LMI customers for its CS program. Walton EMC and Fayetteville both indicated that their program had flexible payment options. See Appendix E for a copy of the survey instrument.

RECOMMENDATIONS

Work with collective action agencies to promote CS.

NCEMC and Green Power EMC played important roles with initial CS development at local utilities in the Southeast. In North Carolina, some EMCs were approached by NCEMC to enter into an arrangement where NCEMC would own and operate the CS system on behalf of the member. The relative novelty of CS and constrained resources of local utilities make the initial hurdles of CS adoption difficult to overcome alone. Thus, collective action agencies like NCEMC can play a role jumpstarting development (similar to public grants for
demonstration projects or pilot programs). See Appendix B for a list of power agencies and providers by state.

Engage local advocacy groups to stimulate CS activism.
Quantitative findings indicate member engagement could help advance CS development. Advocacy groups could assist with organizing member-customers. The interviews and survey responses highlighted that customer satisfaction was a key motivator for CS development. NCCETC’s four-year CS in the Southeast project similarly confirm the importance of having “local champions” for CS. Furthermore, advocacy groups could help close the CS knowledge gap. Anecdotally, Walton EMC experienced a massive jump in subscriptions after a popular Atlanta paper featured their CS program in an article. This prompted Walton EMC to expand their CS offerings in order to keep up with demand.

Research cost barriers to subscriber savings.
The six utility interviewees acknowledged that subscriber savings were important to the success of CS. Most utility representatives explicitly acknowledged that CS programs were designed to appease environmentally minded customers and not to provide financial benefits. Yet as the explosion of rooftop solar indicates, cost-savings (not environmentalism) is the primary driver of solar adoption in the United States. In many places, CS does provide net savings to subscribers. Understanding why CS in the region lacks financial benefits is the first step to understanding what levers can alter the cost calculation. Advances in battery storage will increase CS subscriber savings.

Consider a utility’s overall approach to distributed solar.
Local utilities appear to be applying residential solar tariffs in tandem with CS development. While it is unclear which came first – the tariff or the CS – the connection implies a tradeoff between two forms of solar development. The relationship between a utility’s solar energy crediting system and CS development is an area worthy of future research. Similar to applying a monthly fee, a utility’s crediting system (e.g., net metering) alters the financial calculus for residential solar installation.


CONCLUSION

The CS model overcomes some of the longstanding obstacles of rooftop solar installation, potentially expanding access to the benefits of solar energy. Local utilities can benefit from CS through increased customer satisfaction and retention. This research investigated why local utilities in the Southeast develop (or don’t develop) CS programs through a mixed method approach. The findings suggest that the provision of low-risk opportunities (CS “pilot programs”) and customer engagement aid utility-led CS development. Many utilities offer CS as an alternative to residential solar installation, hoping that CS can offset some rooftop solar uptake. The significant connection between utilities’ applying a residential solar tariff and CS development, highlights the tension of preserving revenue and expanding distributed energy. One barrier to CS adoption in the Southeast is the lack of financial incentives for subscribers. CS programs often provide negligible net savings to subscribers, which limits the attractiveness of the programs for large swaths of the population.
APPENDIX A: BACKGROUND

Community solar is shared solar.

There is no universal definition of community shared solar. However, the common definition is any solar facility which provides power to multiple community members. These programs are voluntary. As more utilities have entered the CS space, though, some solar advocates favor a more restrictive definition. Advocates assert that to qualify as CS, projects should: (1) be located near its community of participants and (2) provide financial benefits to its subscribers. By this definition, the upcoming “community solar” developments by Florida Power & Light and Duke Energy, for example, would not qualify as CS. After discussing with my client, we decided not to limit the definition of CS programs.

CS offers expanded access and cost advantages.

CS expands access to the benefits of solar energy. Installing home solar is not an option for the vast majority of the U.S. population. For many households, rooftop solar is impossible due to homeownership status (renting versus owning), installation restrictions, and/or liquidity and credit requirements. For others, rooftop solar would not be economical due to limited rooftop space, a lack of sun exposure, or inadequate state incentives. Even for those who can feasibly install

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28 Watkins, "A Shocking 80 Percent of Americans Can’t Access Rooftop Solar. Here’s Why..."
rooftop solar, there are valid reasons not to. Compared to rooftop solar, CS benefits from economies of scale (lower cost per kW) and preferred project siting (higher production per kW).

**EMCs and municipal utilities differ but share principles of democratic accountability and local governance.**

The U.S. Energy Information Administration (EIA) classifies electric utilities as (1) investor-owned utilities (IOUs); (2) publicly run or managed utilities; and (3) cooperatives. My research focuses on EMCs and municipal utilities, which taken together, provide power to around 25 percent of the population.\(^29\) In the Southeastern U.S., local utilities play a larger role in electricity provision, supplying power to 45 percent of households.\(^30\) These entities are democratic and governed by their member-customers.\(^31\)

**Municipal Utilities**

Municipal utilities are community-owned and operated on a not-for-profit basis, but different organizational and governance structures may impact the extent of citizen engagement.\(^32\) The various structures have different methods of oversight, decision-making, and member involvement. The municipal utility structures can: (1) operate as a city department; (2) report directly to city council; (3) function as an independent city agency; (4) act as a city-owned corporation; (5) be setup as a “Municipal Utility District”; or (6) work as a “Joint Powers Agency.”\(^33\)

