Solar Utility Network Deployment Acceleration (SUNDA)—Final Report

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NOTICE/DISCLAIMER

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Abbreviations

AE	Advanced Energy
AEC	Appalachian Electric Cooperative
AEPCO	Arizona Electric Power Cooperative
BEMC	Brunswick EMC
BTS	Business and Technology Strategies department
C&I	commercial and industrial
CEC	Clean Energy Collective
CEO	Colorado Energy Office
CFC	National Rural Utilities Cooperative Finance Corporation
CREBs	Clean Renewable Energy Bonds
CSR	customer service representative
CUP	conditional use permit
DER	distributed energy resources
DOE	U.S. Department of Energy
DG	distributed generation
ECEC	Eau Claire Energy Cooperative
EMC	electrical member corporation
EPC	engineering, procurement, and construction
ERCOT	Electric Reliability Council of Texas
Federated	Federated Rural Electric Insurance Exchange
GRE	Great River Energy
GRID	GRID Alternatives
G&T	generation and transmission

IOU	investor-owned utility
IRR	internal rate of return
ITC	Investment Tax Credit
LCOE	levelized cost of energy
LMI	low- to moderate-income
MACRS	Modified Accelerated Cost Recovery System
MAG	member advisory group
MOTSU	Military Ocean Terminal Sunny Point
MTEMC	Middle Tennessee Electric Membership Corporation
NCEMC	North Carolina Electric Membership Corporation
NCREBs	New Clean Renewable Energy Bonds
NDP	National Discounts Program
NPV	net present value
NRCO	National Renewable Cooperative Organization
NRECA	National Rural Electric Cooperative Association
NRTC	National Rural Telecommunications Cooperative
NRUCFC	National Rural Utilities Cooperative Finance Corporation
NZE	Net Zero Energy
O&M	operations and maintenance
PMA	Power Marketing Administration
PMP	Project Management Plan
PPA	power-purchase agreement
PV	photovoltaic
PVAS	Poudre Valley Associate Services

PVM	PV management
PVREA	Poudre Valley Rural Electric Association, Inc.
REAP	Rural Energy for America Program
REC	Renewable Energy Credit
RFP	requests for proposal
RMI	Rocky Mountain Institute
RPS	renewable portfolio standard
RTAC	real-time automation controller
RUS	Rural Utilities Service
SCADA	supervisory control and data acquisition
SCE	Southern California Edison
sCOOP	Solar Cooperative Community Projects
SEC	Securities and Exchange Commission
SEPA	Smart Electric Power Alliance
SETO	DOE’s Solar Energy Technology Office
SPE	special purpose entity
SUNDA	Solar Utility Network Deployment Acceleration
SWPA	Southwestern Power Administration
SWPPP	storm water pollution prevention plan
TVA	Tennessee Valley Authority
Virtual NEM	Virtual Net Energy Metering
WAPA	Western Area Power Administration
WH	Wright-Hennepin Cooperative Electric Association

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1.0 Introduction

The National Rural Electric Cooperative Association (NRECA) is the national association representing 833 distribution and 62 generation and transmission (G&T) cooperatives. From booming suburbs to remote rural farming communities, America's electric cooperatives are energy providers and engines of economic development and way of life for more than 19 million American homes, businesses, farms, and schools in 47 states across the U.S. Member owned and responsive, generally smaller than investor-owned and municipal utilities, often more nimble in services for members, co-ops provide the U.S. Department of Energy (DOE) with a strong partner for testing and accelerating utility-scale solar design, pricing, and delivery models.

In October 2013, NRECA and DOE's Solar Energy Technology Office (SETO) signed a cooperative agreement for a research project focused on reducing costs and identifying and addressing barriers to photovoltaic (PV) deployment at cooperative utilities as they deployed >23 MW of solar in multiple states. The project was structured as an accelerator for co-ops, utilizing an iterative and learning-by-doing process to develop PV engineering designs, streamlined business models, and effective financing and tax structures. The structure defined 3 cohorts of co-ops, organized in phases, to learn from each other and share with the larger co-op community.

DOE awarded $3.6 million in funding for the Solar Utility Network Deployment Acceleration (SUNDA) project under the SunShot initiative. NRECA matched DOE's funds with more than $1.2 million in cost sharing from NRECA and the participating cooperatives.

1.1 Executive Summary

In 2013, when the SUNDA project began, less than 1% of the nation's co-ops had deployed solar PV systems at the 250 kW or greater scale, and only 3% expressed interest. As of December 2017, 10% of all electric co-ops have deployed PV systems of ≥250 kW, 50% have a solar offering for their members, another 10% are actively planning systems, and the average size of co-op led projects has increased from ~80 kw to >1 MW. The SUNDA project's tools and products contributed greatly to this increase. Where appropriate, co-ops worked together to learn from one another and to respond to member interest to implement solar better, faster, and cheaper.

Technology transfer—the job of getting information about an emerging or changing technology—has long been one of the recognized barriers to implementing solar. As DOE has observed in many areas, tools development and study alone are often not sufficient to create change. Education and training are more critical than ever. Many factors come to bear, including rapid changes in solar PV technology, rapidly changing costs, a need for skills development within the utility workforce, as well as an increased selection of service provider offerings. In recognition of the challenge, the SUNDA project delivered a broad selection of educational opportunities. In particular, peer-to-peer interaction was a cornerstone of the entire SUNDA project. These forums facilitated by NRECA were highly beneficial in technology and business knowledge transfer between co-ops and to the broader community. This project not only validated NRECA's prior experience of the effectiveness of building technical and business tools, but also illustrated the value of combining these efforts with NRECA's unique position for accelerating technology transfer and skills development with lasting impact across rural America.

Major shifts took place in the co-op community's evaluation process, business models, program design, and execution of solar projects. The SUNDA project played a significant role in facilitating these developments, which included the following:

- In a change from 2014, co-ops increasingly list experience gained, increased load diversification, reduced demand, reduced peak, and asset upgrade deferral among the benefits of solar deployment. However, "Member Interest" continues to be cited as the primary impetus for current and future solar acquisition, regardless of cost savings or capacity needs.
- Responding to member interest, co-ops are leading the way for community solar. Over time, programs have evolved. Early programs required significant upfront investment; more recently implemented programs offer simpler options, such as non-binding monthly subscriptions or even multiple participation options.
- Despite initial challenges, in 2018 the cooperative power providers—the G&T co-ops—are taking the lead and acting as the aggregator for their distribution co-op members to facilitate acquiring solar facilities at lower costs due to economies of scale (>370 MW to date). G&Ts not deploying solar at this time consistently report that they have other renewable sources—hydro and/or wind—that are cheaper than solar.[1]
- Co-ops are integrating solar into their primary business models; offering members behind-the-meter-equivalent community projects; and enhancing economic development and responding to the growing demand for green energy services in the corporate sector by determining how best to provide services such as solar and energy storage to their key accounts, commercial and industrial (C&I), and agricultural customers.
- There are now several models of financing available to the tax-exempt co-ops that successfully monetize the renewable Investment Tax Credit (ITC). Solar financing is now available through

[1] G&Ts are not the only providers of wholesale power to distribution co-ops; a little over half of all the distribution co-ops are part of G&T families. The rest have different types of power supply arrangements— non-G&T co-ops buy from the energy market and/or get their power supply from providers other than G&Ts.

co-ops' traditional lending partners: National Rural Utilities Cooperative Finance Corporation (NRUCFC or simply CFC), and CoBank.

- The Federated Rural Electric Insurance Exchange (Federated) has developed a standard co-op solar insurance offering, thereby significantly reducing the real and perceived risk of deploying millions of dollars of equipment in the field.

As shown in Figure 1, the SUNDA project touched more than 95% of U.S. electric co-ops through conversations, calls, materials, webinars, trainings, NRECA courses, and NRECA events.[2]

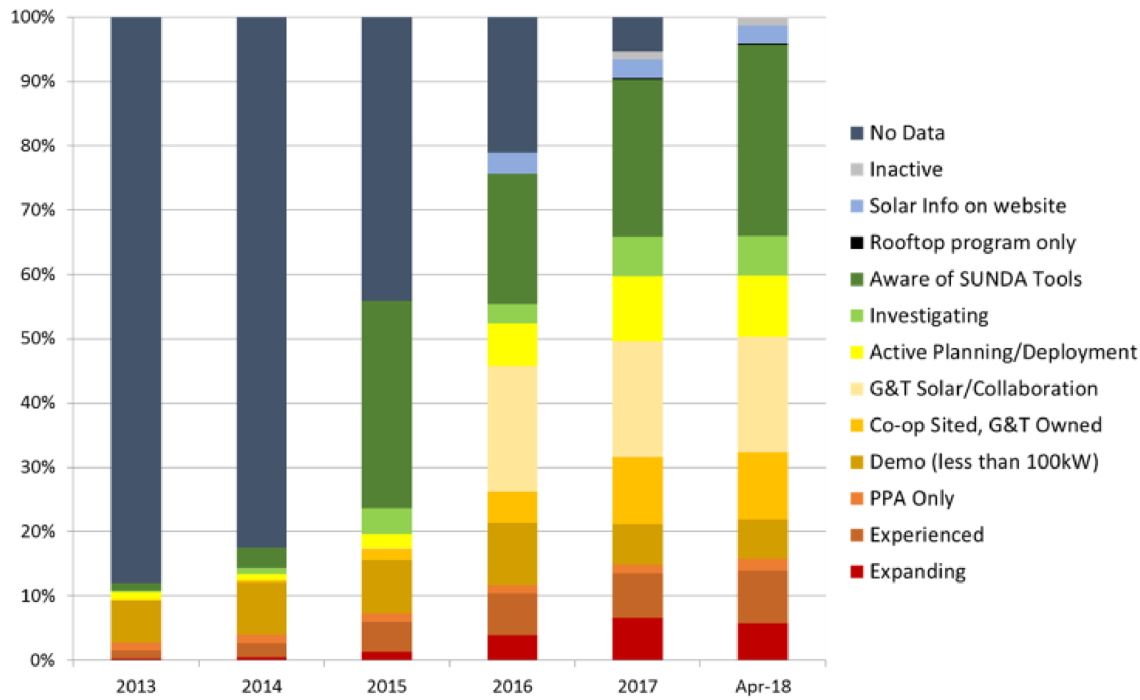


Figure 1: SUNDA Project Impact on U.S. Electric Co-ops

For those interested in proceeding directly to the lessons learned and recommendations resulting from this project, see Section 9 of this report.

The following sections will walk the reader through the project and its structure, the experiential aspects of deploying solar at multiple co-ops across the nation, business models and financing issues for co-op solar, tools and resources developed under this project for the use of co-op utilities, outreach efforts undertaken as part of the project, and the evolution of attitudes and thinking of co-op utilities regarding solar PV and community solar projects.

[2] See Section 7, PV Maturity, for more details.

2.0 Project Description

In 2012, NRECA applied for a grant under the DOE SETO SunShot-sponsored funding opportunity SUNRISE under its topic B, "technical assistance provider." NRECA adopted a business accelerator model to help cohorts of distribution co-ops interested in owning solar to integrate utility-owned solar into their service territory. The SUNDA project was characterized by its use of 5 methods to assist the co-ops: (1) learning by doing; (2) learning in groups/peer-to-peer learning; (3) standardization of designs, processes, templates, and tools; (4) direct technical assistance; and (5) data-driven assessment of project efficacy. This approach, coupled with NRECA's broad geographic reach and world-class outreach, training, and marketing channels,[3] resulted in the award of a 4-year $3,645,657, 25% cost-sharing collaborative agreement.

2.1 Project Structure

The SUNRISE-B topic specifically referred to helping reduce the "soft costs" of utility-owned solar projects. Toward this end, NRECA sought to reduce the barriers to entry for utility-scale, utility-owned solar PV systems, with a focus on co-op-specific project decision-making and planning, including cost reduction through standardization, templates, and shared learning. NRECA collaborated with 15 geographically diverse co-ops serving small and large populations, committed to implementing 23 MW of eligible projects, with goals ranging from 0.25 MW at Oneida-Madison, EC, a small co-op in New York State, to 5 MW for Tri-State, a G&T cooperative based in Colorado. This group of co-ops was segmented into 3 phases of deployments to allow the learnings and experiences of the initial co-ops to be imparted to the later groups.

[3] See Section 6 of this report, Outreach, for more details about NRECA's outreach activities.

Phase I co-ops planned to deploy a system within the next 18 months and were willing to share their experience. Phase II co-ops included those interested in a timeline within the next 30 months but looking for support from the extended SUNDA team. Phase III co-ops were committed to completing a project before the end of the 4-year period of performance but still needed to learn more before planning their projects. Throughout these phases, NRECA met with the co-ops individually and in groups; provided opportunities for peer-to-peer learning; organized technical, financial, and insurance support; gathered the lessoned learned; and made them available to the ~900 other electric co-op members of NRECA. Finally, to ensure that plans were adapted based on evolving needs, the project included a self-assessment and DOE review at the end of each phase, including a revision of the Project Management Plan (PMP) and a Go/No-Go option to proceed or not with the next phase.

2.2 Project Partners

The overall SUNDA effort was managed by NRECA. To assist in reducing the engineering and deal-structure costs of utility solar PV projects, NRECA sought engineering, insurance, and finance companies that could leverage their expertise to develop standardized plans and offerings to reduce the amount of one-off, custom work that had to go into each solar field development.

On the engineering side, Power Secure Solar, NRECA's engineering vendor company, designed the template PV plans at 0.25-MW, 0.5-MW, and 1-MW scales that could be easily and cheaply adapted to the specific needs of a co-op's site. Providing standard designs for co-ops to implement was part of the project's path toward reducing the engineering soft costs of solar PV. Power Secure Solar also assisted by providing direct engineering assistance to a number of the co-ops, brought its deep knowledge of solar PV system design to help develop the cost model used in the PV Cost and Finance Screening Tool, and acted as technical reviewers for Volumes II and III of the Cooperative Utility PV Field Manual (PV Manual).[4]

NRUCFC (or simply "CFC") provided invaluable insight into the intricacies of how the largely tax-exempt electric co-ops can take advantage of the tax benefits of implementing solar PV. CFC wrote the initial draft version of Volume I of the PV Manual, a guide providing all the details that a co-op executive would need about financing these projects and outlining the business models for co-op utility-owned PV. In addition, it provided the basic equations to integrate co-op financing into the PV Cost and Finance Screening Tool, and provided direct support both to the project and the co-ops by participating in multiple webinars. The webinars helped co-ops understand the different pathways toward using tax-advantaged financing for PV projects. CFC, as well as the National Renewable Cooperative Organization (NRCO), the National Rural Telecommunications Cooperative (NRTC), and Co-Bank, developed solar-

[4] See the Tools section of this report (Section 5) for more details on the Template PV Designs, PV Costs and Finance Screening Tool, and the PV Manuals.

specific financing options, such as tax-equity flip structures and lease-back programs, that meet co-ops' needs and monetize the renewable ITC. Each of these organizations participated in SUNDA activities and provided inputs to SUNDA products.

Federated helped reduce the barriers to co-op-owned solar by developing a standard co-op solar insurance offering, thereby significantly reducing the real and perceived risk of deploying millions of dollars of equipment in the field.

The original co-ops that anticipated a deployment of more than 250 kW and joined the SUNDA project were as follows:

1.	Anza Electric Cooperative	Anza, CA
2.	Brunswick Electric Membership Corporation	Shallotte, NC
3.	Central Electric Cooperative	Columbia, SC
4.	CoServ Electric	Corinth, TX
5.	Eau Claire Energy Cooperative	Fall Creek, WI
6.	Great River Energy	Maple Grove, MN
7.	Green Power EMC/Oglethorpe	Tucker, GA
8.	Maquoketa Valley Electric Cooperative	Anamosa, IA
9.	Oneida-Madison Electric Cooperative	Bouckville, NY
10.	Owen Electric Cooperative	Owenton, KY
11.	Pedernales Electric Cooperative	Johnson City, TX
12.	Plumas-Sierra Rural Electric Cooperative	Portola, CA
13.	Sandhills Utility Services	Fort Bragg, NC
14.	Tri-State G&T Association (CO, UT, WY, NM, & NE)	Westminster, CO
15.	Vermont Electric Cooperative	Johnson, VT

For various reasons, a number of these co-ops decided not to move forward with utility-scale, utility-owned projects of their own—including delays in project funding (Sandhills), the project expanding with the G&T lead (Owen), and changes in organizational goals (Central Electric, Plumas Sierra). Many co-ops, such as Vermont and Pedernales, eventually made the decision to go with power-purchase agreements (PPAs) rather than utility-owned systems, and no longer fell within the SUNDA project constraints.

The following is the final list of co-ops that installed projects under SUNDA:

1.	Anza Electric Cooperative/AEPCO	Anza, CA
2.	Appalachian Electric Cooperative	New Market, TN
3.	Brunswick Electric Membership Corporation	Shallotte, NC
4.	CoServ Electric	Corinth, TX
5.	Eau Claire Energy Cooperative	Fall Creek, WI

6.	Great River Energy	Maple Grove, MN
7.	Green Power EMC/Oglethorpe	Tucker, GA
8.	Kansas Electric Power Cooperative	Topeka, KS
9.	Middle Tennessee EMC	Murfreesboro, TN
10.	Poudre Valley REA (a Tri-State member)	Fort Collins, CO
11.	Sussex Rural Electric Cooperative	Sussex, NJ

Although plans and timelines sometimes changed, and co-ops moved to another project phase, eventually the SUNDA co-op participants installed 2.9 MW in Phase I, 12.9 MW in Phase II, and 14.7 MW in Phase III, far exceeding the original commitment of 23 MW.[5] Other co-ops affiliated with the project, but not formally participating, installed another 60+ MW of utility-owned PV during the course of the project, using the materials, templates, tools, and lessons learned from SUNDA. Appendix 1 includes a case study for each participating co-op that deployed a system during the SUNDA project.

2.3 Process

The project held an official kickoff meeting on November 19–20, 2013 at NRECA's Arlington, VA headquarters. This meeting was the first of many collaborative meetings and was essential in fostering the relationships and collaborative culture of the team. It was also an opportunity to orient the team to the basics of PV technology and the goals and process of the project.

Shortly after the kickoff meeting, the team began assembling and sharing preliminary materials on technical designs, business models, procurement, and financing via NRECA conferences and webinars. In another early activity, NRECA undertook a survey of all its member cooperatives to assess the state of solar among them. This survey was an important part of the overall project structure, as it defined a baseline against which to measure the change in thinking and activity around solar PV in the cooperative community. This survey was conducted again at the end of the project to measure the project's impact on NRECA's members.[6]

In the spirit of a business accelerator, NRECA provided resources and tailored technical assistance to help the Phase I projects succeed. This activity involved direct support and consulting. NRECA and Power Secure Solar performed site visits and assessments. Each co-op participated in conference calls with NRECA, Power Secure Solar, and CFC to discuss topics such as the co-op's goals for the project, plans for site location, project financing, and technical details and options. After this initial stage of intense

[5] It should be noted here that utilities list the size of their solar arrays in $MW_{ac,}$ not the more commonly cited solar panel size of MW-DC. This approach reflects the utility perspective that it is AC power that is relevant, but it understates the DC size of the array by 20–40%. (DC array size is typically larger than AC inverter size, to optimize energy produced/system cost.)

[6] See Section 7: PV Maturity for more details.

interaction, ongoing support included quarterly conference calls to track progress and issues, and ad hoc calls and online support as needed.

The co-ops that were active during Phase I shared their experiences at an annual meeting of the team. The 3 questions were (1) What were your original expectations for the project? (2) How did your expectations compare to the reality of implementation? (3) What would you do differently? The structure of the meeting was deliberately designed to discuss not only what worked, but also what did not work, in a trusted and collegial environment. Afterward, the Phase I co-ops became spokespersons to the 200+ co-ops that at the time were exploring solar on NRECA-hosted webinars and conferences. The response from the co-op community was greater than anticipated, and NRECA responded by capturing the lessons learned during Phase I projects to accelerate the development and dissemination of tools and materials.

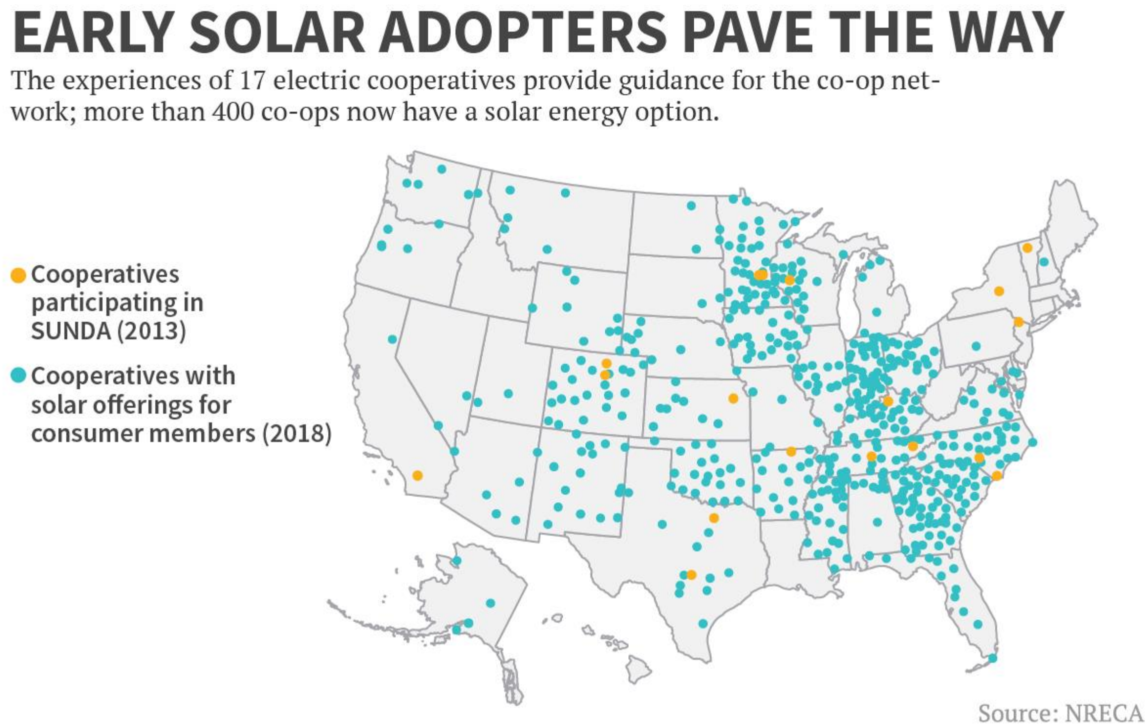
Phase II deployments followed much the same pattern as Phase I but with somewhat less direct assistance from NRECA and Power Secure, as co-ops began to draw more on the initial tools and their peer-to-peer relationships. The lessons learned from the Phase II deployments were then integrated into the revised tools and materials, which were tested and validated by Phase III deployments. The lessons learned, materials, and tools were then incorporated into dozens of training, coaching, and outreach activities.