**Electric Membership Cooperatives**

Electric cooperatives are member-owned, not-for-profit, electric service providers. Generally, electric cooperatives abide by worldwide established principles such as voluntary and open membership, democratic member control, members’ economic participation, and autonomy and independence. Every member-customer in “good standing” has the right to vote for democratically elected directors for limited-term seats on a governing board. Additionally, the board should have the sole authority over self-determination of the EMC.\(^34\)

**Power Providers & Power Agencies**

In addition to different internal organizational structures, EMCs and municipal utilities receive power by different means. Most local utilities do not generate power but instead purchase it from external parties. Generally, local utilities purchase power through a larger power agency (e.g., collective bargaining) who in turn negotiates a Power Purchase Agreement (PPA) with the generation and

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29 "Form EIA-861M data."
30 "Form EIA-861M data."
31 Coughlin et al., Guide to community solar.
32 Benefits of Public Power.
transmission (G&T) utility (e.g., Duke Energy, TVA). Less frequently, EMCs own generation facilities or enter into a PPA directly with a larger electric utility. See Appendix B for more information.

CS uptake varies across the Southeast region.

In the Southeast, EMCs – not municipalities – are home to the majority of CS programs. Research shows only five municipal utilities in the region offer CS compared to 53 EMCs offering CS. Georgia and South Carolina lead both in terms of the number of local utilities offering CS and the number of residential customers exposed to CS offerings. Possible explanations for the variation across state and local utility type may be due to varying state policies or G&T providers (discussed briefly in the following background section). EMCs and munis have differing organizational setups. The variation may also stem from differences in the underlying customer population of these utilities, the primary topic of this paper.

My client tracks which utilities offer CS but cannot accurately gauge the capacity (in megawatts) of the programs. Utilities sometimes do not disclose the capacity of the CS program or do not indicate whether the capacity reflects alternating or direct current. The National Renewable Energy Laboratory’s (NREL) Sharing the Sun project tracks CS projects and capacity in the U.S. However, the database is missing approximately 30 percent of the CS projects for the Southeast, only noting 43 utilities with CS in the region. America’s Electric Cooperatives (NRECA) catalogues CS capacity at EMCs, but its CS tracking is similarly incomplete.

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<td>1</td>
<td>16,311</td>
<td>3%</td>
</tr>
<tr>
<td>GA</td>
<td>41</td>
<td>15</td>
<td>639,088</td>
<td>34%</td>
</tr>
<tr>
<td>NC</td>
<td>26</td>
<td>12</td>
<td>478,526</td>
<td>49%</td>
</tr>
<tr>
<td>SC</td>
<td>20</td>
<td>16</td>
<td>634,493</td>
<td>87%</td>
</tr>
<tr>
<td>TN</td>
<td>22</td>
<td>4</td>
<td>307,891</td>
<td>35%</td>
</tr>
<tr>
<td>VA</td>
<td>13</td>
<td>5</td>
<td>247,640</td>
<td>41%</td>
</tr>
</tbody>
</table>

Table 2. EMCS with CS (Rates of Solar, 2020)

35 Guides for Electric Cooperative Development and Rural Electrification.


State policies impact CS development.

State policies can foster or curtail CS development. Overall, policies in the Southeast discourage distributed solar development. The Southeastern states consistently top the Center for Biological Diversity’s list of “sunny” states with detrimental solar policies. Common policies that support community and distributed solar include (1) net metering, (2) Renewable Portfolio Standards (RPS), and (3) allowing third-party sales of electricity. However, many of these solar-friendly policies do not explicitly apply to local utilities. Public Utility Commissions (PUC) regulate each state’s utilities, but the degree of oversight varies. In the Southeast, for instance, most state PUCs only regulate IOUs. PUC policies can indirectly influence EMCs and municipal utilities by setting standards for the IOUs. For example, North Carolina’s HB 589 requires Duke Energy to file plans for CS with the North Carolina Utility Commission (NCUC). The legislation outlined that CS subscribers must be credited at the avoided cost rate for all the electricity produced by their share of the project (i.e., not true net metering). This regulation for IOUs seems to have spilled over to non-regulated utilities and become the norm for CS programs at local utilities.

Table 3. Municipal Utilities with CS (Rates of Solar 2021)

<table>
<thead>
<tr>
<th>State</th>
<th>Total Munis</th>
<th>Munis w/ CS</th>
<th>Muni customers exposed to CS</th>
<th>% of Muni customers exposed to CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>33</td>
<td>0</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>GA</td>
<td>50</td>
<td>0</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>NC</td>
<td>66</td>
<td>2</td>
<td>13,953</td>
<td>3%</td>
</tr>
<tr>
<td>SC</td>
<td>21</td>
<td>0</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>TN</td>
<td>61</td>
<td>3</td>
<td>79,835</td>
<td>4%</td>
</tr>
<tr>
<td>VA</td>
<td>15</td>
<td>0</td>
<td>-</td>
<td>0%</td>
</tr>
</tbody>
</table>


**Utility power dynamics shift with the introduction of distributed energy resources.**

**Utility-sponsored CS models dominate the region**

In the U.S., the three models of CS are: (1) utility-sponsored; (2) special purpose entity (SPE); and (3) nonprofit.\(^46\) In the Southeast, utility-sponsored models dominate but alternatives exist. This report focuses on utility-led CS since most SELC states effectively ban other models of development.\(^47\) Utilities are well positioned to develop CS. They have the legal, financial, and program management infrastructure for development and administration.\(^48\) Although my research did not delve into SPE and nonprofit models, the availability of alternatives could factor into a utility’s decision making.