This peer-to-peer interaction was a cornerstone of the entire SUNDA project. Consistently, the SUNDA participating co-ops, as well as those co-ops that became unofficial “associates,” identified the opportunities to gather and talk to their peers about each other’s projects and issues as the single most valuable resource of the project.

Project Structure Lessons:

- The iterative process/phased approach provides real-world experience upon which co-op resources can be developed, improved, and validated.
- The team approach, emphasizing peer-to-peer learning, provides a trusted environment for collaborative problem solving and establishes a pipeline of experienced co-op representatives to provide assistance and expertise to other co-ops.
- It is important to establish a baseline and measures to support tracking of project efficacy and impact.
- NRECA’s capabilities are best suited to providing project management and oversight, technical expertise, facilitation of learning within a project team, and sharing of knowledge across the co-op community.

3.0 Solar Deployments



The purpose of the SUNDA project was to be an accelerator for utility solar deployment through a learning-by-doing approach, followed up by a broad dissemination of the learnings. To that end, the project had a goal of installing more than 20 MW of solar at various co-op utilities across the country, with as much diversity of geography, climate, membership size, and economic background as possible. NRECA drew on its relationship with its members to find a number of co-ops that were either ready to deploy utility-owned solar or were looking to implement such a system in the next 4 years. Details of the deployments at each participating co-op can be found in Appendix 1.

Active SUNDA Projects				Gate 1 Begun Permitting metric: permit applied for	Gate 2 Begun Procurement metric: signed contracts	Gate 3 Begun Installation metric: broken ground	Gate 4 Completed Deployment metric: Commissioned
Phase I (Y1 & Y2: 10/13 - 9/15)	**Status**	**State**	**MW**				
CoServ Electric I	**In**	**TX**	**2**	Sep-14	Jan-15	Mar-15	Sep-15
Great River Energy - 1	**In**	**MN**	**0.25**	Jan-14	Jan-14	Mar-14	May-14
Sussex REC	**In**	**NJ**	**0.624**	Mar-14	Jul-14	Jan-15	Nov-15
			2.9				
% of co-ops as of 10/31/2017				100%	100%	100%	100%
% of MWs as of 10/31/2017				100%	100%	100%	100%
Phase II (Y3: 10/15 - 9/16)							
Anza Electric Co-op	**In**	**CA**	**2**	Dec-13	Oct-14	Oct-16	Jun-17
Brunswick EMC	**In**	**NC**	**1.2**	Sep-14	Oct-14	May-16	Sep-16
Eau Claire Energy Cooperative	**In**	**WI**	**0.75**	Apr-14	Aug-14	Jul-15	Dec-15
Great River Energy - 2 (Wright Hennepin)	**In**	**MN**	**2.25**	May-15	Dec-15	Mar-16	Aug-16
Green Power EMC - 1	**In**	**GA**	**6.7**	May-14	Jun-15	Mar-16	Sep-16
			12.9				
% of co-ops as of 10/31/2017				100%	100%	100%	100%
% of MWs as of 10/31/2017				100%	100%	100%	100%
Phase III (Y4: 10/16 - 9/17)							
Appalachian REC	**In**	**TN**	**1.373**	Mar-16	May-16	Jul-16	Dec-16
Green Power EMC - 2	**In**	**GA**	**3**	Jun-16	Nov-16	Jan-17	Jul-17
Kansas Electric Power Co-op	**In**	**KS**	**1**	Jan-16	May-16	Oct-16	Mar-17
Middle Tennesee EMC	**In**	**TN**	**0.8**	May-16	Jul-16	Aug-16	Jan-17
Poudre Valley/TriState G&T	**In**	**CO**	**1.5**	Oct-16	Jun-17	Jul-17	Sep-17
			7.7				
% of co-ops as of 10/31/2017				100%	100%	100%	100%
% of MWs as of 10/31/2017				100%	100%	100%	100%

The figure above lists the co-ops, the size of their projects, and when they completed each of the 4 gates the team used to track milestones for each deployment:

1. Process begun as identified by permit applied for
2. Procurement begun as identified by signed contract
3. Installation begun as identified by breaking ground
4. Deployment complete, as identified by system commissioned and/or providing energy to the grid

The time from the beginning of permitting to commissioning varied greatly across the participating co-ops; from 5 months for GRE’s first deployment to 3.5 years for Anza EC, with the major factor being permitting.

The participating co-ops started by developing a workplan based on their initial goals and identifying a potential site for the deployment. They then had the opportunity to work directly with Power Secure Solar to formulate an initial technical plan. This plan was based on the size and type of equipment already on the co-op distribution network, as well as the proposed location of the solar site. It included detailed drawings of the layout of the solar panel strings, possible inverter and transformer siting, and a detailed bill of materials.

Once each co-op had selected a site for the deployment and completed this initial technical plan, an NRECA staff engineer and Power Secure Solar representative visited the co-op to go over the project. This meeting was useful in connecting with the co-op management and other staff members who would be impacted by the project. The face-to-face meeting helped answer any additional questions that had come up in planning the project or prepping for the visit and also served to support project oversight and reporting requirements. The questions and issues that arose during these visits were incorporated into the revised PV Manuals and became part of the webinars and phone calls that disseminated this information to the larger co-op solar community.

For the vast majority of co-ops, the next phase was to find an engineering, procurement, and construction (EPC) company to actually build the solar facility. NRECA and Power Secure Solar worked with the co-ops to help them develop their requests for proposals (RFPs) and sometimes became involved in helping interpret the proposals that the co-ops received. The value of the template designs became very clear in this process, as they provided a reference against which proposals could be compared, and significant discrepancies could be flagged for questions or revisions.

3.1 Siting and Permitting

Siting and permitting can be more challenging and time consuming than anticipated. For any utility, the optimum placement for a solar array is in proximity to a substation, simply to eliminate the need for installing poles and wires to carry the high currents produced by the array. Also, co-ops frequently own large pieces of land close to these substations. However, environmental and land-use regulations can render unusable what would otherwise be an optimal location.

Permitting is also a totally regional phenomenon. Although there are some federal requirements, there are no standard national processes for solar sites and approvals. Each state and county can have its own regulations. Several co-ops breezed through the permitting process in as little as 4 months, simply because their counties had little in the way of permitting requirements. Other locations took more than 3 years to complete the process. Although much of the process around permitting is out of the hands of co-ops, they do have some control over site selection. The big lesson learned in this process is that a co-op should consider multiple sites and make a selection based on technical, environmental, and permitting requirements. One of the lessons learned is for co-ops to engage a land agent or real estate attorney familiar with the local, state, and federal requirements to review potential issues during the initial site selection process.

3.2 Procurement

In the original SUNDA project proposal, one of the elements that NRECA proposed to reduce the soft costs of utility solar projects was to utilize its National Discounts Program (NDP), a program of NRECA that provides negotiated discounts on equipment and services used by cooperatives. NDP has negotiated discounts with a wide variety of nationally recognized companies on everything from Ford fleet vehicles to Staples office and furniture supplies to the Wyndham Hotel Groups family of hotels. The intention was to use this program to arrange discount pricing on the primary equipment specified in the template designs—panels, inverters, and racking.

At first this program worked well, and favorable pricing, including free delivery in the continental U.S., was arranged with REC Americas, a recognized Tier 1 solar panel supplier. Similar arrangements were made with GameChange racking and for the Advanced Energy inverters. However, two issues quickly arose that limited or negated the usefulness of this program. First, industry pricing was simply changing too fast. A favorable negotiated price on panels would be struck and then ~120 days later, the market price dropped below the negotiated price, obviating any value. NDP then had to renegotiate a favorable price for the contract. This issue arose several times before NDP determined it was not a good use of its limited resources to continually rework these contracts in an unstable marketplace.

Second, the majority of co-ops chose to have EPC firms build their solar facilities. These firms used established designs and procurement arrangements, and thus could offer attractive pricing directly to cooperatives. Although co-ops could procure their own materials to save on the EPC markup, and a few co-ops did so, the savings realized were typically minimal. Contracting separately for the procurement of the primary equipment necessary for each solar project from the design and installation of the solar project increased the burden on the co-op and the risk of unclear responsibility. Ultimately, more co-ops chose to simplify their implementation of solar by utilizing a single EPC firm to handle all aspects of procuring and installing their solar facility.

3.3 Ground Breaking

Ground breaking provides an excellent opportunity to engage the community and local officials in project visibility. Nearly every participating co-op took advantage of this opportunity. However, beyond its PR value, there are some technical considerations. Early in SUNDA, it was not clear that one of the first decisions to be made was what ground cover should be underneath the utility’s solar panels. The reason this issue is important up-front is that it factors into ground preparation. It may or may not make sense to bulldoze the land clear. Removing the stabilizing vegetation means that the soil must be protected from erosion, and proper controls must be put in place; even then, weather can severely impact the site, with associated impacts on project costs and timelines. For example, CoServ spent an additional $200,000 on its project to put down stone and split rock when unseasonably heavy rains occurred for more than a week during the middle of construction. One option if the site is relatively flat and treeless is to leave the vegetation and mow it regularly. This adds long-term maintenance costs but may save significant up-front costs. Eau Claire chose a somewhat novel approach to mowing by choosing to have a flock of sheep graze under its array to control vegetation. If the soil must be disturbed, plans need to be made regarding whether to cover the earth with rock/aggregate or plant the field after site construction. Planting options include typical grasses, native species, and/or pollinator-friendly plantings. The latter option has additional PR benefits because the increased number of pollinators provides benefits for local agriculture; this approach was implemented by Dairyland, a G&T SUNDA associate.

Another consideration in the ground breaking and installation phase is equipment delivery. The equipment may not all arrive at the same time, the materials will need to be staged somewhere, the packaging may not be sufficient to prevent damage or be weatherproof, and security must be addressed. Several unique solutions were implemented by co-ops to address some of these issues, including parking a company truck at the site with a dummy in the front seat, and moving its location each day to make the site look occupied!

3.4 Commissioning

The commissioning ceremony is a huge public relations opportunity and a great time to encourage members to subscribe if the site is being offered as community solar. Although commissioning marks the end of the deployment phase, its success is also dependent on the early planning, and even though no major issues arose in commissioning during SUNDA, several co-ops and EPCs had slight differences of opinion at this stage that might have been avoidable. The checklists and sign-off procedures for the commissioning should be developed early in the final design phase so they can be written into the RFP and both the utility and the EPC can agree on them.

On the public relations side, to take care of any final technical difficulties or delays in construction, the actual ceremony should be scheduled 4 to 6 weeks after the planned commissioning tests to avoid reserving the date with elected officials and not having the site online.

Deployment Lessons:

- Siting and permitting are the biggest variables in cost and time.
- Co-ops should consider multiple sites and select the one with the fewest project impediments.
- A knowledgeable local land agent is a valuable resource in site selection and permitting.
- Co-ops should consider their array's groundcover options early in the planning stages.
- When working with an EPC, co-ops should be sure the contract contains proper project timeline incentives and sufficient project and commissioning details to achieve the desired results.

4.0 Business Models and Finance

A key goal of the project was to develop optimized business models for cooperative solar. The business side of the project can be thought of in 3 parts: (1) how to finance the project so the costs of implementing solar are equitably shared among consumer-members, (2) how to provide and charge for solar energy for those co-op consumer-members interested in pursuing this option, and (3) how to insure a solar array to minimize the risk to the co-op.

Starting with the last part, when the SUNDA got underway in 2014, there was no standardized insurance offering for a cooperative that wanted to own a solar facility. The market was still fairly small, and the cooperative community did not have a lot of experience with PV. NRECA worked with Federated, its SUNDA partner, to provide a common offering for co-ops interested in solar. Federated analyzed the actuarial data for solar facilities in general and determined that it could offer a comprehensive insurance package for co-op utility solar at 37 cents per $100. This rate was sufficiently attractive that virtually all co-ops involved in the project insured their solar projects through Federated.

The next business hurdle facing the project was less easily overcome—how to finance the solar projects. Co-ops have access to relatively low-cost capital financing, typically on the order of 2.5–4.5%. Moreover, they usually are tax-exempt companies, which is important because of the ITC available in the U.S. for investments in certain renewable energy sources. The ITC provides for a tax credit of 30% of the investment amount. For a typical 1-MW facility, this credit amounts to $600,000 or more. A further tax advantage for renewable projects is that they qualify for accelerated depreciation over a 6-year period. The accelerated depreciation can be almost as valuable as the ITC. Being tax exempt means there is no direct way to benefit from this government policy. However, it is possible to monetize the value of the ITC through indirect forms of financing. Essentially, a financing structure can be chosen that includes a taxable partner and grants the tax benefits to that partner in exchange for favorable financing terms. This type of arrangement was already well known in the co-op community for financing wind farms, and CFC, NRECA's SUNDA partner, was well versed in how to structure the tax-equity flip[7] that allows tax-exempt entities to take advantage of tax credit programs. The problem was the broader financial market, as described below.

The typical investors looking for tax-advantaged investments are large fund managers. These investors need to invest tens of millions of dollars in a deal for it to have a meaningful impact for their funds. A typical wind farm deal is in the $50 million+ range and well suited to their needs, but a co-op solar array

[7] Details of this structure and others open to cooperatives can be found in Volume I of the PV Field Manual.

in the range of $1.5 to $3 million is simply too small to attract their interest. Further, the transactional costs to set up the blocker corporations,[8] do all the paperwork, and administer the business over the 6+ years it takes to realize all the tax benefits make it unattractive for deals much smaller than about $8 million. During the course of the project, NRECA and CFC offered an aggregating program to group a number of co-op projects to raise the deal value to the necessary level. The challenge was that co-ops' timelines for implementing the solar projects seldom aligned simultaneously, making it difficult to aggregate them into a single deal. CFC worked with Federated and NRCO to develop the program Solar Cooperative Community Projects (sCOOP), which was used successfully by dozens of cooperatives to finance and construct utility solar projects in the 1- to 5-MW range.

Similarly, NRECA had several meetings with CoBank, a part of the U.S. Farm Credit System that regularly provides loans and financial services to cooperatives. CoBank was able to develop an inverted lease, or lease-buyback program, which also could monetize the tax advantages. This deal structure, essentially a lease with a buyout clause, was significantly simpler in structure and thus easier for boards to comprehend; however, it required the co-op to have either a taxable subsidiary company or taxable partner to make it work. Some cooperatives do have a for-profit subsidiary, often as part of their vegetation management program, so this structure worked for dozens of them.

The final challenge of the co-op solar business model was how to make the solar energy available to the members. There is a strong commitment among co-op to avoid shifting costs from one group to another. This concern was considerable at the beginning of the SUNDA project, as solar was significantly more expensive than other power sources, and a primary purpose for co-ops' existence is to provide at-cost power to its members. Some co-ops and co-op members were concerned that their co-op would spend millions of dollars putting in a solar array that would not be fully self-sustaining, thus increasing the rates paid by all members. To address this issue, most co-op solar programs were initially offered to their members as a long-term lease on the energy output of a number of panels in return for a high up-front payment. On paper, the advantage was paying the co-op back quickly for the money invested in building the solar array and not impacting the members interested only in the lowest-price service possible. In practice, even though members may have expressed strong interest in having a community solar project built, subscription rates were often low. During the course of the SUNDA project, NRECA investigated this issue regarding both the type and pricing of the solar project offering, as well as outreach methods, on-boarding processes, and messages that worked best for encouraging full subscriptions.[9] Various co-ops tried many different offerings and price points, from those that priced the offering to ensure the solar project would not impact the overall co-op revenues to those that attempted to offer the solar energy in kWh blocks at the true cost of generating the solar energy, along with a broad range of up-front charges, as inducements to join the program. Likewise, there were broad

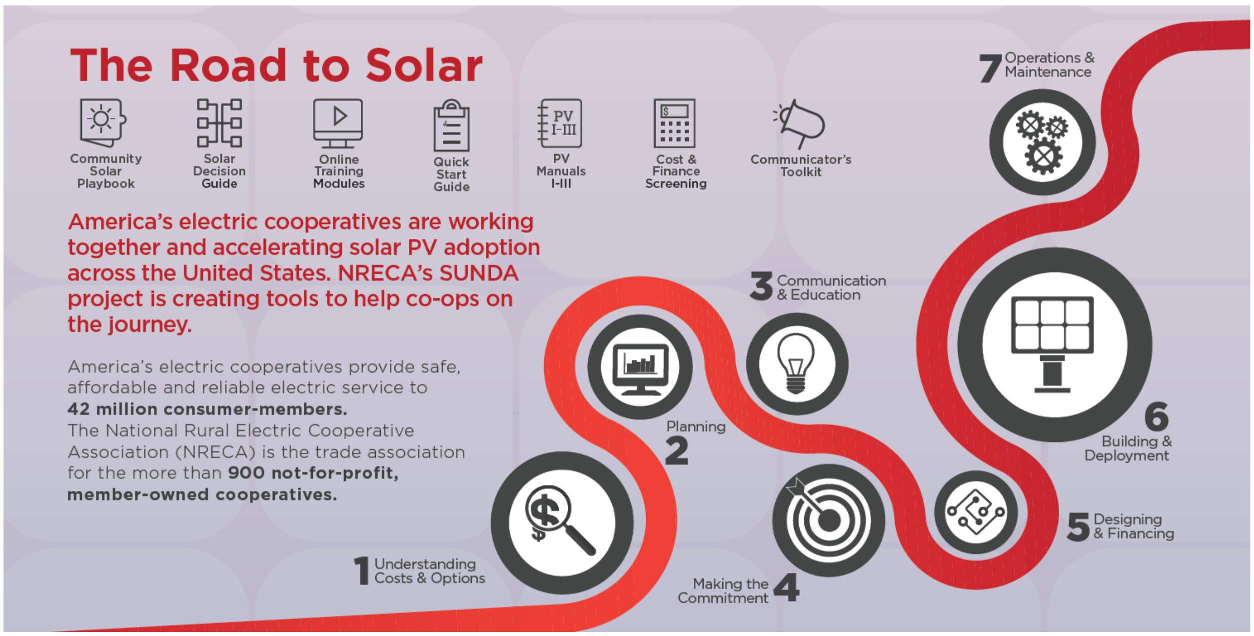
[8] A blocker corporation is a business structure used to protect the tax-exempt status of the co-op while participating in a taxable enterprise.
[9] Please see NRECA's Cooperative PV Adoption Report for more details.

ranges of values offered for any excess energy produced by the panels, from those that did not allow enough panels to create any excess to those that paid only the avoided cost (average wholesale energy rate) to those that paid full retail rate under a net-metering law. As costs decline, solar is being seen more as a 20- to 25-year generation asset than a special case, and co-ops have introduced pay-as-you-go models at near parity to typical retail rates, with low to no up-front costs. Several co-ops offered a variety of solar offerings for their members so a member could choose the option best suiting their needs and pocketbook. Anecdotally, the pay-as-you-go and multiple option programs have generated higher subscription rates.

Business/Finance Lessons:

- Co-ops now have several options for tax-advantaged solar financing and should work with co-op lenders to find the option that best suits their business needs.
- Community solar aligns well with cooperative principles: available to anyone who wants to participate, flexible, local, and consumer owned.
- Community solar business models that require no up-front charges or long-term commitments enhance member interest and subscriptions.

5.0 Tools



A key goal of the SUNDA project was to use the experiences of co-op solar deployments to develop tools and templates that would accelerate learning and reduce risk and effort, making it easier for future co-ops to implement solar. According to the original SUNDA project management plan, an initial version of the PV Field Manual was to be assembled from the materials that the Phase I co-ops needed for implementing their projects, then used by and added to as the Phase II & III co-ops underwent the process. After initial meetings with the participating co-ops, the NRECA team began to assemble materials that explained the various financing options the co-ops could pursue, the different business models they could employ to make solar energy available to their members, the technical details about solar PV, the choices to be made in deciding what types of equipment to deploy, and how this new equipment would need to be operated and maintained over its lifetime. As co-ops generally had no previous experience with solar, the quantity of information that needed to be assembled quickly became too voluminous for a single manual.

The original plan called for the PV Field Manual to be published and widely disseminated at the end of the project. As prices of solar PV equipment continued to fall during 2014, it became clear that there was a very real and immediate demand for this knowledge that would not wait for the end of the project. As a result, the decision was made to complete initial draft versions of the manuals as soon as possible and publish them immediately, then go back twice during the course of the project to update and revise them as needed.

The iterative nature of the SUNDA project, with groups of co-ops participating in Phases I, II, and III, greatly improved the nature and quality of the tools developed. When the lack of a guide, template, or tool became apparent during a phase, the appropriate material could then be added to the project and developed for the next phase. In fact, the majority of the products listed in the Tools section of this report were conceived and developed in response to needs that were unknown at the beginning of the SUNDA project. The flexible, iterative design of SUNDA made it possible to redirect the project as needed and produce resources tailored to identified needs and based on real-world experience.

Ultimately, the tools developed can guide co-ops through the learning and decision process needed to successfully implement solar PV for their members. The following sections describe these tools.

5.1 Just Beginning

5.1.1 Solar PV Getting Started Brochure

In working with the co-ops in the SUNDA project, as well as those following in its footsteps and just beginning to learn about solar, a pattern of topics began to emerge that helped define whether a co-op would be interested in solar and, if so, what type of project would best suit it. These topics frequently were strategic in nature, posing questions the board needed to address. To assemble these topics in one place and spark the beginnings of conversations between board members and with co-op management, the team developed the "*Solar PV: Getting Started*" brochure. This multifold pocket brochure outlines the options of co-ops regarding adding solar PV to their utilities portfolio and provides a framework for the decision-making process.