**Distributed energy changes the roles of buyer and seller**

Solar development often alters the relationship between the electric producer and purchaser. These complex interactions among households (retail electric customers), EMCs and munis (distribution utilities), and power producers (G&T utilities) vary by location. Traditionally, local utilities provide electricity to households by purchasing wholesale power from a G&T utility. Local utilities often use a collective power agency to negotiate the terms of the purchasing agreement. When households install solar, the local utility buys the excess solar production from the household. When local utilities develop CS, households purchase solar through the local utility. Holding electric demand constant, both situations reduce the local utility’s reliance on power from the G&T utility.

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\(^{46}\) Coughlin et al., *Guide to community solar*.


\(^{48}\) Coughlin et al., *Guide to community solar*. 
Local utilities could benefit from CS development

Local utilities could financially benefit from CS in both its wholesale purchase and retail distribution transactions. If the utility develops its own generation source (CS), it will likely buy less electricity from the external supplier. From the retail side, CS could mitigate revenue losses from household solar development if the program replaces some residential solar installation. However, EMCs and municipal utilities cannot directly benefit from generous federal tax incentives (e.g., the solar Investment Tax Credit (ITC) and depreciation) as they are exempt from federal income taxes. It is possible for local utilities to partner with a taxable third-party (e.g., a private solar installer) and take advantage of the ITC and depreciation by proxy.

Power purchase arrangements can help or hurt CS development

In Georgia, Green Power EMC (a cooperative of cooperatives) offers large-scale CS to its membership of EMCs. In contrast, the Tennessee Valley Authority (TVA)...

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50 Funkhouser et al., “Emerging Landscape of US Community Solar.”
51 Coughlin et al., Guide to community solar.

---
must pre-approve most utility-led CS projects. The precise terms of the PPAs will affect the financial feasibility of CS development. See Appendix B for list of power producers.

**Households may forgo rooftop solar in favor of CS subscriptions**
Retail electric customers interested in rooftop solar have a few options. Customers can install solar plus storage and disconnect from the utility entirely or, more commonly, they can install solar and sell back their solar power to the utility (e.g., through net metering agreements). The latter pathway flips the traditional dynamic between who pays and who produces. Utility-led CS offers customers an alternative option for solar generation.

**How do customers participate in CS?**

**Owning shares versus subscribing to shares**
Customers participate in CS programs by subscribing to or buying a share of the system. It is difficult to draw clear, practical distinctions between the subscription model and purchasing model. The structures both represent a claim of the rights to the electricity produced from acquired shares. All things equal, consumers generally save more money by owning a portion of the system compared to subscribing. Consumer-investors are more likely eligible for state or federal tax incentives and/or solar renewable tax credits (SRECs) payments compared to ordinary subscribers.

**Advancements with innovative pricing models**
In the last five years, the types of subscription-based pricing models have flourished. Most utilities in the Southeast use standard subscription pricing whereby subscribers pay a monthly fee or in a one-time up-front payment. However, the “guaranteed discount” approach is increasingly popular as it offers immediate customer savings. For example, subscribers lock in a 10 percent discount over an electricity rate of $.10 per kWh, thus saving $.01 per kWh. The actual rate subscribers will pay for solar thus fluctuates with the retail utility rate. Utilities new to CS will need to modify their billing mechanism to incorporate the CS credits.

According to an NREL study, the levelized cost of commercial solar in most states makes CS development economically feasible, however, customers may not save

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54 Weiss, interview.


57 “Community Solar: Pricing Models.”

58 Coughlin et al., Guide to community solar.
money through CS subscriptions.\textsuperscript{59} Participant savings depend on factors such as the pricing structure, electric tariff rates, solar system design, and irradiance. The majority of utilities in SELC’s region do not detail the expected monetary savings for CS participants. In competitive solar markets outside of SELC’s region, utilities and developers provide consumers with expected savings “calculators.”\textsuperscript{60} Compared to rooftop solar, there is a dearth of customer-facing resources on the lifetime savings from a given program. It is unclear whether subscribers knowingly pay a premium or not.


## APPENDIX B: POWER PROVIDERS

<table>
<thead>
<tr>
<th>STATE</th>
<th>EMC POWER PROVIDERS</th>
<th>MUNICIPAL POWER PROVIDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>The Alabama Rural Electric Association of Cooperatives (AREA) is the collective organization for EMCs. TVA and PowerSouth provide wholesale power to the EMCs.</td>
<td>The Alabama Municipal Electric Authority (AMEA) is the wholesale power provider for municipalities.</td>
</tr>
<tr>
<td>GA</td>
<td>The vast majority of EMCs receive power through Oglethorpe Power Corporation (OPC), a nonprofit owned by its member cooperatives. A few EMCs receive from TVA. Together, the EMCs formed Green Power EMC, which procures renewable energy for its members. It purchases and owns community solar facilities.</td>
<td>The majority of municipal utilities are members of the Municipal Electric Authority of Georgia (MEAG). MEAG provides G&amp;T services to its members. In some locales, the city council sets electric rates. Municipal utilities purchase wholesale electricity from MEAG, TVA, and Georgia Power.</td>
</tr>
<tr>
<td>NC</td>
<td>North Carolina Electric Membership Corporation (NCEMC) is the power supplier for most EMCs and provides load management, power supply planning, and demand side management service. It owns generation assets and has PPAs with Duke Energy, American Electric Power, and SCANA.</td>
<td>Two municipal power agencies: 1) North Carolina Eastern municipal Power Agency (NCEMPA) and 2) North Carolina Municipal Power Agency Number 1 (NCMPA-1). They have PPAs with Duke Energy. ElectriCities is the G&amp;T company that provides customer service, management services, and technical services to most municipal utilities.</td>
</tr>
<tr>
<td>SC</td>
<td>Central Electric Power Cooperative (CEPC) provides wholesale electric service to EMCs. It purchases its power from Duke Energy, Santee Cooper, Southeastern Power Administration and SCE&amp;G (Dominion).</td>
<td>The Piedmont Municipal Power Agency (PMPA) provides wholesale electric service to half the municipal utilities in GA. The remaining municipalities purchase power on the wholesale market or own generating facilities. The South Carolina Association of Municipal Power Systems is the trade association.</td>
</tr>
<tr>
<td>TN</td>
<td>Local power companies in TVA territory must procure power through TVA. Local utilities may apply to TVA’s “Distributed Solar Solutions Program” to develop new solar projects.</td>
<td>All of the municipal utilities belong to the Tennessee Municipal Electric Power Association (TMEPA).</td>
</tr>
<tr>
<td>VA</td>
<td>Most EMCs are members of the Old Dominion Electric Cooperative (ODEC), which provides G&amp;T services for members.</td>
<td>The Virginia Municipal Electric Association No. 1 (VMEA) provides wholesale electric service through PPA with Dominion. The Municipal Electric Power Association of Virginia (MEPAV) is a collection representation organization for the municipalities.</td>
</tr>
</tbody>
</table>

Table 5. Power Agencies & Power Providers

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61 Community Solar in the Southeast Policy Landscape for Public Utilities.
APPENDIX C: METHODS

Statistical Methods
To test the theory of change, I assembled a novel dataset of socioeconomic, environmental, and energy-related variables, estimated at the level of the electric utility territory via areal weighted interpolation. Using my client’s “Rates of Solar” dataset as a starting point, I pulled together data from the U.S. Energy Information Administration (EIA), the U.S. Department of Homeland Security, the American Community Survey (ACS 5-year estimate), and Project Sunroof by Google. I relied on R programming software to merge, modify, map, and analyze the data. The variables from the ACS and Project Sunroof datasets originally reflected estimates at the census tract level. In order to evaluate these variables at the level of the local utility, areal weighting was utilized for the spatial interpolation.

Example of Areal Weighted Interpolation:
The red line shows the service territory for Surry-Yadkin EMC. The census tract shading represents the variation of median household income. Areal interpolation “upscales” the census tracts to the level of the utility service area. Census tracts only partially covered by the service area will be weighted based on land mass and population.

Interpolation Assumptions
1. The population is evenly distributed across the census tract, which masks nuances of population density and variation within the census tract. This simplification matters for census tracts only partially covered by the service area. More granular data (e.g., at the household level) would increase accuracy.
2. The ACS sample reflects the membership population of the utility. Census tracts covered by multiple utilities will be double counted in the analysis. In other words, the results ignore the possibility of consumer energy choice. However, there is limited energy choice in the Southeast. Alternatively, not all ACS respondents are connected to the electric grid and thus are wrongly counted as members of the local utility.

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The Rates of Solar dataset details solar policies for 391 unique local utilities in SELC’s six-state region. Generation and customer statistics (2019) are drawn from the EIA for these 391 EMCs and municipal utilities. The spatial file capturing the utility service territories (2019) for the local electric utilities are provided by the U.S. Department of Homeland Security. The DHS file was missing spatial shapes for Cumberland Valley Electric and Singing River EMC, so only 389 local utilities were included in the analysis.

Socioeconomic data are drawn from the most recent ACS 5-year estimate (2015-2019) from the U.S. Census Bureau, covering 9,852 census tracts across the six-state region. Of the 9,852 census tracts, 159 were removed due to missing median household income data. Data estimating the solar potential are drawn from Project Sunroof, covering 6,216 Census Tracts across the six-state region.