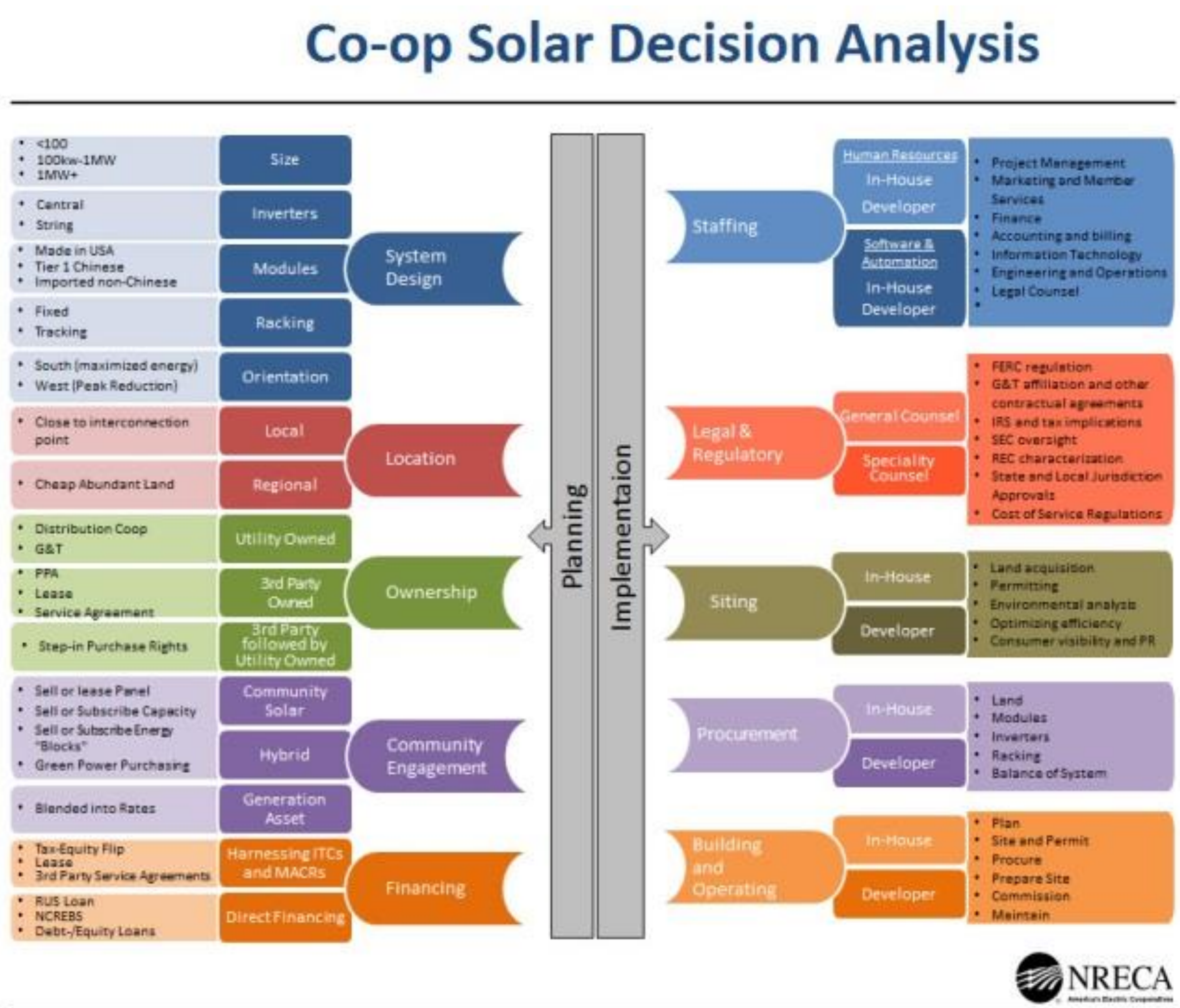
https://www.cooperative.com/programs-services/bts/Pages/SUNDA/Solar-PV-Getting-Started-Brochure.aspx

5.2 Project Scoping

When co-op staff decided they were interested in looking into implementing solar PV, they asked several questions. How big a system should we build? How difficult will this project be? What type of equipment do we need? What will it really cost and how do we finance it? What will the cost of the electricity produced be? How do we offer it to our members? These questions led the SUNDA team to develop 4 tools.

5.2.1 Solar Decision Guide

The "Co-op *Solar Decision Analysis*" is a graphical representation of the options, issues, and decisions a utility must address when deciding to pursue solar PV.



https://www.cooperative.com/programs-services/bts/Pages/SUNDA/PV-Decision-Guide.aspx

This tool shows the following high-level planning factors:

- **System design**, which includes factors such as system size, technology and equipment choices, and system goals—that is, is the goal to produce the maximum amount of power or reduce peak load and peak load costs?
- **Location**. Is the priority on having the system close to operational loads, where land can be more expensive, or lowest cost?
- **Ownership**. The co-op may want to own the PV system as a generation asset. To minimize financial, technical, and legal risks, working with a third-party owner can be attractive. Some co-ops choose a hybrid, in which a third party initially owns the project and then sells it to the co-op later, typically after all tax benefits have been monetized.
- **Community engagement.** The main question is whether the co-op will incorporate a community solar option or provide the power generated from the solar PV system as part of its generation mix and traditional offerings.
- **Financing**. Because co-ops are non-profit, non-taxable entities, monetizing federal and state tax credits is not straightforward. Cooperatives' traditional lending organizations have developed solutions that serve most co-ops' purposes, but there are limitations and tradeoffs. Co-ops have access to low-cost financing through RUS. Some co-ops prefer to work with a local financing entity. Larger co-ops may be able to finance systems themselves.

As a co-op transitions to implementation planning, additional factors include staffing, legal and regulatory issues, siting, procurement, building, and operating. The main question in each of these areas is whether the co-op has in-house capacity or will need to hire outside support.

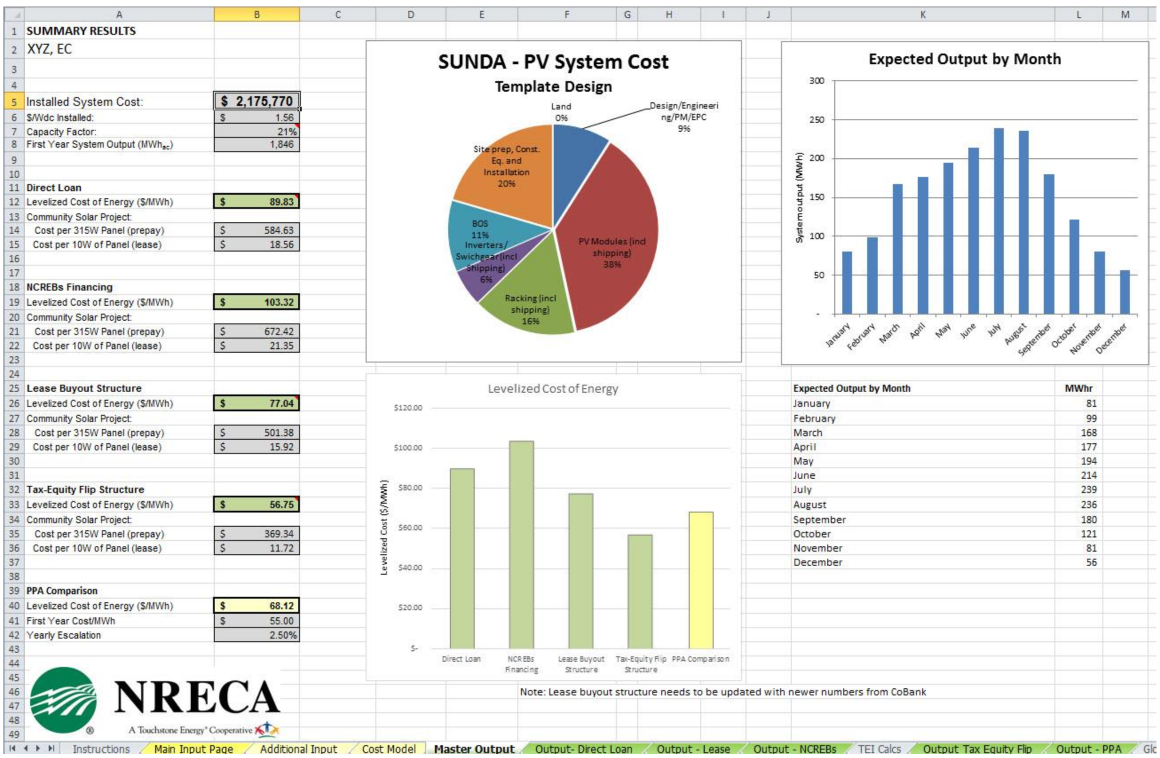
The graphic provides a one-page summary of the major decision factors that co-ops find useful to consider in their planning and implementation.

Findings based on the SUNDA project for each of these areas are summarized in Section 9: Lessons Learned. More detail can be found in the PV Field Manuals and the Community Solar Playbook.

5.2.2 PV Cost & Finance Screening Tool

The structure of the SUNDA project, with its 3 phases, iterative evaluation, and retargeting, allowed the team to change the timeline of deliverables and add new documents, templates, and tools to best suit the needs of the co-op utilities. At one of NRECA's TechAdvantage conference and expos, co-ops primarily asked the SUNDA team these questions: How much will a solar PV system cost fully installed? How much energy will it produce in my location? What will be the cost of the energy that such a system would produce? These questions spurred the development of a new tool that had not been envisioned at the beginning of the project but addressed a pressing need. The "*PV Cost & Finance Screening Tool*" is a spreadsheet-based tool that has succeeded in helping co-ops in the "what if?" stage of planning a solar project.

The tool is pre-loaded with all the information needed to quickly and easily size a PV project in the co-op's service territory and determine the estimated total costs to finance, purchase, and install the system, ending up with a very good estimate of how much energy the system will produce in the desired location. The tool needs just two pieces of information to begin: (1) the size of the desired system and (2) the Zip code in which the array will be located. Using this information, it calculates estimated system costs, and expected output (based on PVWatts)[10] in a matter of seconds, as well as calculating the levelized cost of energy (LCOE) under 4 different financing scenarios.



https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/Cost-Finance-Screening-Tool.aspx

This sort of analysis previously was performed by consulting engineering firms on behalf of co-ops. Results often took weeks and did not provide much insight into how the results were derived or allow self-tailored iteration analysis. Unlike many other analysis tools available to utilities, this one is not a "black box" algorithm, but open and spreadsheet based, so it is possible to see exactly how each number was calculated and modify the inputs, cost models, formulas, or assumptions to suit an individual co-op's particular needs.

[10] PVWatts was developed by NREL. https://pvwatts.nrel/gov.

This tool has proven to be a significant benefit for performing “what-if” analysis and allows users to see all the equations and change any variable until they are satisfied with the results. Managers can refine their projects into something they can take to their boards with confidence, thereby increasing the chance of acceptance. This tool became an ambassador to show co-op boards, managers, and CEOs how much the technology has developed and the costs have shifted.

The ease and speed of analysis also helped increase the size of projects that co-ops deployed. Early in the SUNDA project, co-ops were reluctant to commit to large solar PV deployments, frequently seeking to implement smaller demo systems. The Cost & Finance Screening tool allowed co-ops to quickly calculate the cost of projects of various sizes in their service territory and, more important, calculate the cost of energy from each. The tool illuminated just how much more expensive the energy from a 250-kW system is than from a system 1 MW or larger.

The model data were gathered from the real-world deployment experience of both SUNDA and associate co-ops, and continuously updated over the course of SUNDA to provide up-to-date pricing information. The Rocky Mountain Institute (RMI) provided third-party validation and declared it to be the best publicly available tool of its kind.

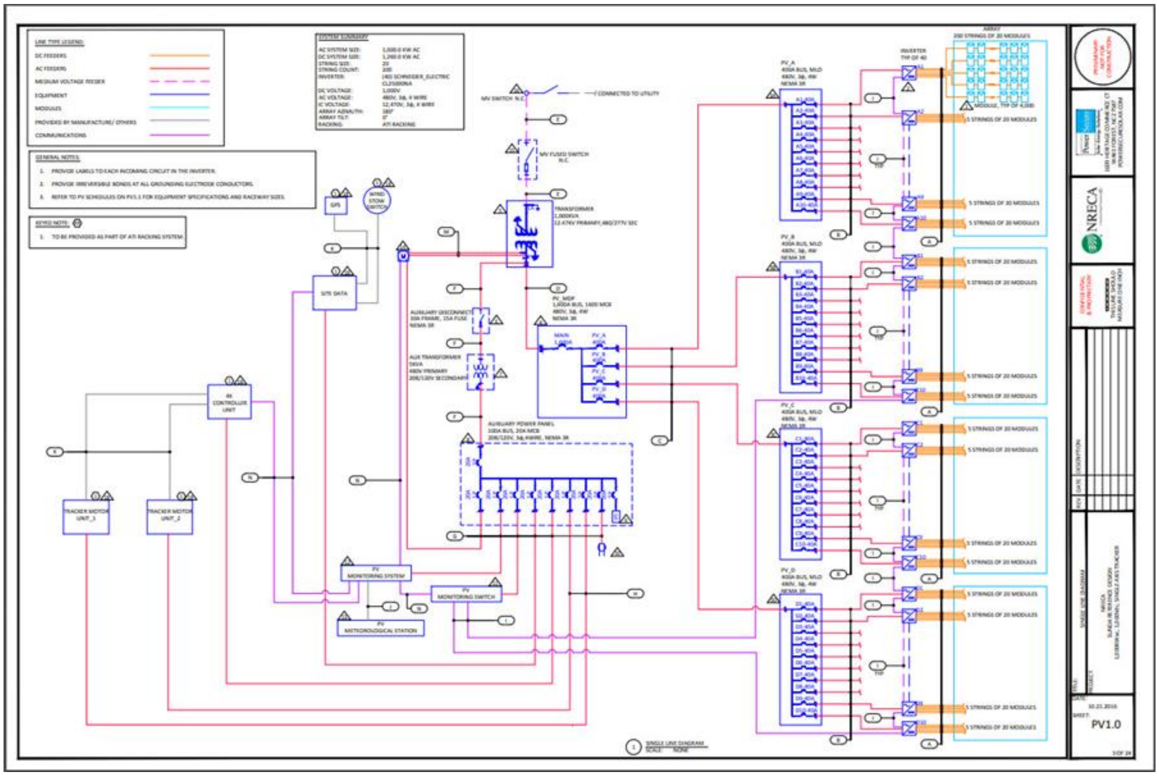
5.2.3 Template PV System designs

The SUNDA team developed a set of 6 template designs for co-ops to use as the basis for PV system projects. The intention for these template designs was to get a utility 90% of the way toward the complete engineering package, with the end product needing minimal modification to suit the footprint of a local site. The template design and specified bill of materials were intended to orient the co-op staff, provide a solid starting point, make procurement easier, and thereby reduce soft costs. The original designs included central inverters because they represented the current state of the art at the time the project began. Three-phase string inverter designs were added later when they became the preferred technology for systems up to 5 MWac. Because many co-ops were initially concerned about building systems as large as 1 MW, 250 kW-AC and 500 kW-AC were also developed to meet the varying needs of both smaller and larger co-ops. Systems larger than 1 MW were envisioned as “postage stamp” multiples of the 1-MW template. Additional designs were developed for 1,500-Vdc systems and single-axis tracking systems as these products became viable in the market. The SUNDA team worked with NRECA’s NDP to offer negotiated discounts on all key components of the “standardized” system.

Most co-ops chose not to use co-op staff to build their PV arrays, as originally intended, choosing instead to use EPC firms specializing in this work. The EPC firms resisted using the template designs because they already had in-house designs with which they were familiar and could build successfully.

Even though the templates were not fully used as expected, they proved very useful as educational resources for co-op staff and references for evaluating and comparing EPC proposals’ features and equipment standards. Although only one co-op—Sussex REMC in New Jersey—chose to build the template design, all SUNDA participating co-ops and many more subsequently have used the template designs as comparison points to evaluate EPC bids.

https://www.cooperative.com/programs-services/bts/Pages/SUNDA/PV-Field-Manual-and-Reference-Designs.aspx



5.3 In-Depth Learning

After a co-op has scoped a project and developed initial plans, much more work needs to be done. Even if a co-op intends to hire an EPC firm to implement a turnkey system, the staff need to understand more about the installation; options for financing the project; the details of various financial structures; options for making the solar energy available to their members; and other issues, such as land acquisition strategies, permitting issues, approaches for ground cover and vegetation management, and a host of other issues pertinent to the project manager, the CFO, and the operations team. Co-ops that want to manage the installation themselves need to learn even more. To maximize the chance of co-op solar PV success, the SUNDA project developed reference materials and online resources to help co-ops address the common choices and challenges involved in implementing a utility-owned solar project.

5.3.1 PV Field Manuals

The PV Field Manuals were developed to provide in-depth information the co-ops generally needed to successfully deploy their solar PV systems during the SUNDA project, and as a reference guide for cooperatives interested in solar.

PV Field Manual Volume I provides a comprehensive look at the management and financial issues surrounding solar PV at co-op utilities. It provides detailed information about the financing models available to the non-taxable co-ops that allow them to take advantage of the tax benefits for renewable generation projects, including tax-equity flip financing, lease-buyout financing, Rural Energy for America Program (REAP) grants, and more.

PV Field Manual Volume II details technical information for co-op utilities regarding how solar PV systems work, and the planning, design, installation, interconnection, and commissioning of a solar PV array. It is written for decision makers and engineers at a utility to bring them up to speed on the technology and technical issues surrounding solar PV.

PV Field Manual Volume III provides detailed information about the ongoing operations, maintenance, and monitoring of a PV system. It includes common test procedures, information about test equipment, safety considerations, performance and component evaluation, and troubleshooting information to allow co-op operations staff to comfortably take on the ongoing responsibilities of owning a PV plant.

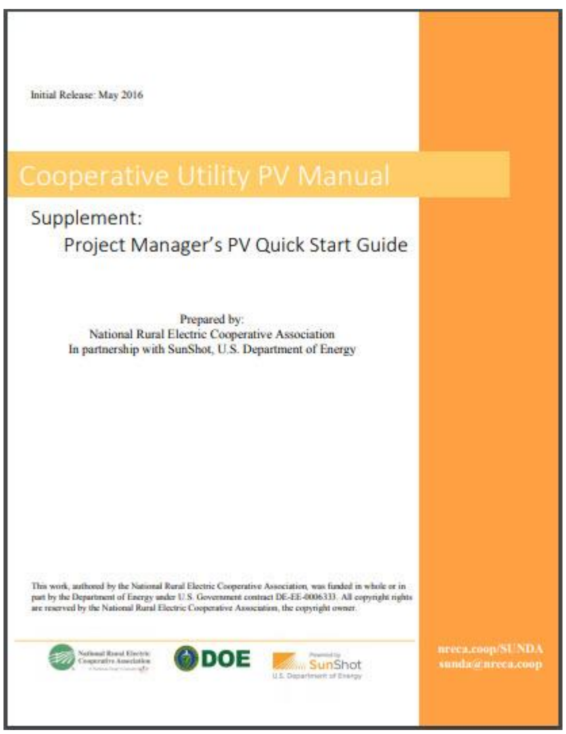
https://www.cooperative.com/programs-services/bts/Pages/SUNDA/PV-Field-Manual-and-Reference-Designs.aspx

5.4 Project Implementation

Once the decision has been made to implement a solar PV project, the challenge becomes incorporating what may be a process that is many months long and affects the daily routine of the co-op. Co-op employees are always busy, and implementing solar PV systems is a new activity for most co-ops, so the NRECA team created actionable guides to support the various co-op functions throughout the process. The first of these was the Project Manager's PV Quick Start Guide. Later, NRECA added the Community Solar Playbook to provide specific guidance for other key roles, including those of the CEO, and finance, marketing, and IT departments.

5.4.1 Project Manager's Quick Start Guide

Implementation of a co-op system is a team effort, so each team needs a strong project manager who is ultimately responsible for coordination and oversight. Using the experience and insight of the project managers for the SUNDA projects, the team developed the Project Manager's Quick Start Guide to provide proven, annotated checklists of what needs to be done when, what to watch out for, and references to other materials, such as the PV Field manuals, to fill in details. It is a high-level guide that helps project managers get started quickly without beginning from scratch.



https://www.cooperative.com/programs-services/bts/Pages/SUNDA/Project-Manager-PV-Quick-Start-Guide.aspx

5.5 Build Consensus

A primary reason that co-ops implement solar is to enhance member satisfaction. To ensure they achieve the member engagement benefits of solar, co-ops need well-defined and integrated communications plans. Further, co-ops' communications, marketing, and member services staff must be involved in planning from the outset. To help co-ops achieve higher member satisfaction, the best practices of the participating co-ops' communications teams were integrated into a Communicators Toolkit. [11]

5.5.1 Communicator's Toolkit

With generous contributions from co-ops (SUNDA participants and others), the Solar Communicator's Toolkit pulls together resources and samples to help co-ops educate consumer-members about how they can participate in cooperative solar development, including community solar. It includes a template plan and sample materials from co-ops with solar projects either online or well on the way to completion.

https://www.cooperative.com/programs-services/bts/Pages/SUNDA/Solar-Communications-Toolkit.aspx

[11] See Section 8: Community Solar, for more details on this process and issue.

5.6 Online Learning

To further support co-op staff learning, the SUNDA project also produced a series of short online modules and recorded webinars that cover all aspects of the co-op PV process, from Getting Started: Solar 101 through evaluating and decision making, siting and permitting, financing options, and engineering and project management. The following link provides access to these modules:

https://www.cooperative.com/programs-services/bts/Pages/SUNDA/Webinars-and-Online-Courses-for-Utility-Solar.aspx

Getting Started

- Solar 101

Strategic Business Options

- Solar Tools: Getting Co-ops Up to Speed on Their Solar Options
- Does Solar Make Sense for Your Co-op?
- Converting PV into Community Solar with Software

Financing Options and Cost Estimates

- Module 1A Utility-Scale Renewables
- Module 1B Community Financing of Renewables
- Module 2 Utility-Owned Battery Storage
- Module 3 Utility-Owned Broadband
- Module 4A Consumer-Side Distributed Energy Resources
- Module 4B Consumer-Side Energy Efficiency
- Cost & Finance Screening Tool Tutorial

Technical Project Management

- Module 1 Introduction to SUNDA
- Module 2 Solar Energy Resource
- Module 3 Site Surveys & Planning
- Module 4 System Components
- Module 5 PV Modules & Arrays
- Module 6 Power Conditioning Equipment
- Module 7 System Design
- Module 8 Mechanical Integration
- Module 9 Electrical Integration
- Module 10 Utility Interconnection
- Module 11 Commissioning
- Module 12 Operations & Maintenance

Community Solar Playbook Course

- Module 1 CEO Governance Module Overview

- Module 2 Marketing, Member-Consumer Services, and Communications
- Module 3 IT to Support Marketing and Program Administration Overview
- Module 4 Business, Finance, and Program Administration Overview
- Module 5 Project Management Planning & PV System Engineering, Commissioning, and Operations

Communications

- Best Practices for Communicating Community Solar Projects

Examples from Electric Co-op Projects

- Case Studies for Deploying Utility-Scale Solar PV

6.0 Outreach

NRECA utilized its extensive training and outreach capacity to collaborate with co-op members and spread the lessons learned from the SUNDA project. The team held annual meetings to share with one another through collaborative discussions and work sessions. NRECA and co-op team members also presented at national conferences, technical meetings, and webinars.

In preparation for the annual team meetings, NRECA supported participants by sending out 3 to 4 high-level questions to the entire team to frame the upcoming discussions. Staff then worked more closely with 3 co-op representatives—generally from co-ops that had most recently completed their deployments—who would kick off discussions. NRECA also provided direct support to participants preparing for NRECA or industry events by providing contextual frameworks based on overarching questions and recommendations for stories to share, using knowledge of the projects. As other co-ops expressed interest in solar and/or the SUNDA project, NRECA staff talked with their representatives to learn more about their current plans and connect them to the appropriate resources. Resources almost always included information about at least one SUNDA project, and often an introduction to one or more of the SUNDA co-op representatives. As the project evolved from year to year, the focus of specific training and outreach activities were tailored based on identified needs.

During the first year, the primary focus was on the orientation, education, and support of SUNDA participants. NRECA hosted a kickoff meeting during the first month of the project to share overarching goals, provide technical training, discuss initial plans for each deployment, and establish connections with and between the participating co-op representatives. NRECA also provided support and guidance on cost-share and federal contract requirements to formalize participation. Each co-op developed a workplan that included the co-op's motivations and goals, planned system size, initial siting information, expectations for financing, anticipated costs, and a proposed schedule. The workplans formed the basis of quarterly follow-on discussions and tailored support. The team began reaching out to the larger co-op community by sharing the initial system designs and technical training via NRECA events, webinars, and the SUNDA web portal. Initial industry exposure of the SUNDA project included coverage in Utility Dive and SUNDA participation in the White House Solar Champions of Change event. To understand the larger co-op community's level of interest in solar PV, the team conducted a series of data collection activities, including the 2014 PV Maturity Survey. These activities revealed that of 585 co-ops, 83 had solar (mostly small demonstration systems), 11 were currently planning solar (at the 100-kW+ level), and

492 expected to install PV of some size in the next 3–5 years.[12] Based on the experience and information collected in the first year, the team developed a training and outreach plan for the remainder of the project.

In the second year, the SUNDA co-ops with Phase I deployments began sharing their experiences via NRECA webinars, events, and industry conference sessions. The format for participants' quarterly calls shifted from check-in calls with NRECA staff to group calls. Each group call engaged representatives from 3 to 4 participating co-ops with common interests or challenges. The participating co-ops shared lessons learned and worked though barriers as they talked about their experiences with peers throughout the community. Through this process, they identified a number of needs that SUNDA could address. Some of the recurring themes revolved around the challenges of getting board approval and engaging their members, finance and business models, land acquisition and siting issues, finding EPC contractors, and a common monitoring tool to gather real-time solar data from multiple projects. They also discussed community solar models, rate structures, and tools for communicating with their consumer-members. Meanwhile, the number of inquiries from non-participating co-ops increased significantly. In the third quarter of the third year alone, NRECA staff talked with 37 co-ops from 20 states. In response, the team (1) added a new email mailing list for cooperatives interested in the SUNDA project and its products; (2) accelerated timelines for several of the SUNDA deliverables, including the Communicators Toolkit and Comprehensive Course; and (3) worked with NRECA's Education and Training staff to develop 2 new courses for co-op board members: Communicating the New Energy Landscape and Strategic Technologies and Their Impact on the Cooperative.

Tools, resources, and lessons learned were developed and shared as quickly as they became available during the third year. Three resources drew particular attention. A summer webinar series highlighting SUNDA co-ops' experiences and community solar drew record audiences—one webinar attracted 562 co-op representatives from 196 co-ops. The Cost & Finance Screening Tool, which enabled co-ops to estimate energy output and costs for a PV system in their own Zip code, was shared across the co-op community and the industry. It was validated against actual co-op deployments and by RMI's staff, who called it the best publicly available tool of its kind. The Communicators' Toolkit pulled together resources and samples from co-ops that had successfully completed projects. These communications resources helped co-ops educate consumer-members on participation in cooperative solar development, including community solar. In addition, a full-day technical course was well received at Co-op University, as was a half-day workshop on the SUNDA tools at the Solar Power International conference.

In the fourth year, the main focus was on peer-to-peer learning between the SUNDA co-op participants and other co-op representatives across the country. The team conducted several Solar Interest Group

[12] Interestingly, even though collectively co-ops were planning ~150 MW in the next 3–5 years, they actually installed more than 773 MW in the next 4 years.

discussions—3 via conference call and 4 at NRECA live events. The conference call format enabled the team to share information with co-op staff not able to travel to an event. The live events were conducted at CEO CloseUp for co-op CEOs, TechAdvantage Conference & Expo for co-ops' technical staff as part of NRECA's annual meeting, Directors' Conference for co-op board members, and CONNECT for co-op communicators. The live event format—led by the SUNDA co-op representatives, who were adept at sharing their stories and fostering a collaborative environment—resulted in more robust, interactive sessions. During this final year, the team also refined the SUNDA tools and conducted extensive outreach to share information and highlight the success of the project.

Over the course of the project, NRECA and participating co-ops' staff were featured as conference speakers and panelists in multiple venues. NRECA events included TechAdvantage; CONNECT; Directors Conference; regional and annual meetings (for co-op CEOs and board members); Co-op University (co-op staff); Tax, Accounting and Finance conference (for co-op finance staff); Member Advisory Groups (co-op technical staff who help guide NRECA's BTS research agenda); and CEO Close-Up. Sessions were also held at co-op-hosted events through their statewide associations and G&Ts in 14 states. External industry events included the Solar Power International conference, IEEE and CEATI meetings, the Smart Electric Power Alliance (SEPA) Utility Solar Conference, PowerGen International, WinUP Conference, and the Energy for Economic Growth Initiative event. In addition, the project was covered in NRECA and industry publications.

NRECA's major publications include the following:

- ***Rural Electric (RE) Magazine***, the flagship publication of NRECA, provides electric co-op directors/trustees, chief executives, and front-line employees with the in-depth information they need to make sound decisions in today's fast-paced electric utility industry. RE Magazine has 24,000 subscribers.
- ***Electric Co-op Today (ECT)*** is a news site dedicated to coverage for news and information about the electric cooperative industry. It is distributed to co-op employees and directors, vendors in the electric industry, legislative and regulatory offices, and industry.

Events and updates were advertised via a variety of channels, including the following:

- ***TechUpdate***, an e-newsletter focused on technology and distributed to nearly 20,000 co-op employees (includes engineers, operations, CEOs, general managers, managers, financial staff, membership services personnel, executive assistants, customer service representatives).
- ***NRECA's vendor, CommPartners,*** distributes webinar announcements to about 10,000 subscribers, including CEOs; select committees; and communications, finance/accounting, and member services and marketing departments.
- ***Cooperative.com*** is an NRECA website that includes a secure and private industry site for the CEOs, directors, and staff of NRECA electric co-op members, along with other voting members of NRECA. It currently has more than 70,000 registered users.

By fully engaging NRECA's training and outreach capacity, the SUNDA team was able to offer more than 50 trainings, at least 70 outreach sessions in 39 states, and more than 2 dozen NRECA and industry journal articles to reach more than 10,000 professionals in the electric utility business.

For a list of training and outreach activities, see Appendix 2, Training and Outreach Activities.

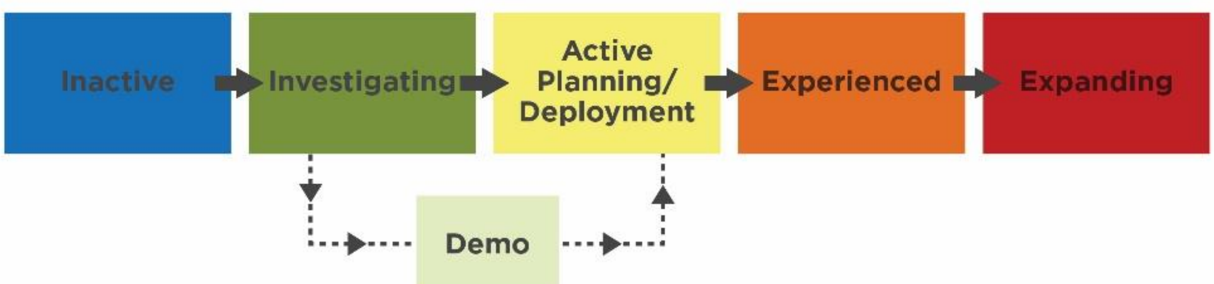
Outreach Lessons:

The experience of the SUNDA team during the 4-year process yielded several lessons that are key to enabling success in similar projects.

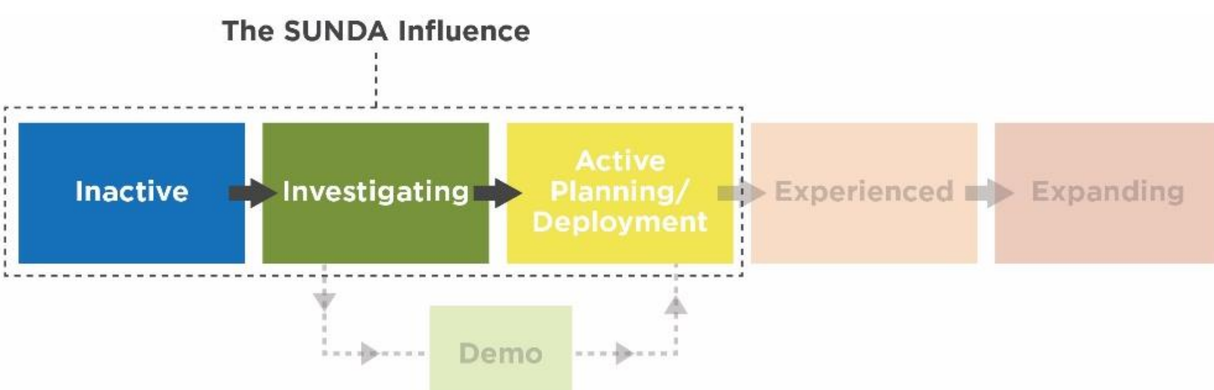
- In-person meetings are imperative for building trust and collaborative problem solving. Group calls can be effective when individuals already know each another.
- Peer-to-peer learning is best. Co-ops want to hear from other co-ops. They want to understand other co-ops' motivations, experiences, and lessons learned. They want to know what worked, what didn't, and what experienced co-ops would do differently if they could.
- Training and outreach activities that share co-ops' lessons learned and experiences are critical to accelerating the adoption of new technology in the co-op community.
- Unstructured time at in-person meetings to allow discussion among co-op peers is as important to solving problems and sharing ideas as formal work sessions.

7.0 PV Maturity

Based on the experiences of the participating SUNDA co-ops, the team developed a model for understanding co-ops' processes for adopting solar. Although the process varies from co-op to co-op, 5 main stages emerged. Initially co-ops are unaware of their solar options, or ***Inactive***. Next, often in response to member interest, a small number of co-op staff and/or board members begin ***Investigating*** solar resources. Some implement small (less than 100 kW) ***Demo*** systems. When potential options match interests, a co-op's board and staff may formally engage in ***Active Planning*** with the expectation of **Deploying** a larger solar PV array. Once a deployment (of at least 100 kW) is completed, a co-op is considered ***Experienced***. An experienced co-op that decides to add a deployment(s) is categorized as ***Expanding***. This general PV Maturity process is depicted as follows.



The SUNDA project and its products most effectively assist co-ops in the early stages of this process. The SUNDA outreach process and buzz about co-ops doing projects raises the interest among those that have not yet looked at options, followed by providing specific tools targeted at the recipient's stage in the process. For example, the Decision Guide and board-focused Solar Brochure on solar options help



co-ops move from ***Inactive*** to ***Investigating***. The remaining SUNDA tools all support the transition from initial ***Investigating*** to ***Active Planning*** on through ***Deployment***. NRECA's ongoing distributed energy resources (DE R) efforts outside of SUNDA enable ***Experienced*** co-ops to share and advise others. Applying the model to the larger co-op community, additional classifications were needed to characterize and distinguish current activities. For example, when co-ops enter the ***Active Planning*** phase, they consider multiple options, such as the following:

- Achieving economies of scale through collaboration with other co-ops or their G&Ts, in some cases working with the G&T to have a G&T-owned system installed within a distribution co-op's service territory
- Installing a small demonstration systems (<100 kW)
- Installing utility-scale solar (>100 kW)
- Possibly partnering with third parties to deploy solar arrays and purchase solar energy under PPAs after reviewing the costs and risks, and determining that the best option is a more conventional, conservative path

To provide a more detailed picture of co-ops' solar adoption processes, the expanded classifications were defined as follows:

- ***Expanding***: Experienced co-ops that are in the process of adding deployment(s)
- ***Experienced***: Co-ops that have installed at least one system of 100 kW or larger
- ***PPA Only***: Co-ops that purchase solar only via PPAs
- ***Demo***: Co-ops that have at least one small system (<100 kW) but no larger systems
- ***Co-op Sited, G&T owned***: Distribution co-ops for which their G&Ts have installed a local system in their distribution territory
- ***G&T Solar/Collaboration***: Co-ops that participate in a collaborative project(s) with at least one other co-op; these projects are most commonly led by G&Ts
- ***Active Planning/Deployment***: Co-ops whose boards of directors have voted to investigate solar and are actively working toward deployment
- ***Rooftop Program Only***: Co-ops that have only rooftop programs. They do NOT have solar as part of their mix, part of a community solar offering, or as a demo system. This group is new and small as of 2017.
- ***Investigating***: Co-ops for which a formal decision has not yet been made, but whose staff are investigating options and costs to support decision making
- ***Aware***: Co-ops for which at least one staff or board member has attended a webinar or training event with SUNDA content
- ***Solar Info on Website***: Co-ops that do not have solar as part of their offerings but do have guidance on solar, typically on interconnections and/or net-metering policies for behind-the-meter systems

- ***Inactive***: Co-ops that have considered solar and consciously made the decision not to implement systems at this time
- ***No Data***: Co-ops for which NRECA does not yet have solar activity data

The expansion of these classifications in and of itself begins to tell the story of co-ops' increasing engagement with solar power and the increase in member interest. Based on SUNDA and NRECA surveys, NRECA's database of renewable activity, and direct communications with individual or groups of co-ops, the SUNDA team gave each of the 910 co-ops a single classification and tracked their progress. Some co-ops fit into more than one category, so classifications were made based on an individual co-op's most advanced activity and greatest direct involvement. For example, a co-op that has both a demonstration-size system of less than 100 kW and at least one system larger than 100 kW would be classified as ***Experienced*** rather than ***Demo,*** and one that has its own 100-kW+ system and participates in a collaborative project would be classified as ***Experienced*** rather than ***Collaboration.***

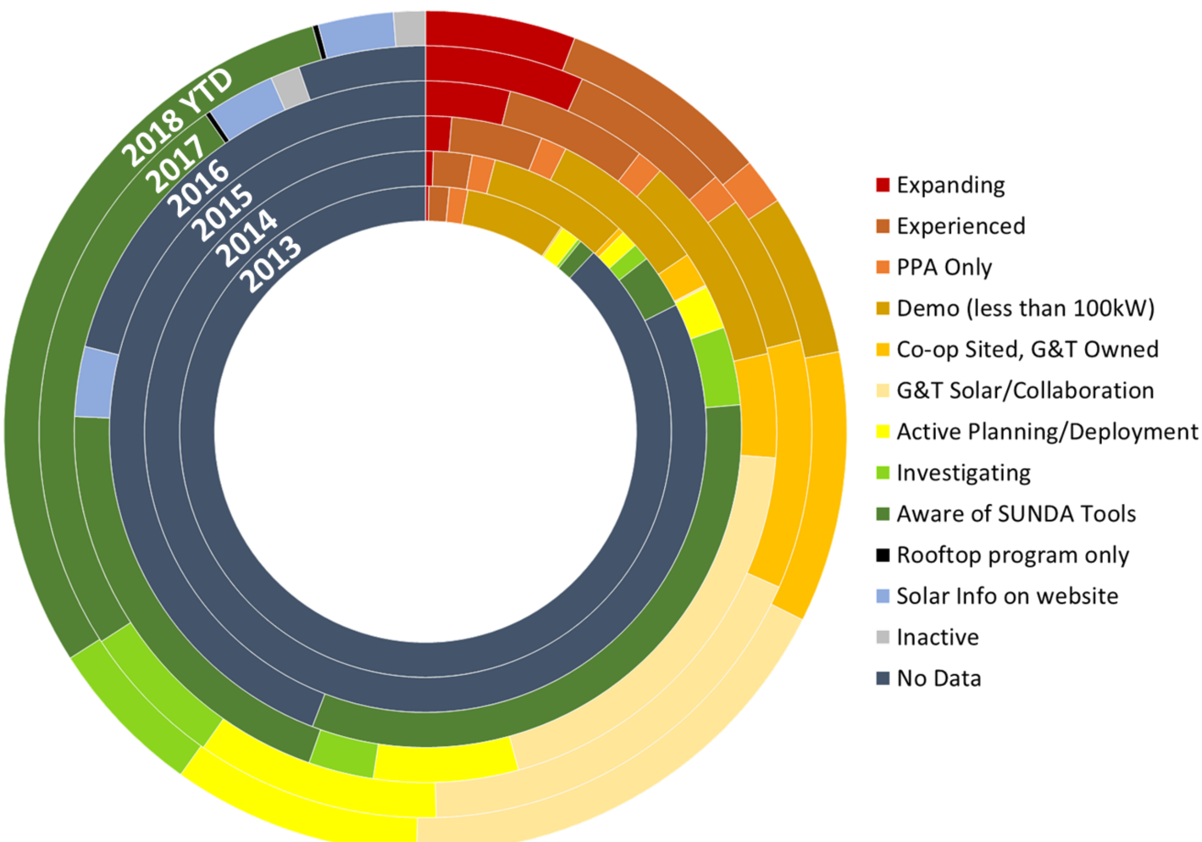


Figure 2: Progression of Co-ops' Solar Adoption

In 2013, only 10% of co-ops had deployed solar or expressed interest in deploying systems of >250 kW. Most were unaware of changes in technology and costs. The majority of deployed systems were under

100 kW. In 2014, co-ops expected to deploy >150 MW in the next 3–5 years. SUNDA participants began Phase I deployments and shared early lessons with the team and a small group of other co-ops that had expressed interest in the project but had not formally joined the team. As Phase I systems were being completed and Phase II systems were underway in 2015, the team published articles about these success stories in NRECA's online and print publications, and offered a series of webinars that drew hundreds of co-op participants. One webinar had more than 560 participants from nearly 200 co-ops. Based on the significant increase in interest, the SUNDA team accelerated plans to produce a range of tools and trainings to support co-ops' evaluation, decision making, implementation, and operation of solar PV systems. By the end of 2017, the SUNDA team had deployed arrays totaling more than 30 MW. G&Ts in many states took on lead roles in aggregating interest and leveraging economies of scale. Co-ops played a leadership role in implementing the emerging solar ownership model of community solar—at 196 co-ops! Overall, co-ops have deployed more than 860 MW of solar as of April 2018, nearly 5 times as much as projected in 2014. Today, many co-ops recognize solar as a valuable tool.

Figure 2 gives a graphical depiction of this evolution and the influence of the SUNDA project. Each circle represents the known status of the ~900 co-ops that were members of NRECA for the years 2013–2018 YTD (April 2018). In general, the red, orange, and yellow tones depict co-ops with and/or planning solar deployments. The green categories represent early, informational, or investigative discussions with the SUNDA team. The blue to gray segments represent co-ops without utility-sponsored solar or plans for it in the near term. As the chart shows, engagement with the SUNDA team became a leading indicator for co-op solar deployment.

Using the PV Maturity Model and the modified classifications, the SUNDA team was able to assess each member co-op's place in the maturity process and provide the SUNDA tools most appropriate to its needs.

The number of projects and size of deployments increased significantly as co-ops responded to the challenges of delivering the solar resources their members requested. According to NRECA's internal records, co-ops **collectively currently own or purchase more than 860 MW of solar PV**—up from 94 MW in 2013 (see Figure 3).

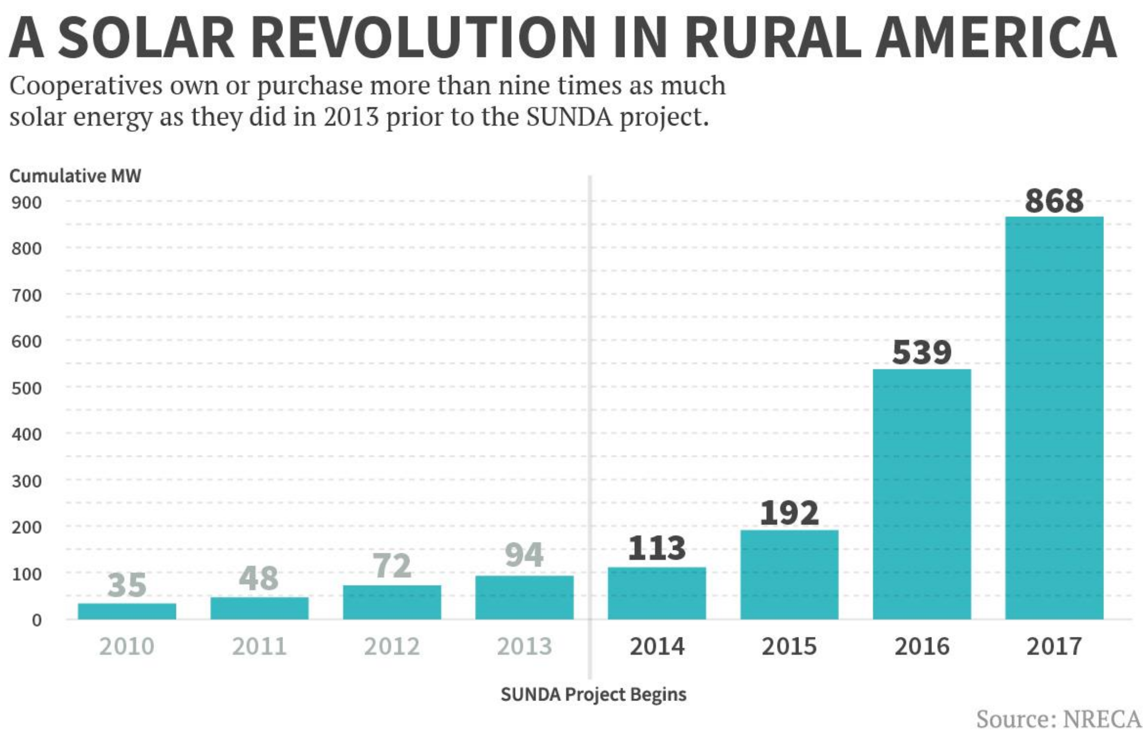


Figure 3: Co-ops and Solar PV Ownership or Purchase

Going forward, co-ops are planning to bring online more than **800 MW of additional solar PV** by 2022.[13] The frequent announcements of new projects indicate that these numbers likely underrepresent growth over this period. (These totals do not include member-owned DER solar systems—primarily residential and <10 kW in size.)