### Table 6. Key Quantitative Variables

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS_binary</td>
<td>1= existing CS program, 0= no CS program</td>
<td>ROS</td>
</tr>
<tr>
<td>perc_white</td>
<td>Proportion of occupied housing units with a “white alone” household. People who identify their origin as Hispanic, Latino, or Spanish may be of any race.</td>
<td>ACS</td>
</tr>
<tr>
<td>Solarfee_binary</td>
<td>1= monthly fee (fixed or variable) on residential solar, 0= no fee on residential solar</td>
<td>ROS</td>
</tr>
<tr>
<td>State</td>
<td>Utility jurisdiction (AL, GA, NC, SC, TN, VA)</td>
<td>ROS</td>
</tr>
<tr>
<td>Type</td>
<td>Municipal utility or Electric Cooperative</td>
<td>ROS</td>
</tr>
<tr>
<td>Perc_rent</td>
<td>Percent of population who rents (versus owns)</td>
<td>ACS</td>
</tr>
<tr>
<td>Perc_collplus</td>
<td>Percent of population over the age of 25 with a post-secondary degree (Bachelor’s, Master’s, Professional Degree, or Doctoral degree)</td>
<td>ACS</td>
</tr>
<tr>
<td>Perc_extremepov</td>
<td>Percent of the population for whom poverty status is determined with a ratio of income in 2019 to poverty level below .5</td>
<td>ACS</td>
</tr>
<tr>
<td>Median_inc</td>
<td>Median family income in the past 12 months (2019 inflation-adjusted dollars)</td>
<td>ACS</td>
</tr>
<tr>
<td>Perc_highinc</td>
<td>Percent of the population for whom poverty status is determined with a ratio of income in 2019 to poverty level above two.</td>
<td>ACS</td>
</tr>
<tr>
<td>Existing_installs_count</td>
<td>Number of buildings estimated to have a solar installation, at time of data collection</td>
<td>Sunroof</td>
</tr>
<tr>
<td>Yearly_sunlight_kwh_total</td>
<td>Total solar energy generation potential for all roof space in that region</td>
<td>Sunroof</td>
</tr>
<tr>
<td>Kw_total</td>
<td>Number of kW of solar potential for all roof types in that region (assuming 250 watts per panel)</td>
<td>Sunroof</td>
</tr>
</tbody>
</table>

64 Utilities are counted once regardless of whether they operate in multiple states. The original Rates of Solar spreadsheet includes two entries for a utility operating in two states.

65 Both of the utilities excluded are small. Southern Rivers EMC has a customer base of around 330 meters and Cumberland Valley Electric has a customer base of around 70.

66 [https://www.socialexplorer.com/data/ACS2019_5yr/metadata/?ds=ACS19_5yr&table=B25006](https://www.socialexplorer.com/data/ACS2019_5yr/metadata/?ds=ACS19_5yr&table=B25006)
Statistical Analysis

A linear probability model adjusting for robust standard errors was used to assess the relationship between the variables of interest on the likelihood that a utility has at least one community solar project. I adjusted for robust standard errors to correct for heteroskedasticity.

Since the CS_binary outcome variable is dichotomous, I also ran logit and probit regression models to assess the validity of the OLS output. I included the same covariates in both modeling techniques. Typically, logit and probit models are used for a binary outcome variable, however, both techniques can be appropriate. Since the linear, logit, and probit regression models showed consistent results with respect to the statistical significance and the direction of impact for the explanatory variables, I report results from the linear probability model for ease of interpretability.

The consistency across the three models mean that the effects are not sensitive to different modeling choices (functional forms).

<table>
<thead>
<tr>
<th>Table 1. MODEL INFO: OLS Linear Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations: 389</td>
</tr>
<tr>
<td>Dependent Variable: CS_binary</td>
</tr>
<tr>
<td>Type: OLS linear regression</td>
</tr>
</tbody>
</table>

**MODEL FIT**

\[ F(13,375) = 13.23, \ p = 0.00 \]
\[ R^2 = .31, \ \text{Adj.} \ R^2 = .29 \]

**Standard errors:** Robust, \( \text{type} = \text{HC1} \)

<table>
<thead>
<tr>
<th>Est.</th>
<th>s.e.</th>
<th>t-val</th>
<th>p-val</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>0.17</td>
<td>0.22</td>
<td>0.77</td>
</tr>
<tr>
<td>% white</td>
<td>-0.07</td>
<td>0.11</td>
<td>-0.64</td>
</tr>
<tr>
<td>Rooftop solar tariff (binary)</td>
<td>0.14</td>
<td>0.06</td>
<td>2.45</td>
</tr>
<tr>
<td>State GA (binary)</td>
<td>0.05</td>
<td>0.07</td>
<td>0.84</td>
</tr>
<tr>
<td>State NC (binary)</td>
<td>0.12</td>
<td>0.04</td>
<td>2.98</td>
</tr>
<tr>
<td>State SC (binary)</td>
<td>0.33</td>
<td>0.06</td>
<td>5.22</td>
</tr>
<tr>
<td>State TN (binary)</td>
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<td>2.47</td>
</tr>
<tr>
<td>State VA (binary)</td>
<td>0.14</td>
<td>0.07</td>
<td>1.89</td>
</tr>
<tr>
<td>Municipal utility (binary)</td>
<td>-0.33</td>
<td>0.04</td>
<td>-8.27</td>
</tr>
<tr>
<td>% rent</td>
<td>0.11</td>
<td>0.21</td>
<td>0.52</td>
</tr>
<tr>
<td>% w post-secondary edu</td>
<td>0.51</td>
<td>0.31</td>
<td>1.62</td>
</tr>
<tr>
<td>% extreme poverty</td>
<td>-0.83</td>
<td>0.6</td>
<td>-1.37</td>
</tr>
<tr>
<td>Median HH income</td>
<td>0</td>
<td>0</td>
<td>-1.72</td>
</tr>
<tr>
<td>% high income</td>
<td>0.47</td>
<td>0.4</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Significance Codes: .001 = **** ; .01 = *** ; .05 = ** ; .1 = *

---


Table 7. MODEL INFO: General Linear Model - Logit

Observations: 389
Dependent Variable: CS_binary
Type: Generalized linear model
  Family: Binomial
  Link function: Logit