During the SUNDA project, shifts occurred that influenced co-ops' solar maturity and adoption. The main external factors were decreasing hardware and labor costs, and increasing consumer interest. In response, co-ops implemented board policies for solar, increased their understanding of the actual costs and risks, worked with their finance partners to develop innovative financing options, collaborated with one another, and evolved the community solar model. The development, adoption, and implementation of these enablers were facilitated by SUNDA tools and outreach, and propagated learnings from the early adopters throughout the co-op network.

As co-op PV maturity developed, projects generally moved from being pursued on a case-by-case basis by individual distribution cooperative, to collaborative projects with other co-ops—often their G&T partner. This shift is reflected in Figure 4, which shows that, although distribution co-ops currently have

[13] Ownership numbers, excluding PPAs, are 217 MW and 62 MW, respectively.

more existing PV generation, planned installations are dominated by G&T-led projects. The 2017 survey indicates that 31 of the 42 interviewed G&Ts (73%) either have solar or plans for solar.

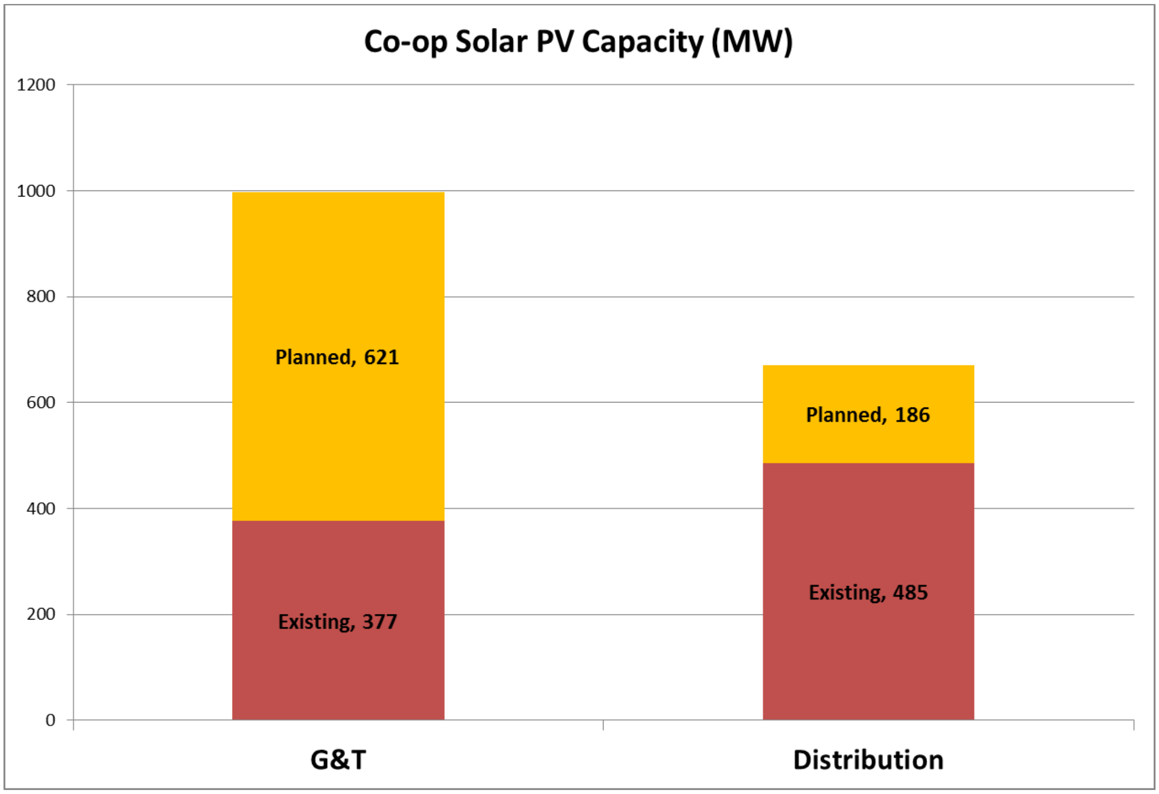


Figure 4: Comparison of G&T and Distribution Co-ops' Existing and Planned Solar Capacity, as of April 2018[14]

Early in the project, some distribution co-op staff who expressed interest in solar considered their all-requirements contracts could be somewhat of a challenge to deployment. Some contracts include a "carve-out" that allows a distribution member to produce some local generation (typically 1–5%), but about half of the contracts require the distribution co-ops to purchase 100% of their power from their G&T. G&Ts are cooperative entities owned by the distribution cooperatives who are members of, and purchase power from, the G&T. The contract between a G&T and its member distribution cooperatives provides long-term financial stability and enables the G&T engage financial institutions to finance generation, transmission, and infrastructure costs for 25- to 50-year investments. Under the cooperative business model, many distribution co-ops acquire power supply in a collective manner. The model ensures the financial strength of the membership and reduces the costs and risks of power supply. The G&T/distribution cooperative model requires co-ops to be creative and flexible in how they approach local resources and, over the course of the SUNDA project, co-ops overwhelmingly have demonstrated

[14] Note: Totals do not equal total existing deployments because shared projects and those not classified as G&T or distribution led are not included.

that creativity. Solutions have reflected the cooperative democratic principles, a focus on cost, and a responsiveness to member interests.

Before the end of the first year of the SUNDA project, a number of G&Ts and their distribution members began talking about solutions that would allow them to implement projects and stay within their contracts. Today, these solutions fall into a few general categories:

1. A distribution co-op owns or purchases the output of one or more systems under the carve-out defined in the contract.
2. A distribution co-op owns and operates one or more systems, sells all of the output to the G&T because the latter can purchase power from any qualified facility, and the G&T then sells the power back to the distribution co-op. Sometimes a is fee applied.
3. A G&T owns or purchases solar PV, sites it in a co-op's service territory, and dedicates the output of the system to that co-op's members. To gain efficiencies, some G&Ts have implemented a series of locally sited systems within the service territories of multiple distribution co-ops.
4. A G&T owns or purchases solar PV and includes it as part of the power mix for all of its members. These larger deployments ease financing, design, and system integration.
5. Often a G&T combines options 3 and 4 to provide local systems for community solar and large systems (20+ MW) as part of its own generation resources.

The co-op model allows both distribution co-ops and G&Ts to be agile, flexible, and member responsive so they can develop solutions that are democratic, consumer focused, cost conscious, and financially strong. The success of these options is reflected in SUNDA survey results. In 2014, 59% of responding distribution co-ops characterized their all-requirements contract as a challenge to solar deployment. In 2017, only 7% of the same group of co-ops took this view. In general, G&Ts saw increasing interest among their members and responded by taking more of a leadership role, aggregating interest to leverage economies of scale and deploying more solar at lower costs across the membership. As a result, more than half (56%) of the co-ops responding to both the 2014 and 2017 surveys reported in the latter that they now participate in a G&T-led solar project; also, there has been a shift from small, demonstration solar in 2013 to full utility-scale solar projects tied to system resource and capacity planning.

Increasingly, G&Ts and their members are working together on community solar programs, which historically have been very small (<50 kW) and run by the distribution co-ops. As project numbers and sizes have increased, about half of the 42 G&Ts interviewed by the SUNDA team have developed or purchased community solar systems on behalf of their distribution members. In some cases, the G&T leads or coordinates a common community solar program across its distribution co-op members. In others, the distribution co-ops develop their own programs, tailored to local needs and interests. This collaboration has led to a significant increase in the number of community solar projects, as shown in Figure 5.

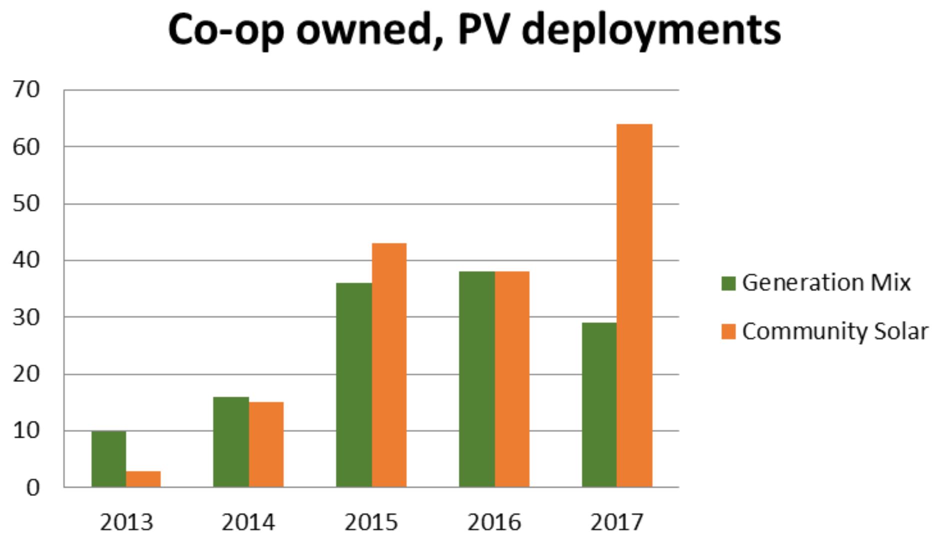


Figure 5: Co-op-Owned PV Deployments

Although fewer generation mix systems are deployed, these projects are scaled to pursue the lowest-cost options, resulting in larger systems. Figure 6 shows the average size of community solar projects owned by co-ops, compared to generation mix projects. The emergence of the community solar model is clearly portrayed by the steady rise in size of community solar projects from 2013 to 2017 (discussed further in Section 8 of this report).

Figure 6 also sheds light on some other events that happened over those 5 years. As the price of solar panels stopped dropping so precipitously by 2014, many more co-ops began implementing solar projects. However, many of these were still small or pilot-scale projects, causing a temporary down-tick in the average size of co-op solar projects for the next two years. Finally, in 2016 as SUNDA project findings began to be widely disseminated, and many co-ops learned more about the benefits of larger solar projects. This resulting in several large projects being started by co-ops across the nation and a significant increase in the average size of generation mix solar projects as they came online in 2017.

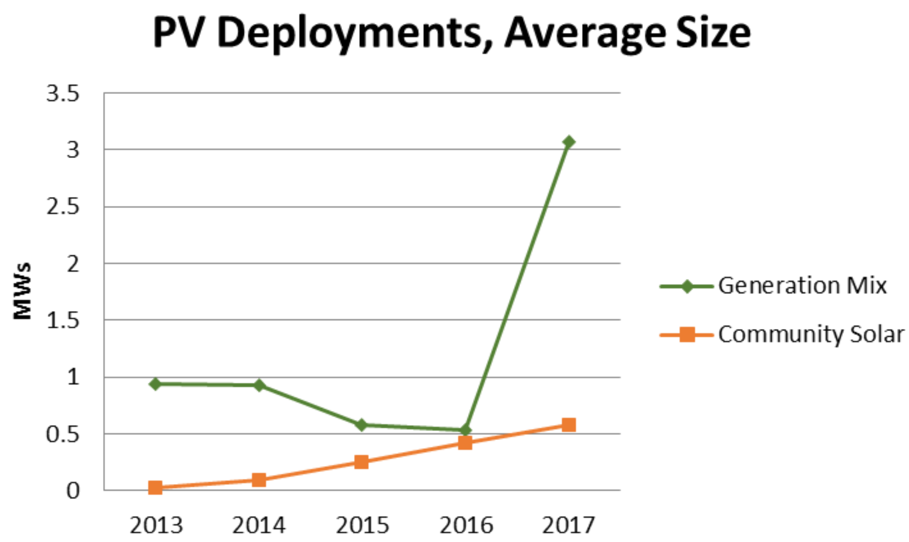


Figure 6: PV Deployments, Average Size

As of early 2018, solar projects at larger scales (>30 MW) can match fossil fuel energy costs in parts of the country. This development has led to a shift in thinking about solar energy. Although the last 5 years of co-op solar growth have been driven largely by member interest and demand for solar despite its additional costs, the continually falling cost of solar energy makes it an attractive financial option. Today, solar can provide a sound financial investment on behalf of a co-op's membership, alleviating system congestion, addressing peak load, and offering a hedge against future fossil fuel costs.

Not all co-ops are planning solar, either for generation or community solar purposes. Of the 12 G&Ts that do not have solar PV or plans, 9 report having other renewable sources—wind and/or hydro—that are more affordable at this time.

The data indicate that the cooperative business model is as strong as ever. Co-ops have established a long and successful history of providing services to consumer-members that continues to this day. The cooperative ownership structure allows the co-op business to operate on a service-at-cost basis to deliver needed and wanted services. However, some challenges for co-ops remain regarding solar maturity and adoption. Areas sited in the survey for additional attention as follows:

- The general public's lack of knowledge about solar: The public perception is that solar is much cheaper than conventional generation sources causing power companies to resist the implementation of more solar. The truth is that, currently, solar is generally more expensive than conventional energy options.
- Ramping: With co-op solar projects increasing from sub-MW-size arrays to 1 MW or more, there is increasing concern regarding how the rest of the distribution and generation system will respond to the rapid drop in output of a solar plant as cloud shadows roll over it.

- Financing: Taking advantage of the tax incentives for renewable projects is significantly harder for tax-exempt cooperatives, and recent tax reforms have adversely impact co-ops more than third-party energy suppliers because the reforms decrease incentives for potential tax-equity partners.
- Billing software integration: Although community solar is a very attractive means of implementing solar and increasing member satisfaction, significant challenges remain in integrating this generation source into co-ops' back-office billing systems. The suppliers of the billing systems are responding to their clients' needs, but this issue has caused problems for many early adopters of community solar.
- Rates and rate structures: Another great debate is how best to implement a solar offering and properly compensate the members that generate excess power from their solar assets without shifting costs to the rest of a co-op's members. Early models tended to be revenue neutral for the utility; however, more recent offerings try to reflect the full market options available to consumer-members. Distribution co-ops continue to experiment with rate structures and community solar programs that meet their budgets, capacity, and member needs. For residential members, co-ops have increased program offerings.

SUNDA's PV maturity work confirms increasing interest and adoption of solar PV throughout the co-op system. The scale of recent adoption by G&T co-ops, with plans for more and larger solar, validate solar's inclusion in the resource mix as a positive business move even beyond member satisfaction or political mandates.

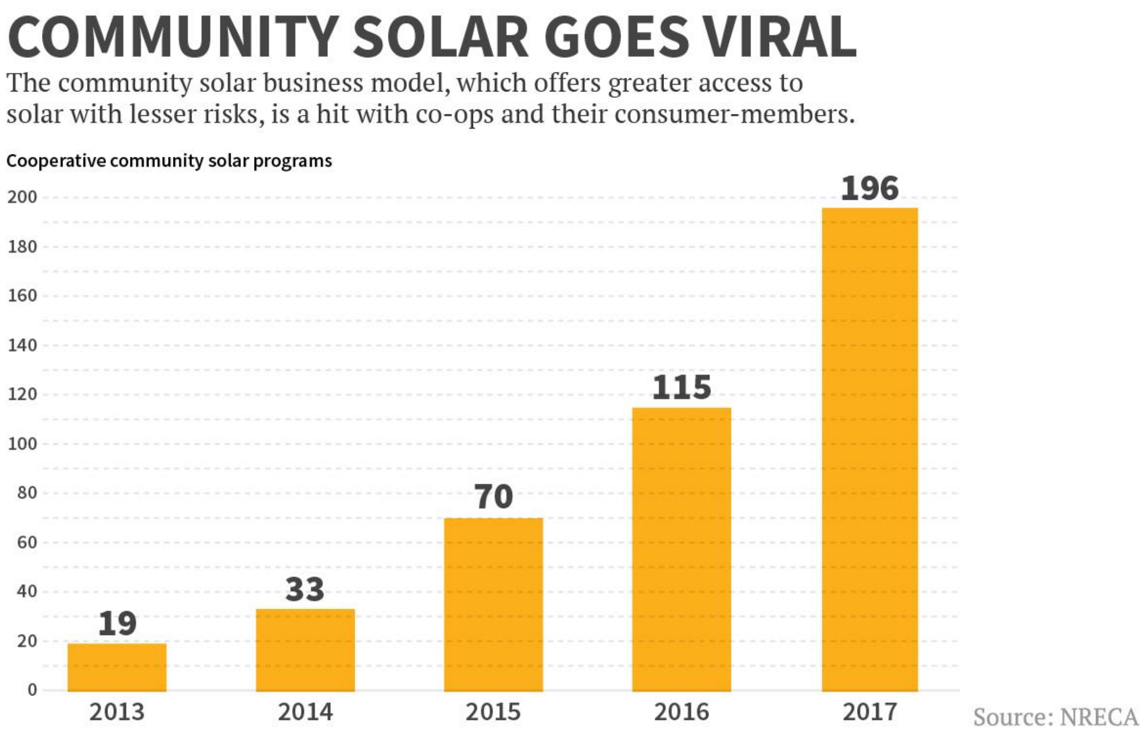
PV Maturity Lessons:

- Co-ops are deploying solar and larger systems that leverage economies of scale.
- G&Ts have taken on a leadership role in response to their distribution members' interest, which reflects the increased interest of consumer-members.
- Solar installations continue to be driven by consumer-member interest, but increasingly for system or financial benefits for the whole membership.
- Co-ops remain confident that they can accommodate the addition of solar to the distribution system, although concerns remain about multiple or large installations. They report confidence in managing more and larger solar programs.

8.0 Community Solar

In 2009, United Power, a cooperative based in Brighton, Colorado, was among a scant handful of utilities experimenting with a new solar business model: offering customers the option to participate in a solar program managed by the utility by either purchasing or leasing panels in an array. Participants in the co-op's community solar program received a credit on their bills for the power produced by their panels. Fast forward to 2018: 198 co-ops—nearly a quarter of NRECA's membership—offer community solar to their members.

The community solar model has gone viral among co-ops. The rapid growth of this program can be explained in part by how well it aligns with the cooperative principles: it is available to anyone who wants to participate, it is flexible, it is local, and it is consumer owned.



Cooperatives lead the utility sector in adoption of the community solar business model. The SUNDA project enabled this growth by converting the experiences and lessons of early adopters into tools, and making those resources available to the rest of the membership. A community solar webinar offered in

2015 attracted 562 participants; a webinar on how to market community solar to members had 267 participants. These discussions informed the Community Solar Playbook, a detailed guide on developing a community solar program.

Although the SUNDA team's financial analysis showed that solar arrays of 1 MW or more improve the economics of solar ownership, the larger arrays came with the challenge of fully subscribing the programs. Several SUNDA participants saw their community solar subscriptions plateau at somewhere between 30% and 60%. To address this challenge, the SUNDA team contracted with 3Degrees, a clean energy marketing firm, to conduct research on the design, administration, and communications around community solar, and develop recommendations and strategies to achieve subscribership goals. With better program design and improved consumer communications, the programs are more likely to meet co-ops' needs and deliver on the expectations of their consumer-members. To these ends, 3Degrees conducted the following research:

- In-depth phone interviews with staff at 21 co-ops on program design, implementation, and marketing
- Online focus group with consumers, conducted over 3 days
- Analysis of community solar participants, using co-op data from 12 co-op community solar programs in 10 states

8.1 Community Solar Design, Implementation, and Communications

3Degrees conducted interviews with staff at 21 co-ops that offer community solar. The conversations covered the following topics: the motivation for offering community solar, program goals, pricing and design decisions, implementation, and challenges.

One important finding centers on the driver for co-ops offering community solar. Co-ops are motivated by a desire to remain relevant in a fast-changing energy landscape and meet the needs and expectations of their members.

The program models typically fall into two categories: (1) the participant sells solar power back to the co-op and receives a bill credit; and/or (2) the member buys green energy from the array—in other words, a solar tariff model. With the first option, an alternative to rooftop and net metering, the credit will vary from month to month; the second option provides for a fixed rate for purchasing solar power.

The interviews revealed a number of challenges: operational challenges, difficulties in educating members about community solar, and how to effectively communicate offerings.

Most of the operational challenges affecting community solar are the same as for other cooperative solar deployments and are covered elsewhere in the report. The lack of expertise with monetizing tax credits and determining the appropriate rate structure for new community solar programs are challenges specific to community solar, however. Because co-ops are not for-profit entities, they do not have much experience with taking advantage of tax credits. In addition, even though co-ops have experience in setting rates for electric service, the pricing of a premium energy product is relatively new for many of them.

Educating members about a new energy product—subscription in a solar array—also posed a difficulty for some co-ops; some also have tried to use this opportunity to combat misinformation about rooftop solar.

Co-ops struggled to market their programs. Not all co-ops are accustomed to marketing their products and services. Cumbersome sign-up processes added another layer of difficulty and slowed subscriptions.

8.2 Educating Consumers on Community Solar

A 3-day online focus group provided helpful insights into the consumer education process, what potential participants want to see in a community solar program, and their expectations.

In order to better understand the task of educating consumer-members about community solar, the researchers conducted an online focus group with 33 participants over the course of 3 days. Seventeen of them lived in a rural area; the remaining group was split between small city and suburban neighborhoods. Twenty-eight of the participants lived in a single-family detached home. Only one of those 28 participants did not own the house.

Education about the program piqued participants' interest. Community solar compared favorably to rooftop solar. By the end of the discussion, the share of participants who were "very interested" had increased; however, the willingness to participate was dependent on price. As one participant noted, "signing up can't result in a net loss to my wallet."

The top 3 factors affecting the decision to participate were (1) the up-front investment, (2) any premium over the short term, and (3) net monthly impact over the long term. "Cost. Especially upfront costs. That will always be a part of the discussion. Long term costs and savings would also be considered."

Not surprisingly, the ability to save money ranked first among the benefits that could affect the decision to participate (23). The next most popular benefits were promoting renewable energy (13) and protecting the environment (13).

Of note for co-ops, the concept of collaborating on solar and sharing the burden appealed to 9 of the 28 focus group participants. "We can come together to create more sustainable energy options and help each other save money doing so."

When the participants were asked how they would like to receive information about a community solar program, they expressed a preference for in-person communication: a postcard mailing followed by a town hall meeting. They wanted to hear from the utility about the program.

Signing up needs to be easy; preferably, participants can use the same system used to pay their bills, and the benefits should be reflected on those bills within a month.

Research on costs conducted as part of the SUNDA project shows that solar becomes more cost effective at 1-megawatt or larger. In many areas of the country, arrays larger than 1 megawatt can frequently produce electricity comparable to the wholesale energy rate. Declining costs mean that community solar can and should be priced to sell.

8.3 Community Solar Market Research

3Degrees analyzed community solar participants from 12 co-ops in 10 states. The analysis used publicly available data on lifestyle, housing, and demographics to gain a better understanding of a target market for these programs.

The typical pricing for early community solar programs makes them premium products. Community solar participants have higher home values, live in higher-density areas, and have higher household incomes. They are also older, have a greater net worth than the average co-op member, and have lived in their homes longer.

Community solar participants are more likely to be female, live in a single family or townhome, and work in a professional or technical occupation.

Newer business models, like monthly subscription services, have significantly lowered the cost of participation and seen increased subscriptions.

8.4 Evolving Models

Over the course of the SUNDA project, concerns that the programs would not be fully subscribed lessened for many of the co-ops. The positive response and good publicity offset the financial concerns.

Community solar is not a typical utility offering. For example, Grand Valley Power, based in Grand Junction, Colorado, developed a community solar project whose energy will cover 90 percent of the energy needs for 6 to 10 low-income families. Six Colorado co-ops, including SUNDA participant Poudre Valley REA (PVREA) are now working with the Colorado energy office to develop community solar programs that reduce the energy burden for low- and moderate-income members.

3Degrees' recommendations included the following:

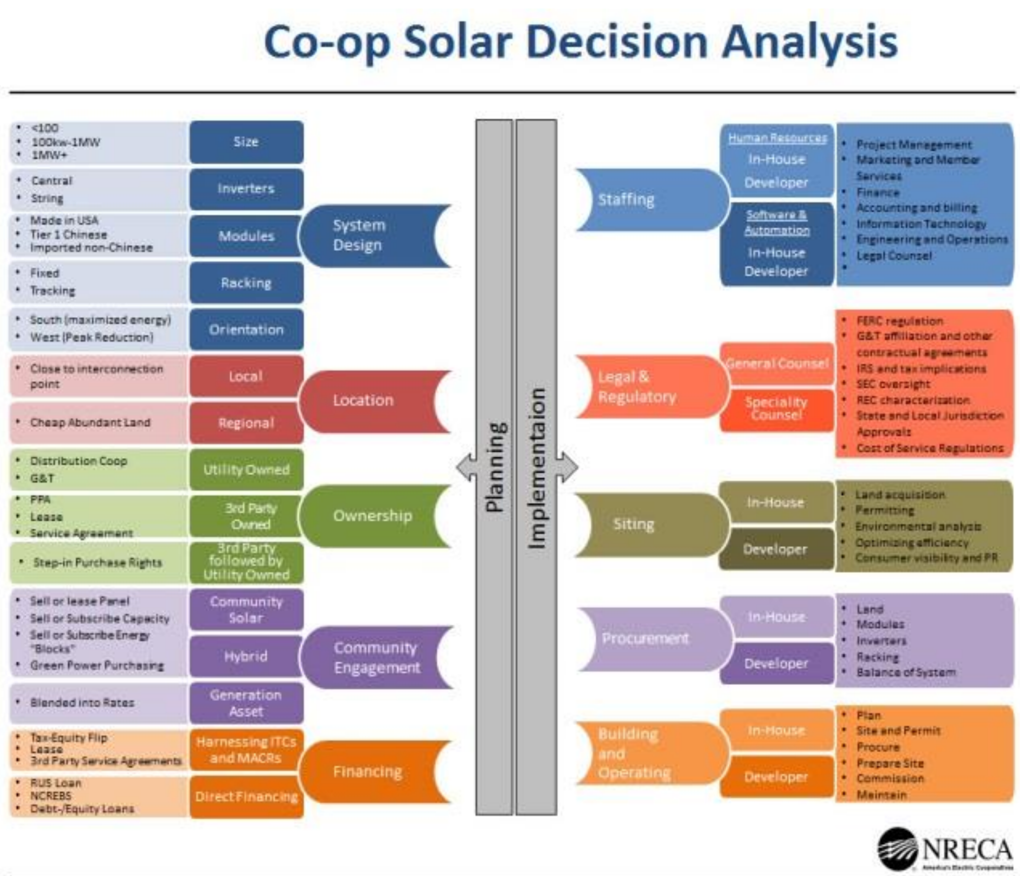
- Program design and pricing must strike a balance between the utility's interest and the desires and expectations of consumer-members. High up-front costs, long-term contracts, and penalties for canceling a contract make the program less attractive for many consumer-members. A co-op that takes this approach should plan on investing in a robust marketing campaign. On the other hand, easy-in/easy-out contracts and low up-front costs make recouping the investment difficult.
- Consumer-members want participation to be hassle-free. Long contracts will deter many prospective participants.
- Many consumer-members expect and want to see benefits within the first month. They also want to see the credit on their bills.

These preliminary recommendations, based on the initial research, deserve further investigation. NRECA intends to pursue opportunities to conduct a statistically valid survey of consumers to confirm these early findings.

9.0 Lessons Learned

The manuals, guides, and tools developed under SUNDA contain all of the lessons learned from the participating and associated co-ops, and should be a primary source of information for those interested in pursuing their solar options. However, it is interesting to examine some of the specific lessons learned.

Many factors influence a well-informed decision to undertake a solar project. Typical drivers of a co-op's solar strategy include member demand, power supply needs, management of PV-related cross-subsidies, the renewable energy market, state policies and regulations, and staying current with evolving technology. For co-op boards lacking experience with solar energy, the decision to invest resources can be difficult. A major focus of the project was to facilitate decision making by gathering lessons learned through field experience. The Solar Decision Guide, mentioned earlier and shown below, provides a useful framework for organizing the lessons learned.



9.1 Planning

Over the course of the project, several changes in thinking occurred around system design, ownership, community engagement, and financing due to the evolving industry, technology, and costs, as well as experience gained through the field deployments. The SUNDA guides can help streamline this process, thus saving significant time and money compared with a co-op starting from scratch. Having a structured process can be especially helpful for a co-op's first project but can also aid in future projects. The following are some general planning lessons learned:

- *Go into a project with specific goals in mind; this approach will shape the type and size of system installed, and the overall program structure and member engagement strategies.*
  It is important for a co-op to determine the specific reasons it wants to implement solar and what a successful implementation would look like. There are various reasons that co-ops pursue solar. Although member satisfaction is the number one reason cited, solar can also benefit co-ops through load shaping or peak reduction, alleviating congestion issues, acting as a hedge against long-term fuel costs, and responding to environmental and regulatory requirements. Regardless of the reason(s) for pursuing solar, to maximize benefits it is important that co-ops engage with their members from the very beginning to build interest and community buy-in.
- *Board needs to understand the value proposition, the risks, and how to manage them.*
  Several co-ops experienced delays, or even project cancellation or redirection, simply because the board did not understand the project well enough to assess the real risks. Working with the board early in the process and keeping it updated during the design and development process pays dividends.
- *Co-ops constitute a diverse community; there is no one-size-fits-all solution for solar.*
  At the beginning of this project, the plan centered on developing a standard solar design that could be implemented at most co-ops, including a standardized parts list and vendor agreements already in place—essentially solar in a box. This concept sounded good on paper, but it did not consider the individual decision-making processes and local variables for each co-op. It turned out that some co-ops wanted central inverters, perhaps integrated with battery storage, others were interested in string inverters, and still others wanted tracking systems to help them match evening peaks. No one-size-fits-all solution will do.

9.1.1 Ownership

The early questions regarding ownership revolved around G&Ts and the all-requirements contract,[15] as well as whether it was better to own or lease the hardware or just buy green solar power under a PPA. Three answers became clear during the course of the project:

- *All requirements contract challenges have been overcome.*
  Early on, 67% of the distribution co-ops that were considering solar and responded to the *2014 PV Maturity Survey* characterized their existing contracts with their G&Ts as a challenge to implementing a solar project of their own. As interest at the distribution co-op level increased, these cooperatives brought that interest to the boards of their G&Ts. Today, the majority of G&Ts and their distribution co-op members are working collaboratively and within their existing contracts to implement solar projects that make sense for their members.
- *PPA versus ownership risk mitigation*
  Although the specifics about these decisions are unique to each co-op, most choose to implement PPAs to reduce the risk of unfamiliar technology or manage the risk of a technology being leapfrogged by another in the future. Ownership is not the right model for some co-ops.
- *Aggregating projects through the G&T is advantageous.*
  G&T can frequently act as an aggregator for multiple distribution projects under a single development contract and achieve scale discounts even though installations may be scattered over multiple sites.

9.1.2 Finance

Unlike in 2013, co-ops today have a range of financing options and partners. Their traditional lending partners have developed programs that take advantage of government tax benefits and leverage the low-cost capital available to co-ops.

- *Tax-equity flip financing can be too expensive for small projects; this financing typically is best suited to 5 MW+ projects.*
  The transactional costs—fixed fees for creating the required companies and legal paperwork—typically make this option prohibitively expensive for projects much under $10 million. Most co-ops choose a tax-advantaged lease structure for their financing, but should always check with CFC, CoBank, or other lenders to investigate current options.
- *Tax incentives and tax law have and continue to change, and may significantly impact projects.*

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[15] Distribution co-ops typically buy their energy from a G&T co-op. The G&T's board is made up of representatives from each member distribution co-op. To raise the capital to build the generation facilities and transmission system, the G&T guarantees its revenue stream through wholesale power contracts stipulating that the distribution co-ops will buy all their energy from the G&T—an all-requirements contract. Though some contracts allow a small amount of self-generation by the distribution co-op, it is usually capped at a very low level.

The 2018 tax reforms had a two-fold impact on co-op solar projects. Because of the new lower corporate tax rate, there is less capital-seeking tax-advantaged investment opportunities. This change has restricted the size of the capital market and will likely drive up rates. In addition, the monetization value of the accelerated depreciation of hardware is dependent on the corporate tax rate, and thus dropped proportionally, raising the effective price of a PV system for co-ops by that same amount.

- *Finance partners are familiar with solar projects and are available to co-ops to help determine the best course of action: RUS, CFC, CoBank, NRCO, and NRTC.*
  In 2013, when SUNDA began, few options existed for financing a solar project. As of 2018, the typical co-op financing partners have options available for those co-ops interested in financing a solar project at favorable rates.
- *Pay attention to tax credit deadlines, as they may impact cost and availability of components.*
  During the SUNDA project, the ITC was scheduled to end. In the year before deadline, a steady increase in prices occurred as all available product was committed to those projects trying to beat the deadline. Similarly, delivery dates increasingly were moved into the future. When considering a project, look at the dates for the sunsetting of the ITC and any other tax-related deadlines that may have significant impacts on a project's schedule.

9.1.3 Location

Most distribution co-ops want to have their solar facility located in their service territory to promote customer buy-in and increase member satisfaction. However, there are situations in which remote options should be considered.

- *Land use issues*
  There can be competition for available land in or close to population centers. In some areas, there are concerns about using arable land for solar.

- *Generation-scale projects*
  G&Ts can also implement large deployments (20 MW+) that often match the cost per kWh of fossil fuel sources.

9.1.4 System Design

The technology for implementing solar continues to evolve, and new technology is entering the market all the time. The general trend has been toward larger arrays, string inverters, tracking systems, and higher voltages.

- *Scale matters—larger systems have non-equipment costs similar to those of smaller systems.*
  The fixed transactional costs and overhead expenses of building systems under 1 MW do not vary much. Also, smaller systems do not get the volume discounts that purchases for larger

systems do. Thus, a 100-KW system winds up being much more expensive than a 1-MW system on an energy output basis. Projects in the 1-MW range can provide power at 17% lower LCOE than those at 250 kW, and projects in the 5-MW range can provide power at 9% lower LCOE than those at 1 MW. If the local need is insufficient to build a larger system, consider collaborating with nearby co-ops to increase the scale of project procurements to achieve economies of scale.

- *Solar technology is changing fast, and it is important to know about the latest technology trends.*
    - At the beginning of the project, most existing utility-scale systems had string voltages of 600 VDC, but there were signs that 1,000 VDC was becoming accepted. Two years into the project, 1,500-VDC systems began appearing and are considered the standard today, with systems of 2,000 VDC and higher now beginning to appear. Reviewing technology trends is especially important when considering spares, because older technologies may become harder to find as time passes.
    - Inverters also have experienced a significant shift. At the beginning of the project, the standard for a MW-scale system was to use 500 kW-AC central inverters as building blocks. Partway through the project, 3-phase ungrounded string inverters began becoming available for smaller systems and became the recommended technology for systems up to 5 MW by the end of the project; there are now reports of future 100-MW+ systems being designed with string inverters.
    - A third example is tracking. At the beginning of the project, the engineering team recommended fixed structures because trackers of that era were deemed both too expensive and unreliable. Tracker manufacturers responded to these challenges with more reliable (sealed bearings, etc.) and more flexible (individual row trackers, etc.) systems at lower costs. Utilities also began realizing that there was often significant value in having more energy later in the afternoon to reduce peak demands, a situation facilitated by tracking systems. Thus, by the end of the project, most co-ops were seriously evaluating single-axis tracking systems for new installations.
- *Energy storage is the latest emerging solar trend.*
  The cost of energy storage is falling rapidly, so this technology needs to be evaluated in the planning stages of any new solar project. Although it was generally too expensive to be part of most of the SUNDA projects, energy storage is becoming an increasingly important consideration for co-op renewables planning and may drive some decisions around system design,inverter selection, and for how to optimize the value of solar investments.
- *IEEE1547-2018 now allows for advanced inverter functionality.*
  At the beginning of SUNDA, existing safety regulations made it mandatory that any fluctuation in the grid voltage or frequency caused the inverter to immediately disconnect from the grid and wait 5 minutes before attempting to come back online. The new “smart inverters” allow the inverters to ride through brief voltage and frequency variations and can also be used to provide VAR support and other grid stabilizing functions. Co-ops should learn and understand how these functions might benefit their systems and interact with their existing safety equipment. Also, if a

co-op is buying solar from a third party, these settings and issues need to be included in contracts and PPAs.

- *Interoperability and systems monitoring are important.*
  Another important lesson the co-ops stressed was the importance of system monitoring, especially when a co-op starts implementing multiple systems. Having a well-defined and/or standardized and interoperable monitoring interface (as opposed to a custom data-stream/interface from each project's developer) will help centralize and coordinate PV system management, and facilitate future integration of PV systems. The tradeoff between more detailed modeling versus saving costs has leaned toward more detailed monitoring to reduce the need for expensive "reactive" maintenance truck rolls, especially if systems are spread out over a large co-op territory.
- *Be careful when considering innovative solar designs.*
  One cautionary note sounded was to be careful when considering innovative system designs that use non-standard components or construction techniques. All designs using non-industry-standard equipment should be reviewed by competent technical due diligence experts to balance the gains from an innovative design against the need to keep the system running if the supplier of non-standard system components goes out of business. During the SUNDA project, Ten-K Solar closed its doors, leaving some co-ops with unsupported equipment in the field. For lower risk, co-ops generally suggested working with EPCs and vendors that offer industry-standard equipment.

9.1.5 Community Engagement

Over the 4 years of the SUNDA project, attitudes about solar shifted from it being a special product for a few (typically wealthy) members to being something in which all members can participate.

- *Community solar should include monthly subscriptions.*
  Early community solar projects coming online in 2014 and 2015 typically had large up-front payments associated with them to recoup the capital expenditure and avoid cost-shifting to non-participating members. Co-ops with these plans frequently had difficulties in fully subscribing their projects. Mid-way through the SUNDA project, one co-op adopted a pay-as-you-go plan with no up-front charges or switching fees. This plan allowed the co-op to offer solar energy at near parity with its conventional sources. Many other co-ops have followed suit; this approach has greatly improved their ability to reach targeted subscription levels. Flexibility in subscription offerings and responding to member demand pays off.
- *Co-ops need to think about the effect of future projects on community solar program design.*
  The costs associated with PV continue to decline, though not as dramatically as in the 2013–2017 period, resulting in a potential pitfall. The risk is designing a solar program today that locks members into a pricing model that may be higher than the next solar facility that the co-op implements, thus potentially incurring member dissatisfaction. Co-ops should be prepared to

evaluate and, where appropriate, implement pricing revisions for members to address changing circumstances.

9.2 Implementation

The major decisions for implementation will involve what to do in house and what expertise to bring in. Co-ops have successfully completed projects both by doing everything themselves and hiring others for a turnkey solution. The decision will depend on how much risk a co-op is willing and able to take on.

9.2.1 Staffing

Solar projects are different from legacy co-op projects. At the beginning of SUNDA, co-ops had a tendency to view solar as an engineering/operations-only issue, like legacy projects. However, because solar is a consumer-centric energy service, projects involve all co-op functions. Solar impacts all departments, particularly if a co-op implements a community solar project.

- *Have a dedicated project manager.*
  The experience of the participating co-ops, regardless of whether they built the project in house or contracted with an EPC, was that managing the implementation and coordinating all aspects of the project required about 80% of an FTE for at least 6 months. For details about the project manager's responsibilities, please see the *Project Manager's Quick Start Guide.*
- *Communications and member engagement are important factors from the beginning.*
  The communications staff can begin to generate excitement about a solar project well before the ground breaking, thus maximizing member engagement, which has been the primary objective of most co-op solar to date.
- *Solar can be a staff-building, team-building, and career-development exercise.*
  One co-op CEO said that involving the staff in the system build was the best team-building exercise the co-op had done in years. Another CEO attributed having solar and SmartGrid projects as the only way he was able to hire new, young engineering staff. Finally, one SUNDA project manager said that implementing this project was the most fun he has had on the job in years because he was learning so much and doing something new.

9.2.2 Legal and Regulatory

There are few significant legal issues around solar that differ from other utility operations. The following addresses some of these legal issues. Co-ops are encouraged to work with their attorney on these and other solar matters addressed throughout this report.

- *Renewable Energy Credits (RECs).*

Some solar developers still encourage co-ops to sell the RECs from a new solar development as a cost-recovery method. According to the EPA, RECs are legal instruments that contractually convey the attributes of renewable electricity (i.e., environmental attributes) to their owner. Thus, the REC owner has exclusive rights to make claims—either explicitly or implicitly—about “using” or “being powered with” the renewable electricity associated with a REC. However, if the RECs are sold, the project—and the energy from produced from it—may no longer be billed as renewable or green. Co-ops may want to retire their RECs to retain the “greenness” of their solar project and ensure that the RECs convey to the co-op with any solar PPAs they enter. One exception would be if the co-op invests in solar as a low-cost source or fuel-price hedge and does not intend to claim any green value or refer to it as a renewable. There may be state laws to consider as well.

- *Accepting money before completing construction can be risky.*
  If co-ops accept money from a member to be part of a community solar project before the facility is completely built, it could violate Securities and Exchange Commission (SEC) regulations, as such an action may be construed as selling a security. It is best to accept money only after the facility is online, though it is usually safe to enroll members earlier as long as no money is exchanged.

9.2.3 Siting and Permitting

Based on the SUNDA co-ops’ experiences, siting and permitting are the most significant variables regarding cost and the project’s timeline. Help from knowledgeable local land experts can greatly smooth the process of choosing the right site and getting it permitted.

- *Soft costs such as permitting are highly variable, based on siting of the project.*
  Significant soft costs for the co-op are related to site selection and permitting. Because co-ops operate in 47 states, each with different regulations, there is no standardized permitting process. Experience with the SUNDA co-ops suggests that permitting time and costs can vary widely and unexpectedly. One co-op had sites rejected because of “vernal pools,” which are seasonal wetlands. Another co-op experienced significant delays when evidence of an endangered species was found on the proposed site. Yet another sited a system near an airfield that needed an FAA ocular (reflection) study. Reflection studies also may be needed for major roads and other situations. Understanding the permitting challenges of a given site early in the process allows co-ops to adjust their plans and timelines proactively.
- *Consider multiple sites.*
  Although access to lands is usually easier for co-ops because of their rural locations, when choosing a location for a solar project, they should start by considering multiple sites and evaluating them for their environmental and permitting issues, as well as their technical suitability. It is easier to change sites early in the process than after completing significant design and development work. Plan ahead, have multiple site options, and start discussions with

permitting authorities early. One of the most important lessons that SUNDA participants stressed was "*Allow adequate time for land acquisition and permitting."*

- *Pay for a thorough geotech analysis.*
  Participating co-ops also recommended not skimping on geotech analysis during the design process. Saving money up front can lead to significant delays and additional expenses when something unusual shows up after installation begins. A thorough analysis should uncover potential issues, like hidden rock that makes installing the piers more expensive, or vernal pools that make permitting difficult.
- *Work with your community.*
  Site selection can sometimes lead to contention with the community. Not all members feel that a solar facility makes a good neighbor. Concerns range from issues about converting agricultural land to the visual impact and potential impacts on property values. Good communications with members and neighboring properties when selecting a site, as well as a willingness to make reasonable accommodations, can often alleviate community concerns. Finally, co-ops recommended involving local emergency responders early in the process to address their specific concerns, especially for their first large project, when the technology is still unfamiliar.

9.2.4 Procurement

The solar equipment marketplace is a dynamic and turbulent one. In uncertain markets, buyers need to be vigilant and accept a certain amount of risk. However, co-ops can take steps to help mitigate those risks.