MODEL FIT
$\chi^2(13) = 133.46, p = 0.00$
Pseudo-$R^2$ (Cragg-Uhler) = .51
Pseudo-$R^2$ (McFadden) = .41
AIC = 218.69, BIC = 274.18
Standard errors: Robust, type = HC1

<table>
<thead>
<tr>
<th></th>
<th>Est.</th>
<th>s.e.</th>
<th>t-val</th>
<th>p-val</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3.51</td>
<td>-0.71</td>
<td>0.48</td>
</tr>
<tr>
<td>% white</td>
<td>-1.95</td>
<td>1.57</td>
<td>-1.24</td>
<td>0.22</td>
</tr>
<tr>
<td>Rooftop solar tariff (binary)</td>
<td>1.08</td>
<td>0.51</td>
<td>2.1</td>
<td>0.04  **</td>
</tr>
<tr>
<td>State GA (binary)</td>
<td>2.23</td>
<td>1.36</td>
<td>1.64</td>
<td>0.1   *</td>
</tr>
<tr>
<td>State NC (binary)</td>
<td>2.26</td>
<td>1.28</td>
<td>1.76</td>
<td>0.08  *</td>
</tr>
<tr>
<td>State SC (binary)</td>
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<td>1.2</td>
<td>3.34</td>
<td>0     ****</td>
</tr>
<tr>
<td>State TN (binary)</td>
<td>2.63</td>
<td>1.51</td>
<td>1.74</td>
<td>0.08  *</td>
</tr>
<tr>
<td>State VA (binary)</td>
<td>2.65</td>
<td>1.41</td>
<td>1.88</td>
<td>0.06  *</td>
</tr>
<tr>
<td>Municipal utility (binary)</td>
<td>-3.89</td>
<td>0.53</td>
<td>-7.4</td>
<td>0     ****</td>
</tr>
<tr>
<td>% rent</td>
<td>2.26</td>
<td>3.73</td>
<td>0.61</td>
<td>0.54</td>
</tr>
<tr>
<td>% w post-secondary edu</td>
<td>9.3</td>
<td>4.93</td>
<td>1.89</td>
<td>0.06  *</td>
</tr>
<tr>
<td>% extreme poverty</td>
<td>-17.62</td>
<td>10.17</td>
<td>-1.73</td>
<td>0.08  *</td>
</tr>
<tr>
<td>Median HH income</td>
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<td>0</td>
<td>-1.73</td>
<td>0.08  *</td>
</tr>
<tr>
<td>% high income</td>
<td>6.49</td>
<td>6.78</td>
<td>0.96</td>
<td>0.34</td>
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</table>

Significance Codes: .001 = **** ; .01 = *** ; .05 = ** ; .1 = *
Table 8. MODEL INFO: General Linear Model - Probit

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<tr>
<th>Observations: 389</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: CS_binary</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Type: Generalized linear model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family: Binomial</td>
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</tr>
<tr>
<td>Link function: Probit</td>
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</tr>
</tbody>
</table>

**MODEL FIT**

χ²(13) = 132.59, p = 0.00
Pseudo-R² (Cragg-Uhler) = .51
Pseudo-R² (McFadden) = .41
AIC = 219.56, BIC = 275.05

Standard errors: Robust, type = HC1

<table>
<thead>
<tr>
<th></th>
<th>Est.</th>
<th>s.e.</th>
<th>t-val</th>
<th>p-val</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
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<td>1.73</td>
<td>-0.88</td>
<td>0.38</td>
</tr>
<tr>
<td>% white</td>
<td>-0.87</td>
<td>0.93</td>
<td>-0.93</td>
<td>0.35</td>
</tr>
<tr>
<td>Rooftop solar tariff</td>
<td>0.58</td>
<td>0.29</td>
<td>1.99</td>
<td>0.05  **</td>
</tr>
<tr>
<td>(binary)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State GA (binary)</td>
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<td>0.69</td>
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<td>0.14</td>
</tr>
<tr>
<td>State NC (binary)</td>
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<td>0.64</td>
<td>1.74</td>
<td>0.08  *</td>
</tr>
<tr>
<td>State SC (binary)</td>
<td>2.07</td>
<td>0.56</td>
<td>3.7</td>
<td>0      ****</td>
</tr>
<tr>
<td>State TN (binary)</td>
<td>1.29</td>
<td>0.76</td>
<td>1.69</td>
<td>0.09  *</td>
</tr>
<tr>
<td>State VA (binary)</td>
<td>1.24</td>
<td>0.71</td>
<td>1.74</td>
<td>0.08  *</td>
</tr>
<tr>
<td>Municipal utility (binary)</td>
<td>-2.12</td>
<td>0.25</td>
<td>-8.59</td>
<td>0      ****</td>
</tr>
<tr>
<td>% rent</td>
<td>1.92</td>
<td>1.97</td>
<td>0.97</td>
<td>0.33</td>
</tr>
<tr>
<td>% w post-secondary edu</td>
<td>5.01</td>
<td>2.66</td>
<td>1.89</td>
<td>0.06  *</td>
</tr>
<tr>
<td>% extreme poverty</td>
<td>-9.72</td>
<td>5.09</td>
<td>-1.91</td>
<td>0.06  *</td>
</tr>
<tr>
<td><strong>Median HH income</strong></td>
<td>0</td>
<td>0</td>
<td>-1.63</td>
<td>0.1</td>
</tr>
<tr>
<td>% high income</td>
<td>3.31</td>
<td>3.66</td>
<td>0.91</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Significance Codes: .001 = **** ; .01 = *** ; .05 = ** ; 1 = *