- *As with any construction project, know with whom you are contracting and build performance incentives/penalties into the contract.*
  Another learning experience from SUNDA was in the contracting process. Because EPCs frequently can be in high demand, there were several instances of EPC firms terminating contracts with co-ops simply because they got a better contract offer to do a different job. RFPs need to have built-in incentives and/or penalties to ensure the installation is done on time, and the specifications and acceptance inspection/testing need to be spelled out clearly.
- *Working with an EPC can minimize a co-op's risk.*
  Separating the procurement from the rest of the contract increases the burden on the co-op as well as the risk of unclear product and performance liability. A single source provider—the EPC—reduces the chance of incompatibilities, finger-pointing, and general risk. However, the tradeoff of contracting the work to others is that the co-op does not build in-house solar expertise.
- *Communications with other co-ops can identify good regional EPCs.*
  Although it may seem obvious, as part of the EPC vetting process, co-ops should ask their neighboring co-ops and municipal utilities for recommendations on solar EPCs. Installers tend to be regional, even though a region may be as large as several states, and local knowledge can be

helpful. Some installers truly are nationwide, so asking which EPCs other co-ops have worked with, on NRECA's DER listserv for NRECA voting members, may provide additional options for co-ops to consider.

9.2.5 Building and Operations

When it comes to constructing and maintaining a solar facility, co-ops generally already have the core skill sets among their staff. Among the co-op participants in the project, there generally was nothing particularly difficult or complex about building, maintaining, and troubleshooting solar equipment that could not be handled by co-op engineers and electricians.

- *Although engineering and construction can be done in house, it is usually more efficient to use a dedicated EPC.*
  Early in the SUNDA project, it was anticipated that many co-ops would want to build their own arrays to save money. Though building a solar facility is certainly within the capabilities of most co-op personnel, co-ops need to consider the man hours involved. A project manager typically will need to be tasked ~80% for at least 6 months, plus a crew of 6 mechanical and electrical workers for 2 months, to build a typical 1-MW array. The experience is certainly rewarding and builds a lot of in-house expertise, but most co-ops find that their employees simply do not have the time. EPCs' experience allows them to provide the services faster and at competitive cost.
- *Solar operations and maintenance (O&M) may represent an opportunity for co-ops.*
  Frequently, co-ops have found that, whereas it is easy to hire EPC firms to build arrays, it is harder to find companies that will reliably perform routine maintenance and repair. Several co-ops in the project found that bringing this function in house was manageable and often added job satisfaction for their crews. They included a clause in their EPC contracts to have the EPC train co-op staff. In locations with significant third-party solar facilities installed, co-ops may be able to offer O&M services as a side business, similar to offering tree and vegetation management services.

10.0 Future Work

SUNDA was a very successful project for DOE, NRECA, and the co-op community. This success and corresponding momentum potentially can be leveraged to support new initiatives and future work. The key success factors to build on include those provided by NRECA, as follows:

- Relationships with co-op utilities
- A collaborative project format that enabled peer-to-peer learning and exchange
- A cross-functional approach that included business, financial, technical, and communications expertise
- Extensive outreach and training capabilities

These factors came together to accelerate solar knowledge and deployment across the co-op network. SUNDA engaged the entire co-op community and built a strong core of co-ops committed to exploring emerging DER technologies.

NRECA's commitment to supporting co-ops in their solar development efforts did not end with the SUNDA project. SUNDA held its final meeting at PVREA in Colorado on November 15–17, 2017. More than 45 people from 2 dozen cooperatives, including 11 G&Ts and representatives from NRCO, NISC, SEDC, CFC, and CoBank convened with DOE SETO staff for an in-depth and wide-ranging discussion of what co-ops have learned and the challenges that lie ahead.

Participants of the final SUNDA team meeting identified the following key areas for further development:

- Advanced solar installations that include energy storage solutions
- Stand-alone energy storage pilot projects
- Distributed energy system integration, to include interoperability, data analytics, supervisory control and data acquisition (SCADA) system control, forecasting, and system optimization
- How best to serve and partner with commercial, agricultural, and industrial members to help them meet their renewable energy goals and needs
- How to utilize advanced renewable technologies to attract and retain key commercial accounts to spur local workforce and economic development

The SUNDA project helped co-ops understand a typical solar installation. The next logical step is to include storage and other DER resources as a means to further optimize the value of the cooperative's investment in solar. Stakeholders agree that storage is a next step, but adding storage is not as simple as it might first appear. The known challenges include integration with control systems, dispatch algorithms, high-speed data communications (broadband), and battery technology/chemistry selection. Currently, manufacturers have their own proprietary systems, which are frequently incompatible with components from other manufacturers and existing utility systems. Similar to the situation at the beginning of the SUNDA project, a few co-ops have begun initial efforts. More are looking to develop pilot systems in the near future. Other co-ops are looking at pilot storage projects independent of solar or other DER.

Further, there is added value co-ops can bring to support both C&I and the larger community of interest. The business models for how to value products and services or work with consumer-members around combined DER and storage options are in their infancy, and have not been validated. C&I customers increasingly have sustainability, CO2 reduction or renewable goals and options for meeting those goals, including third-party providers. It is not yet clear how co-ops and C&I members should collaborate to meet the needs of both parties. Offerings and rate structures will need to evolve.

The right offering of DER and advanced energy services can be a key component of attracting and retaining businesses in rural communities. Data and warehouse distribution centers, and operations like them, represent significant load as well as the opportunity to support regional workforce development and economic growth. NRECA and Touchstone Energy® Cooperatives (an NRECA-affiliated marketing cooperative) are working with co-ops on evaluating best practices in collaborative efforts between co-ops and their C&I members, as well as third-party members.

In response to the final meeting conversations, DOE representative Ammar Qusaibaty said, “The SUNDA project has changed how people at DOE view co-ops.” He believes co-ops are “truly shaping the frontier of innovation in solar.”

11.0 Conclusion

Evolution of the solar market has been faster and more expansive than anticipated, and America's electric cooperatives are playing a key role.

NRECA has completed up a 4-year, national solar installation research project that aimed to reduce costs and lower barriers to PV deployment. SUNDA brought together 17 cooperative partners and experts to install more than >23 MW of PV solar, converting research and lessons learned into actionable guides for co-ops across the country.

NRECA created a suite of resources to help co-ops at every stage of the solar deployment process. From analyzing financing options to operating and maintaining the completed array, the resources included standardized engineering designs, cost and financial screening tools, a communications toolkit, and online and in-person training. These resources facilitated collaborative problem solving within the cooperative network and reduced implementation barriers for co-ops like PVREA.

"We wanted our next community solar project to be an owner/operator model, but lacked the expertise," said Jeff Wadsworth, president and CEO at PVREA. "SUNDA provided an opportunity for us to acquire knowledge in areas such as design, financing, procurement, and marketing. SUNDA played a significant part in the success of our third community solar project, and the lessons learned should be invaluable to other cooperatives wanting to build and own their solar farm."

By providing resources based on the real-world experience of co-ops across the country, this DOE-supported project has helped enable a significant increase in cooperative solar. Today, total solar energy capacity at electric cooperatives is more than 4 times what it was in 2015, capable of generating more than 860 MW of electricity. The number of co-ops that have some solar or are actively planning systems is up by more than 50% since before the collaboration. The SUNDA project established cooperatives and NRECA as valuable partners, and helped cement the co-ops' leadership in community solar.

NRECA and the co-op community found the SUNDA project to be one of the most beneficial technology projects ever undertaken. NRECA would like to thank DOE for including the co-ops in the SunShot Initiative and enabling the advancement of co-ops' understanding, expanding their solar options, and developing resources to facilitate implementation.

Appendix 1:

SUNDA Co-op Case Studies

DE_EE-00063333-D4.12
4/30/2018

Great River Energy (GRE) – Phase I

State: MN
Type: G&T
Number of Meters: 685,000 through 28 member distribution co-ops

Project Summary

Great River Energy (GRE) provides wholesale electric service to its 28 member cooperatives, which distribute electricity to approximately 685,000 consumers in Minnesota, or about 1.7 million people. GRE was an early adopter of solar, looking to experiment to determine the best manner to provide non-residential solar expertise to its members on behalf of their consumer-members.

GRE's 259-kW research and demonstration array at its Maple Grove headquarters tests the performance of 3 types of panels; the 19 arrays across Greater Minnesota have a generating capacity of 20 kW each and provide statewide distributed generation (DG) information. All of the projects are helping GRE and its member cooperatives evaluate the impact of solar energy while providing up to 450,000 kWh of renewable energy annually—equivalent to powering about 38 homes.

Overall, the average annual output for each of the arrays is slightly lower than the 15% capacity factor predicted going into the projects, but it represents "one of the realities of solar in Minnesota," according to Andy Bergrud, the GRE project manager. One of the project team's biggest takeaways regarding solar generation on the GRE system is how much of an effect frequent, rapid power swings have on the output—again, due to Minnesota's tendency to have more cloudy than pure sunny days. An understanding of the sudden shifts in power output caused by cloud interference is an important lesson learned for utilities, which must find ways to properly manage the grid as more solar and other renewable energy resources are interconnected to the electric system.

The 3 GRE systems are the following:

- 54 kWp traditional ground mount, using Sharp modules and Solectria inverter
- 108 kWp innovative ground-mount system, using TenK modules, racking, and power electronics
- 95.4 kWp parking lot canopy, using Suniva modules and Advanced Energy inverter

Simultaneous to the SUNDA deployment, GRE deployed nineteen 20-kW arrays across the state at its various distribution co-op members. Although GRE intended to deploy these small, local systems to promote member awareness, the disbursed nature of the deployment proved financially disadvantageous. A single maintenance issue at a remote location typically required 2 truck rolls to diagnose and fix. The associated cost exceeded the value of the output of the array for the year.

Background Information

- **Existing Renewable Assets**

GRE also receives power from wind, hydroelectric, and a waste-to-energy power plant. In addition to the solar arrays constructed for this project, GRE already had an existing 72-kW array. Following this installation, it installed 19 more solar arrays across its members' service territories, each one at 20 kW.

- **Reasons for Installing Utility Solar**

GRE installed utility solar in response to demand from its member distribution cooperatives and to meet Minnesota's Renewable Energy Standard. Under the standard, it is required to produce 25% of its electricity from renewable energy sources by 2025. GRE has already exceeded those requirements.

Project Timeline

Permitting Began:	1/10/14
Procurement Began:	1/10/14
Installation Began:	3/17/14
Deployment Completed:	5/23/14

Technical Details

1. **Project Size**

Final Project Size (MWp):	0.272
Final Project Size (MW-AC):	0.258

2. **Equipment Installed**

<u>Traditional ground-mount system</u>

Size:	54 kWp
Modules:	180 X Sharp 300 W panels
Inverter:	Solectria 40 kW
Racking:	Fixed ground-mount Creotecc racking with helical screw anchors; oriented with 28-degree tilt

<u>TenK System</u>

Size:	123 kWp
Modules:	300 X TenK Solar 410 W
Inverters:	500 W TenK Solar micro-inverters
Racking:	TenK Solar racking with 26-degree tilt and 2-foot ground clearance

Power Electronics consists of 18 x 6 kW inverter busses; each bus includes 12 x 500 W TenK micro-inverters.

<u>Parking Lot Canopy</u>

Size:	95.4 kWp
Modules:	360 X Suniva 265-W panels
Inverters:	Advanced Energy 100-kW central inverter
Racking:	Parking canopy with 20-degree tilt with 8-foot minimum ground clearance

Remote Monitoring:

Each system includes a Schneider Ion 7550 revenue-grade meter with 1-second monitoring. Monitoring encompasses the following:

- Global horizontal irradiance (GHI)
- Plane-of-array (POA) irradiance
- Ambient temperature and back-of-panel temperature
- Wind speed and direction
- DC power into inverters
- AC power out
- AC into meters
- Power factor
- Power quality
- Total harmonic distortion
- Frequency
- Volts
- Amps

GRE selected a variety of tier 1 equipment to test, based on recommendations from other co-ops, the SUNDA project, and its own research.

3. Procurement

GRE procured the PV modules, inverters, and racking themselves; its general contractor obtained the remaining items. GRE had a number of difficulties with supplies. First, it experienced a month's delay in delivery for all of the TenK Solar equipment. Then, in summer 2017, TenK Solar declared bankruptcy and ceased operations. GRE was able to procure sufficient spare parts from TenK Solar before it ceased operations. The Creotecc racking was delivered and received on site shortly before being notified that Creotecc was closing its U.S. business. For its inverters, GRE chose an Advanced Energy inverter shortly before that firm discontinued manufacturing inverters. Two months after installation, the manufacturer of the Solectria inverters changed ownership. Sharp's module manufacturing facility in Memphis, TN, closed about one month after the commercial operations date on the project.

The other issues all were related to the long-term ownership of the asset, equipment warranties, and replacement parts. On a normal solar project, GRE would not have had 3 different suppliers for modules, inverters, and racking. Using common equipment across the site, and multiple sites when possible, is one thing GRE would have done instead. Given the instability in the supply chain, GRE suggests that cooperatives consider placing procurement of all equipment under one EPC contract to reduce those risks. Arranging the logistics and timing of the equipment delivery with an installation vendor, and arranging laydown areas, are dedicated jobs needed to ensure no negative effects on the job site or local building use. GRE ordered extra modules because they are shipped on pallets, and the marginal cost of ordering a full pallet was lower than ordering only what it needed. The additional modules will be held in inventory as replacements.

4. Siting and Permitting

GRE was required to obtain the following permits for its headquarters arrays:

- An ocular study on the potential glare impact of the array on pilots flying to and from a nearby airport
- A permit with the city of Maple Grove to ensure that the grounding was properly connected
- A building permit for the parking canopies, which required a foundation inspection

5. **Building and Operating**

Installing the arrays was a straightforward process:

- Each of the 3 systems took only about 3 days to be installed and wired.
- The TenK Solar system was simpler because of the use of modules as structural members. TenK Solar also claims minimal shading losses because of the parallel design and increased safety due to a lower-voltage system.
- The parking canopy company erected the canopies; a local electrical contractor installed and wired the array.

O&M will be done by the GRE Generation Division. To limit the amount of vegetation management, GRE installed landscaping fabric and decorative rock under the panels for weed maintenance.

To interconnect the system, GRE followed the Wright-Hennepin Cooperative Electric Association (WH) interconnection process. WH is the local electricity provider and one of GRE's member-owner cooperatives. WH reviewed the one-line drawings, interconnection application, and metering solutions, and required a walkthrough of the electrical room and a test of anti-islanding.

The system is connected directly to the 480-V bus in the building and offsets the building load. WH installed a new bidirectional meter at GRE's headquarters to meter any excess PV generation back onto WH's system. GRE additionally installed 3 ION 7550 production meters to monitor each of the arrays, and is collecting solar production data through its building management system. Setting up this metering and billing system required standards-based coordination between the GRE and WH metering groups.

GRE installed a high-resolution data acquisition system to collect data on each of the 3 systems for further study. In addition to showing the energy production of each system, GRE is interested in exploring the relative kWh per kWp contribution for each of the 3 systems; the effects of snow on the systems; and long-term production, degradation, and system reliability. Thus far, GRE has seen little difference between the capacity factors of the 3 systems.

6. **Other Technical Details**

    a. **System Impact Analysis**

Due to the size of the system, a system impact analysis was not required.

    b. **System End-of-Life Plan if Applicable**

A system end-of-life plan was not required by any governing body or GRE's financing partner.

7. **System Photos**

https://www.dropbox.com/sh/ffpjmrh6wgd7i9q/AABg_UpEDiXvZEYc2J_3nojFa?dl=0

Financial Details

1. **Business Model/Ownership**

Financing was arranged by GRE through a 10-year CoBank lease. GRE owns the production of the system; Farm Credit Leasing and CoBank own the asset for 10 years. After 10 years, GRE has the option to purchase the asset from CoBank. GRE receives all the power produced by the system to offset energy demand at its headquarters building.

2. **Financing**

See above.

3. **System Costs**

Roughly $4.50/Watt-dc

Legal and Regulatory Challenges

GRE experienced no significant legal or regulatory challenges with this project.

Outreach and Engagement

1. **Community Solar if Applicable**

N/A

2. **Member Engagement**

GRE engaged its distribution cooperative member-owners throughout the project by using a variety of methods, including GRE board, member manager, and staff presentations, and website articles.

3. **Employee Training, Time Requirements, and Engagement**

GRE kept employees informed of the project status through company meetings, brown-bag lunch presentations, and via the GRE internal website. GRE employees responsible for O&M received training from the PV installer and the equipment manufacturers.

4. **Board Engagement**

See Member Engagement, above.

Lessons Learned

1) There are limited inverter sizing options for various interconnection voltages and isolated vs. non-isolated installations. Site capacity should be driven by inverter size rather than the inverter size being driven by the desired capacity. For example, 150-kW and 20-kW systems are almost completely unavailable for a 480-V isolated inverter.

2) Consider site security options during site selection. Will you need fencing around the inverters or disconnects? How will future projects restrict access to PV wiring and prevent vandalism to the panels?
3) Helical piles can save on installation costs and time. Perform a geotechnical study to see if they can be used on the site.
4) Equipment supply can be unreliable, so confirm ship/delivery dates early with equipment supplier.
5) Cable access prevention requirements vary significantly by inspector. GRE installed PVC conduit behind its panels for improved cable management, which was approved by the city inspector.
6) Start discussions with permitting agencies early. GRE was fortunate that the city was very receptive to its project.
7) If the project is near or on airport property, an ocular impacts study may be needed.
8) Interconnection application requirements can require lengthy reviews, depending on the experience of the local utility.
9) Metering expectations vary by site. GRE suggests starting the interconnection and metering conversations very early to determine communications requirements, meter type, sampling intervals, billing periods, net metering/billing philosophy or policies, and rates.
10) Use proven, mature companies and technologies. Avoid companies with proprietary equipment or small install bases.

Future Plans

After installing these systems, GRE installed a small solar array for each of its distribution members, followed by a 2-MW array for Wright-Hennepin. GRE continues to provide support for its member-owner cooperatives as they consider renewable energy options.

More Information

Primary Contact:
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Website:
http://greatriverenergy.com/we-provide-electricity/making-electricity/solar/

Press Release:
http://greatriverenergy.com/wp-content/uploads/2016/03/Solar-fact-sheet-2016.pdf

http://greatriverenergy.com/wp-content/uploads/2015/05/Solar-Member-Initiatives-2017.pdf
http://greatriverenergy.com/wp-content/uploads/2015/05/solar_perf_summary1.pdf

Video:
https://www.youtube.com/watch?time_continue=2&v=uHDkTBMocE4

GRE – Phase II – Wright Hennepin

State: MN
Type: Distribution
Number of Meters: 50,000

Project Summary

Wright-Hennepin Cooperative Electric Association (WH) is a distribution cooperative in Minnesota and a member-owner of GRE, a Minnesota G&T cooperative. WH had an interest in adding solar energy to its wholesale power supply. It worked with GRE to develop a 2.25-MWac solar array located near Buffalo, MN, which is in WH's service area. GRE and WH evaluated Minnesota-based PV solar system manufacturer TenK Solar, but ultimately decided its design was not suitable for a multiple-MW project. Instead, a fixed-racking system using Heliene PV modules manufactured in Canada was selected. GRE and WH also considered string inverters, but found this design to be slightly more expensive than the selected central inverters manufactured by Solectria. The solar facility is a GRE-owned asset; the energy output is 100% dedicated to WH's wholesale power supply.

The project began in April 2015. Once the permits were in place and the engineering procurement contractor had been chosen, the final design was selected in mid-December 2015. System installation began in April 2016, with construction completed in June 2016 and system commissioning in August 2016.

Background Information

- **Existing Renewable Assets**

WH has 4 existing community solar arrays; 3 are located at its Rockford, MN headquarters and another at its substation outside of Medina, MN. The headquarters arrays are 32 kW, 30 kW, and 150 kW, respectively. The Medina array is 150 kW. More than 80 members participate in these community solar arrays. The existing projects are currently fully subscribed and producing power for those participating members.

WH owns 2 commercial solar projects that provide energy under a 25-year agreement. The first is a 150-kW array located on land adjacent to the City of Rockford's water tower. The second is a 28-kW rooftop array installed at the Rockford City Center Mall.

- **Reasons for Installing Utility Solar**

WH decided to add utility-scale solar to its wholesale power supply as a way of diversifying its power resource mix.

Project Timeline

Permitting Began:	5/15/2015
Procurement Began:	12/15/2015
Installation Began:	3/15/2016
Deployment Completed:	8/20/2016

Technical Details

1. Project Size

Final Project Size (MWp):	2.589
Final Project Size (MW-AC):	2.25

2. Equipment Installed

Modules:	8,352 x 310W Heliene Solar Modules
Inverters:	3 Solectria central inverters 1,000 VDC, 750 kW-AC
Racking:	Solar Flex Rack G3-PX racking, oriented due south with 30-degree tilt
Remote monitoring:	SolrenView

3. Procurement

In April 2015, WH issued an RFP for large-scale solar PV generation resources, located within WH's service area, with a capacity no smaller than 1.0 MWac and no larger than 6.0 MWac. Through a competitive bidding process, GRE's generation engineering department was selected to develop the project.

4. Siting and Permitting

GRE proposed to develop the project at a 13-acre parcel owned by GRE. This site was selected due to unobstructed solar irradiance, minimal grade, and existing fencing. The land is not suitable for tilling, so it possessed little agricultural value.

GRE obtained all needed permits for the project, including a conditional use permit (CUP) from Wright County. It was fortunate to get the project permitted before a 6-month solar moratorium was put in place in Wright County in 2016. The moratorium was enacted to allow the county time to develop and implement an improved solar permitting process.

5. Building and Operating

As the project developer, GRE contracted with Energy Concepts for EPC services. Energy Concepts subcontracted the construction scope to ZEN Energy.

Now that it is operational, WH performs system O&M. WH staff received O&M training from ZEN Energy, the PV system installer. The training included learning the relevant state and national electrical codes.

WH chose to have the array facing due south at the optimum angle for energy production, rather than aligning the array for maximum solar production during its peak load periods.

6. **Other Technical Details**
    a. **System Impact Analysis**

WH and GRE performed an impact analysis, and determined that there would not be any significant grid impacts.

   b. **System End-of-Life Plan if Applicable**

The CUP includes a decommissioning plan that involves removing and recycling the equipment after GRE opts to discontinue use of the solar facility. The decommissioning plan requires restoring the site to its baseline conditions. GRE is responsible for implementing the system end-of-life plan.

7. **System Photos**

https://www.dropbox.com/sh/f4xn7hslj0761p2/AADdoFx_xxBsdgltUNrR57Iaa?dl=0

Financial Details

1. **Business Model/ Ownership**

Financing was arranged by GRE through a 10-year CoBank lease. GRE owns the production of the system, and Farm Credit Leasing and CoBank own the asset for 10 years. After 10 years, GRE has the option to purchase the asset from CoBank. WH buys all of the production from GRE, which controls the RECs.