In addition to exploring alternative functional forms, I explored different explanatory variables stemming from hypotheses about the drivers and barriers of CS. Ultimately, I excluded some variables from the primary regression model because of negligible impacts on the model estimates (and missing data). For instance, I hypothesized that the utility retail electric rate may influence CS uptake. From the utility perspective, a higher rate (cost per kWh) could indicate high energy costs from the power provider and thus incentive to develop alternative energy sources (increased likelihood of CS development). From the customer perspective, higher electric rates could similarly motivate them to look for lower cost options (CS or rooftop solar). The inclusion of the EIA variable for the residential retail electric rate was not statistically significant and had no effect on the other explanatory variables (not correlated).
Variables from the Sunroof dataset were not statically significant and were excluded from the primary model due to incomplete information. Around 30 percent – 130 local utilities – did not have sufficient Sunroof data, which impacted the t-statistics and p-values (statistical significance) of the model. Sunroof data is primarily reported for urban centers, which introduces bias to the regression (rural areas will be underrepresented). See below map for distribution of Sunroof data.

Map 1. Distribution of Sunroof Solar Data

**Interview Methodology**

The purpose of the interviews was three-fold: (1) To help shape the content of the electronic survey, (2) to provide qualitative context to the quantitative analysis, and (3) to explore drivers of CS not captured by quantitative data. The interview selection focused solely on utilities with existing CS programs according to the Rates of Solar spreadsheet. Starting late January, I reached out via email in waves of three to four local utilities. Selection aimed for variation in location and utility type. However, utilities based in North Carolina were more responsive, likely due to the association with Duke University.

I conducted six semi-structured interviews with local utility managers and engineers between February 2021 and March 2021. The interviews averaged around 30 minutes and were conducted via phone or Zoom, depending on the preference of the interviewee. Otter.ai web-based software was used to transcribe the interview recordings. For quality control, I listened to the interviews and manually corrected the transcripts as needed (see supplemental material for transcriptions of the interviews). The semi-structured interview protocol asked practitioners to describe the utility’s approach to renewable energy, the impetus
of CS development, and the popularity of the CS program. This approach was useful in accommodating widely varying experiences with CS.

**Utilities contacted for interviews (completed interviews in blue)**

- Brunswick EMC (EMC – NC)
- Green Power EMC (G&T Cooperative – GA)
- Pee Dee Electric (EMC – NC)
- Roanoke Electric (EMC – NC)
- Aiken Electric Cooperative (EMC – SC)
- Cape Hatteras (EMC – NC)
- Coastal Electric Cooperative (EMC – GA)
- Fayetteville (Municipal – NC)
- Nashville Electric Service (Municipal – TN)
- Northern Neck Electric Cooperative (EMC – VA)
- Rappahannock Electric Cooperative (EMC – VA)
- Tennessee Valley Authority (G&T – primarily TN)

In addition to the above, Scott Fielder (TVA Media Relations) responded to my interview request by connecting me with BrightRidge (Municipality – TN). Jeff Paul from Walton EMC (EMC – GA) reached out upon completing the electronic survey to share more about his experience with CS at the utility.

### Interview Analysis

Data analysis for the interviews used an iterative coding process. I began with open coding guided by the research interest in CS development and factors of utility decision-making around solar energy. The codebook for the interviews was derived using structural, descriptive, and attribute coding approaches. First, I reviewed the transcripts for the overarching topics discussed (descriptive coding). Generally, these flowed from the interview questions. Next, I identified subthemes within each topic (structural coding). For example, one topic was “solar expertise”, and a subtheme was “issues with residential installers.” Finally, to put the interview in context and summarize characteristics about the utility, I employed attribute coding of descriptors such as, utility name, state, type, power provider, plans for CS expansion, and the success of the program.

I established reliability through repetition and an external reviewer (a fellow Master of Public Policy student in the Environment & Energy Concentration). Once intimately familiar with the responses, a color key was used to highlight applicable instances of each overarching category or sub-category.

### Survey Methodology

Given that many of the variables of interest (customer demand, access to solar expertise) were not available in any accessible dataset or publicly available online,
I created a new quantitative survey instrument to collect key information. The Rates of Solar dataset contained some contacts for the utilities in my client’s region. However, spreadsheet listed no contacts for around 80 percent of the utilities in the region.

To obtain contact information, I reviewed each utility website and identified the relevant email address. For 10 percent of utilities, no email address or online contact form was given. Due to time constraints, these utilities were not contacted about the survey. For the remaining utilities, 100 only used customer service web portal link for inquiries. The remaining 210 had contact information for either specific individuals or general customer service shared inboxes.

Survey respondents were given 10 days to complete the 16 question (max) survey. Leveraging conditional responses, respondents answered different questions whether they (1) had a community solar program, (2) were considering developing or expanding a program, and (3) whether they had ever considered offering community solar. The questions consisted of a mix of Likert scales, short answer, and multiple-choice questions. See Appendix E for the survey instrument.71 The survey was sent out February 19th at 8am EST. Two follow up emails were sent to the group of utilities with email addresses on February 26th and March 1st. The survey design was based on interviews with utility representatives and two existing survey instruments on CS.72

Survey Analysis
The original intent of the survey was to quantify the results in order to include in the statistical analysis. However, the low response rate prevented this. Out of the 310 utilities, only 11 recipients completed the survey prior to the deadline. Additionally, four of the respondents had never explored offering CS and thus did not contribute to the key Likert scale questions of interest. The Likert scale CS responses for (1) perceived barriers, (2) perceived advantages, and (3) perceived benefits, were quantified (ordinal rating scale) and aggregated. This approach is similar to the Community Solar for the Southeast Gap Analysis Report.73 NCCETC’s survey was to a variety of organizations in the Southeast. There were two EMC respondents and no municipal utility respondents. They received 33 responses to the survey out of 129 potential respondents (25.6 response rate).74

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72 Community Solar for the Southeast: Gap Analysis Report; Funkhouser et al., "Emerging Landscape of US Community Solar."


APPENDIX D: INTERVIEW PROTOCOL

Primary Areas of Focus
1. General approach to solar development
2. Initial discussions surrounding community solar
3. Factors (barriers, concerns, benefits) of community solar development
4. Customer interest in community solar program

Sample Questions
1. How would you describe [utility name’s] approach to clean energy (e.g., solar, wind)?
   a.  *Probe:* Why do you think [utility name] takes this approach (e.g., customer preferences, business interest, government regulation, etc.)
2. Can you tell me about the initial discussions surrounding community solar development?
   a.  *Probe:* What initiated the exploration into community solar?
   b.  *Probe:* Who was involved in the decision-making process?
   c.  *Probe:* What concerns were raised?
   d.  *Probe:* What benefits were discussed?
3. How did [utility name] navigate instituting a community solar program?
   a.  *Probe:* Who helped with the technical aspects? How about the financing?
4.  *[Connected to above Q]* Did the idea of solar + storage come up?
5. What was challenging with the development of the program?
6. What was surprising about the development of the program?
7. How would you describe customer interest in the program (e.g., the popularity of the program)?
   a.  *Probe:* How did [utility name] introduce and engage customers?
   b.  *Probe:* How has customer demand for the program changed over time (if at all)?
8. Some utilities tailor their CS program to attract low-and-middle income customers, is that something [utility name] has thought about?
9. How do you currently view the community solar program?
   a.  *Probe:* Are you satisfied with the program?
10. Are there discussions about expanding the program?
11. If so, can you talk about some of the considerations discussed with expansion?
APPENDIX E: SURVEY INSTRUMENT

Qualtrics survey sent to 310 local utilities.

1. Do you own any power generation sources?
   a. Yes
   b. No

2. How frequently are member-customers involved in the decision-making process at your organization?
   a. Hardly ever
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

3. Does your organization currently offer a community solar program to its customers?
   a. Yes
   b. No

4. Does your organization plan to develop a new community solar program in the future?
   a. Yes
   b. No

5. [Conditional on having a community solar program] How would you describe the popularity of the community solar program(s) with residential solar?
   a. Not popular
   b. Slightly popular
   c. Moderately popular
   d. Very popular
   e. Extremely popular

6. [Conditional on having a community solar program] How would you describe the popularity of the community solar program(s) with business/commercial customers?
   a. Not popular
   b. Slightly popular
   c. Moderately popular
   d. Very popular
   e. Extremely popular

7. [Conditional on having or planning to have a community solar program] Below are potential factors that commonly hinder community solar development. For each factor, please indicate whether it was a barrier when assessing community solar potential.
Below are factors that often enable community solar development. For each factor, please indicate whether it served as an advantage when assessing community solar potential.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Not applicable (not a barrier)</th>
<th>Weak advantage</th>
<th>Moderate advantage</th>
<th>Strong advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High upfront costs</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Inaccessible financing</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Uncertainty about program model &amp; pricing</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Unfamiliarity with program design</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Unfamiliarity with storage options</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Limited solar expertise</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Difficulty integrating with billing system</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Restrictive state policies</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Restrictive local or municipal policies</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Restrictive power purchase contracts with G&amp;T provider(s)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of customer interest</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of board or management support</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

8. [Conditional on having or planning to have a community solar program] & [Conditional on responses to barriers of community solar] Below are factors that often enable community solar development. For each factor, please indicate whether it served as an advantage when assessing community solar potential.
9. In general, which aspects of community solar are the most appealing to your organization?

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Not at all appealing</th>
<th>Slightly appealing</th>
<th>Moderately appealing</th>
<th>Very appealing</th>
<th>Extremely appealing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory compliance (i.e., RPS requirements)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer engagement/satisfaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer retention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Better integration of solar to the electric grid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar access for low-to-moderate income (LMI) customers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. [Conditional on response to the appeal of LMI subscribers] For the program, how does [utility name] plan to attract or retain low-to-moderate income (LMI) subscribers. Select all that apply.
   a. Reserved capacity for LMI customers
   b. Discounted or subsidized cost
   c. Information campaigns
   d. Guaranteed savings on electric bill
   e. Donation program
   f. Flexible payment options
   g. Easy credit reassignment (e.g., if the customer moves)
   h. Other [space for write-in response]

11. Is there anything else we should know about community solar at your organization? Please detail below.
   a. [Space for write-in response]

12. May we contact you if we have follow-up questions about the survey?
   a. Yes
   b. Maybe
   c. No