2. **Financing**

See above.

3. **System Costs**
    a. **Total Cost:** $4,500,000.
    b. **Cost per Watt-DC:** $1.74

Legal and Regulatory Challenges

WH experienced no significant legal or regulatory challenges with this project. WH credits this fact to its experience with solar, as well as working with established partners such as GRE and CoBank. WH also was able to get permits before the local county established its moratorium.

Outreach and Engagement

- **Community Solar if Applicable**

The Dickinson solar array completed through the SUNDA project does not include a community solar offering, but WH already has several such programs. In its existing programs, members have had the option to buy up to 100% of their residential usage at a rate of $0.155/kWh. Non-participating WH members did not want to subsidize solar program participants, so a long-term contract with WH was created. According to the agreement, members can sell their contact to another home if it is in WH territory.

WH discovered that many members do not want 100% of their electric use to come from their solar project but do want to take a step in a green direction. After they take this step, members receive a yard sign that helps to spread the word about the solar array. To help its members get a piece of the pie, WH offers a range of payment plans to help combat the $1,350 price for one full panel. To subsidize the 4 community solar arrays, WH did not build them until they were more than 80% subscribed. Two of the arrays are 150 kW. The buy-in models have changed over time, and WH works to keep members satisfied through responsive customer service; a commitment to maintenance on the arrays to ensure maximum output; and a continual evolution of WH's solar offerings, thus providing members with new opportunities to participate in renewable programs.

- **Member Engagement**

WH used a variety of methods to inform members about their renewable choices and renewable projects, including a website, social media, and newsletter articles. WH also conducts ongoing surveys that include questions on renewable options to understand member perception as it relates to programs, pricing, and rates.

- **Employee Training, Time Requirements, and Engagement**

WH kept its employees informed throughout the process. There were no substantial time requirements, as the majority of the work was done by GRE and its subcontractors.

- **Board Engagement**

Board members were regularly informed about the project through an ongoing education process. From the top down, the board members were regularly informed about financing and the procurement process. In fact, some board members decided to learn more by buying panels of their own.

Lessons Learned

WH and GRE had little difficulty in permitting or installing the system because of their experience with installing previous solar arrays and participating in the SUNDA group. Their lessons learned include the following:

- Start permitting early and be sure that the site selected will be easily permitted.

- GRE's prior experience with small, remote solar locations showed the co-op how to specify good remote monitoring down to the combiner box level; both companies anticipate that this capability will reduce the truck rolls needed to properly maintain and service the array.
- Technology is changing rapidly, driving down the price for hardware. Also, solar insolation in Minnesota is relatively low. The annual capacity factor is under 15%.
- For community solar programs, there are many unknowns, but every company needs to make the right choice without knowing all of the answers. Some things are a gamble, which is normal. To increase the level of comfort with the project, everyone must be OK about the offerings. Offering multiple participation options is a safe way to accomplish this goal.
- Having a reliable and dependable development partner can make a huge difference in accomplishing a project like this one.

Future Plans

WH continues to explore alternative options to provide renewable options for its members as both technology and members' interest evolve.

More Information

Primary Contact:
Bob Sandberg for both community solar and utility solar.
Website:
https://www.whe.org/services-products/electric-services/solar-power/wh-solar-community.html

Press Release:
http://greatriverenergy.com/wp-content/uploads/2015/05/Dickinson-Solar-Project.pdf

Sussex REC

State: NJ
Type: Distribution
Number of Meters: 12,000

Project Summary

With 12,000 members, Sussex Rural Electric Cooperative (Sussex) is the only electric cooperative in New Jersey. Organized more than 70 years ago as part of the rural electrification program, Sussex has grown and changed, as has its member base. From a solely agricultural beginning, when just having an electric light was the goal, members today require a high level of reliability to support their highly connected lifestyles.

The cooperative manages 20.2 miles of transmission, 608.4 miles of overhead distribution, and 88 miles of underground distribution lines to handle a peak load of 37 MW. Although the Sussex membership had expressed only limited interest in PV, in 2014 Sussex was approached by a military base it serves to install a PV system on base.

Picatinny Arsenal, an Army base located in Wharton, NJ, has a renewable mandate to acquire 30% of its energy from renewable sources by 2025. Sussex has owned and operated the electric distribution system on the base under a privatization contract since 2002. Picatinny Arsenal identified as its site an old munitions burning ground that was environmentally remediated and capped. A solar project was well suited for the remediated property. The cooperative decided to manage and construct the solar field using co-op employees with some outside contracted assistance. Although Sussex gained a great deal of experience and found it valuable, the co-op indicated it would not choose to build another system on its own, but would hire an EPC firm. Another lesson learned was the speed at which the industry was changing. With both inverter and panel types and sizes, it is important not to let much time linger between engineering and procurement as things will change in the industry. This issue was not insurmountable during the Sussex deployment, but was a point of some frustration and project delay.

Sussex deployed a 624-kW-DC/500-kW-AC system at Picatinny in fall 2015. The base requested a solar array and funded the project; Sussex was responsible for building the system. Sussex owns, operates, and maintains the system, and the base receives the array's output at no charge. This arrangement will continue as long as Sussex remains contracted as the privatized utility on base. If Picatinny does not renew the contract, the base will assume ownership of the system.

As of July 2017, the interconnection agreement was accepted between the base and its investor-owned utility (IOU).

Background Information

- **Existing Renewable Assets**

Before this project, Sussex had installed a small solar field at its Sussex, NJ headquarters, served by First Energy. Across its territory, only about 30 members have residential solar arrays. Third-party solar vendors in the territory have been unable to offer economic pricing.

- **Reasons for Installing Utility Solar**

Picatinny Arsenal has a renewable mandate under Executive Order 13963 to acquire 30% of its energy load from renewable sources by 2025. To help meet this goal, it reached out directly to Sussex for support in building a solar array. This project will produce 3–4% of total load for the base.

Project Timeline

Permitting Began:	3/31/14
Procurement Began:	7/1/14
Installation Began:	1/15/15
Deployment Completed:	11/19/15

Technical Details

1. **Project Size**

Initial Project Size (MW):	
Final Project Size (MWp):	.622
Final Project Size (MW-AC):	0.5

2. **Equipment Installed**

Modules: 1782 330-W panels and 110 310-W panels
Inverters: 2 Advanced Energy 0.25 MW
Racking: Schletter ballasted system, 20-degree tilt, with a 207-degree azimuth orientation
Remote Monitoring: PVM software (see the Building and Operating section below for more details)

3. **Procurement**

Sussex selected its equipment from one of the companies participating in the NDP.

The procurement process presented Sussex with several challenges. First, there was a significant waiting period for materials, especially the breakers and the switchgear, which took more than 3 months to arrive. Second, the frame size ordered did not match expectations. Sussex received a cut sheet from a vendor and planned a system based on those specifications. Before placing its order, Sussex requested an updated quote to reflect the vendor's participation in NRECA's National Discounts Program, but did not realize that the new cut sheet listed a different panel frame size. Although able to use the racking it ordered, Sussex had to purchase new fittings to attach the panel frames to the racking, which cost another $9,000. Sussex recommends double-checking the cut sheet before ordering solar panels and paying close attention to the frame size and other size specifications.

4. **Siting and Permitting**

Picatinny Arsenal took responsibility for acquiring the environmental permits and received an indication from the New Jersey state government that the solar field site did not require any additional permitting.

However, because the construction site is designated as a Superfund site, Sussex required EPA approval before any digging. Sussex worked with the Army's environmental division to get this approval, which did not involve a formal permitting process. Because it remained compliant with all applicable EPA regulations, Sussex was not denied permission to dig.

5. **Building and Operating**

The chosen site is a brownfield, meaning that the land could have levels of hazardous substances, contaminants, or pollutants. In this case, the site was an old burning ground for the disposal of ammunition and is also classified as a wetland. A contractor was brought in by the military to reclaim and cap the site by doing the following:

- Testing the ground to a specified depth for unexploded ordnance
- Modifying the contours of the ground
- Adding a layer of protective fabric covered by 2 feet of compacted fill and 6 inches of loose topsoil

In addition to the field for the solar array, the reclamation plan contains berms (small hills to direct drainage), swales (ditches to collect drainage), and an asphalt parking lot. After re-grading the land and paving the parking lot, the site was seeded. Unfortunately, the contractor hired by the base to maintain the vegetation did not perform this job because it did not want to risk of any liability incurred by kicking a rock into the panels. The vegetation grew more than 4 feet tall and onto the panels. Sussex now maintains the vegetation and is collecting pricing estimates from vegetation management firms. Sussex recommends that vegetation management be included in the O&M contract. The row spacing is wide enough for mowers; as of summer 2017, Sussex was using weed whackers to reach beneath the panels.

In addition to modifying the land, Sussex had to tailor the SUNDA engineering design because the lot was not a basic square. Sussex decided to perform all the construction labor with co-op staff. This decision resulted in cost savings on some labor and contracting expenses, but other duties likely could have been done with cheaper labor. During the construction process, Sussex faced a number of challenges, including the following:

- The DC breakers required a lot of custom work by the vendor after an incorrect order was shipped. The order was later corrected.
- A delay between ordering the racking and panels resulted in the wrong racking size being ordered. Also, a vendor changed the thickness of its panels, so fittings to hold the panels were the wrong size. Sussex paid several thousand dollars for new clamps to fit the adjusted size.
- Sussex did not anticipate the need for pallet jacks, which caused delays when receiving equipment deliveries.
- The racking was damaged during transportation to the site because the steel bandings holding the racking together came loose. At the time of delivery, some of the racking was bent but still usable.
- Extreme cold forced construction to halt, thus lengthening the project timeline; the entire field was covered in snow for weeks. This situation provided an unanticipated challenge because Sussex had expected to be done before winter arrived.
- Sussex did not order all of its equipment at once to avoid space issues; for future projects, it will order everything at once and find a way to store all of the equipment on site.

Sussex considered the need for security measures in addition to its fence but decided against them because the area is known for wandering bears that deter people from exploring their property.

Sussex deployed PV management (PVM) software, but the process was not as smooth as it had hoped. Numerous IT issues arose with the software, including difficulties with the IP address, the inverter's firmware, and integration between parts built by different companies. Eventually the IP was reset and remained stable, and the inverter vendor visited the site to swap out some I/O boards on the inverters. The monitoring system shows a communications failure on inverter A, but the inverter is still working properly. Errors arise mostly in early morning and late evening. Because everything appears to be functioning correctly at this time, the vendor suggests that it is a nuisance alarm, meaning the error threshold should be changed. Sussex also is having some problems with the vendor's trouble ticket system.

Sussex oriented its array to 207 degrees south to maximize afternoon peak power production. The base's loads are almost exclusively during the daytime, from 7:30 a.m. to 4:30 p.m.

6. Other Technical Details

a. System Impact Analysis

A system impact analysis was performed by Leidos and completed in November 2017. One concern involved the distribution recloser feeding the line with which the solar interconnects. This concern was mitigated by adjusting the time between reclose operations, which affords the inverters enough time to react to loss of source and shut down before islanding.

b. System End-of-Life Plan if Applicable

Sussex does not have a formal system end-of-life plan yet. It will be up to the base to decide whether to retire the array or replace parts to keep it operational.

7. System Photos

https://www.dropbox.com/sh/q9py1u3h8k8jxwk/AABeRg12wLcKbMgJzAjNa-72a?dl=0

Financial Details

1. Business Model and Ownership

The military base provided funds to build the array and owns the land. It originally raised approximately $450,000—enough money for a 220-kW array—but later found $1 million in funding to expand the project. All energy from the system belongs to Picatinny Arsenal at no additional cost, but Sussex owns, operates, and maintains the physical system. Sussex owns the RECs from the array and sells them to raise money for improvements and expansions to the solar system. At the end of the contract between Sussex and Picatinny, the array will be turned over to the base, though this will likely be long after its useful life.

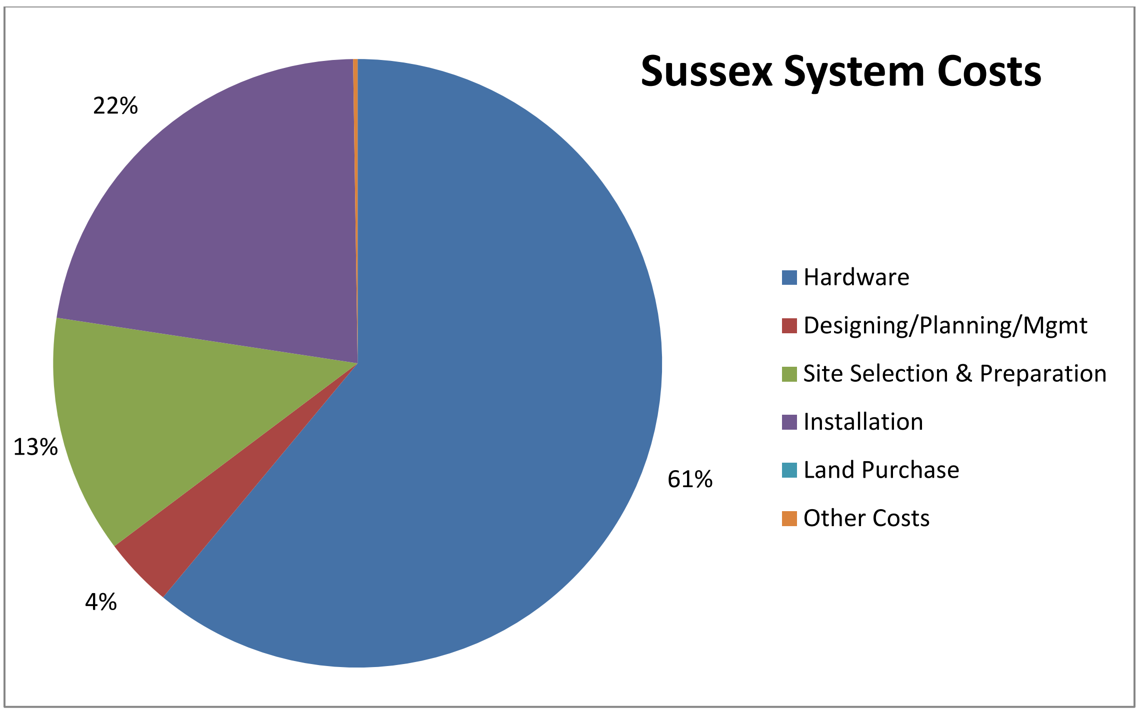
2. Financing

The project was funded by Picatinny Arsenal.

3. **System Costs, if Available and Able to Share**

Overall, total cost was less than Sussex had anticipated. Sussex estimated the cost of the system would be $1.6 million, but it only spent $1.2 million. Much of this saving can be attributed to labor costs, which were much lower than expected because Sussex was able to do most of the work through its in-house subsidiary. Having ownership of the system, not just a contract, helped out a great deal. Sussex also found that the labor personnel used for expanding the system allowed it to be completed much more quickly than the original installation because its employees had more experience with the installation process.

Total Cost: $1.21 million
Cost per watt-DC: $2.06



Legal and Regulatory Challenges

Sussex faced significant legal challenges while trying to interconnect this system to the local IOU, First Energy. Both First Energy and the Army had deep concerns about liability issues and who would be responsible for various technical failures or accidents, should they arise. After months of negotiations, the two sides were able to reach a compromise, and the system was interconnected in July 2017, more than a year and a half after it began producing power.

Outreach and Engagement

1. **Community Solar if Applicable**

N/A

2. **Member Engagement**

The project was mentioned in a newsletter, but because it was specifically built for the military base, no significant member outreach campaign was conducted. Sussex's membership has not shown much interest in community solar. Questions are mainly from members interested in residential rooftop systems.

3. **Employee Engagement and Training**

Sussex employees were heavily engaged in this project, as much of the labor was done them. Sussex correctly anticipated the staffing needs for general contract labor, soil and civil engineering, and other typical project tasks. However, it did not anticipate how many project management hours would be required; the managing project engineer worked roughly full-time for the duration of the project.

All employees were briefed on basic system knowledge and the intent of the project. Sussex ran specific safety training on anti-islanding for line workers and electricians. It demonstrated anti-islanding during commissions and explained why the panels are oriented 207 degrees south. In addition to employee trainings, Sussex ran safety training for the local fire department.

For future projects, Sussex would compare contract labor to using its own labor and project management resources. One of the primary drawbacks to using internal labor is that it drew staff away from other work. However, for a smaller project (under 1 MW), Sussex would likely still use in-house labor for the installation. For a larger project or community solar, Sussex would strongly consider bringing in professional project management and contract labor.

4. **Board Engagement**

Sussex's board was aware of and involved in the solar project. Generally, board members saw this project as good practice for a community solar array and got more comfortable with solar throughout the project.

Lessons Learned

Procurement Lessons Learned:

- Every solar vendor now offers a range of products, allowing for more competition and better pricing. The tradeoff is a longer procurement timeline. Sussex recommends contacting all vendors and asking what solar products the manufacturer offers in addition to its flagship product.
- Use plug-and-play gear whenever possible, and buy an integrated system instead of using different vendors. This approach may make the installation process easier.
- Be sure products have appropriate lead times for delivery.
- Do your due diligence when researching companies. The solar industry has experienced a lot of market volatility and company turnover. Contracting with a company that later goes out of business creates additional challenges.

- Use plug-and-play switchgear/equipment. Sussex found it hard to get the equipment purchased from different vendors to match up together.
- Order all equipment well in advance. Sussex's project was delayed because of not receiving the switchgear needed to complete it. This fact alone has pushed the project back by 4–6 weeks.
- Working with EPA was not as onerous as feared. Sussex needed permission before digging into the ground to lay conduit. The approval process took 2–3 weeks. Sussex anticipated a longer period.

Building and Operating Lessons Learned:

- When installing the wiring, Sussex used a leapfrogging technique to connect the modules, thereby saving 20% of material wiring costs by using fewer runners. [16]
- Sussex recommends using a plug-and-play, skid-mounted inverter system to reduce installation logistics. The use of such a system would save time because it would not require the precise placement of conduits needed when casting a pad.

Future Plans

Sussex plans to expand the military base array, depending on interconnect agreements and future funding from the base, in the next 5 to 10 years. The base is also in contracting to install a 2-MW natural gas co-generation facility. Off base, Sussex is considering offering a residential housing (rooftop) solar program.

More Information

Primary Contact:
Mike Osbourne
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Press Release/Articles:
http://www.ect.coop/power-supply/renewable-energy/new-jersey-electric-co-op-building-solar-project-on-old-superfund-site/73651

[16] Cost-Saving PV Source-Circuit Wiring Method: http://solarprofessional.com/articles/design-installation/cost-saving-pv-source-circuit-wiring-method#.WaBhRfmGPmE

CoServ Electric Cooperative

State: TX
Type: Distribution
Number of Meters: 226,000

Project Summary

CoServ Electric is a distribution cooperative that serves more than 225,000 electric meters across 6 counties in a rapidly growing area of North Texas. Created in 1937 as Denton County Electric Cooperative, CoServ has grown to have a staff of about 450 employees serving 188,000 members. CoServ supports the rapidly growing suburban and rural areas north of Dallas and Fort Worth. Its membership is divided between the Dallas-Fort Worth suburbs and its more rural northern area. CoServ provided this community solar solution in response to member interest in solar power; it also wanted to find a standard design and processes that could be replicated across its service territory for implementing solar at scale to provide the best cost options for its members.

In 2015, CoServ installed a 2-MW-AC capacity system on a 16-acre site in Krugerville, Denton County, Texas. The system was installed with the intention of offering co-op members a community solar solution. The business structure was developed to make solar affordable to members through the purchase of blocks of electricity in 200-, 400-, 600-, or 800-kWh increments for 12.5¢/kWh a month. This price covers the power cost for the solar production and transmission and distribution costs of service. The solar energy component of the price will remain constant for the 30-year life of the project and may be reduced as additional lower-cost solar production is blended into CoServ's solar energy portfolio.

Background Information

- **Existing Renewable Assets**

CoServ operates a small 200-kW solar rooftop array at its headquarters in Corinth, Texas and a wind REC purchase program for members who want to be 100% renewable.

- **Renewable Policy**

CoServ members have 2 options for installing their own DG: (1) a net metering option for DG systems up to 50 kW-DC for systems not including any excess generation purchase, or (2) a buyback option that allows excess generation to be purchased by CoServ at avoided cost but does not include any net metering.

- **Reasons for Installing Utility Solar**

CoServ installed its solar array to provide members with access to affordable renewable energy and help the co-op prepare and plan for a more solar-intensive energy mix. There are no local or state renewable energy mandates applicable to electric cooperatives.

Project Timeline

Permitting Began:	9/14/14
Procurement Began:	1/1/15
Installation Began:	3/15/15
Deployment Completed:	9/15/15

Technical Details

1. Project Size

Final Project Size MWp: 2.66
Final Project Size MW-AC: 2

2. Equipment Installed

Modules: Solarworld 315 W, quantity: 8,448
Inverters: Advanced Energy (AE) 500 kW—600-VDC input, 480-VAC 3-phase output, quantity: 4
Racking: Schletter fixed-tilt rack ground-mount drive pilings, angled 25 degrees, oriented due south
Remote Monitoring: Draker (a BlueNRGY company) monitoring system

CoServ selected equipment based on recommendations from the SUNDA project and its EPC, PowerSecure.

3. Procurement

CoServ directly sourced and purchased the solar panels and inverters for this installation. It faced no significant challenges in the procurement process. CoServ received a significant discount on its inverters because AE was in the process of switching to 1,000-V inverters. In retrospect, CoServ would have refused the discount and gone with higher-voltage inverters. Procuring maintenance and support for a discontinued inverter and finding replacement inverters at 600 V was challenging. In addition, AE subsequently ceased production of its inverter line.

4. Siting and Permitting

CoServ's biggest challenge was finding and acquiring land. Many sites had too many restrictions or did not meet required specifications, such as having a paved road, so CoServ could take early deliveries of modules. After finding a peanut farm that had not been cultivated in many years, site prep began in early 2015. The soil was light sand with some clay. After removing the loose top layer, CoServ was able to compact the land to proceed with the site installation.

Normally, grass or rye is planted beneath the rows of panels to control erosion. Unfortunately, there were unseasonably heavy rains in the Dallas-Fort Worth area that caused a full month of delay. Erosion became a problem because the planting could not take place. The site itself is close to the 100-year floodplain on a 5–10% grade. Extra work had to be done, and subcontractors were hired to implement erosion control. Rock dams and gravel were added at every fifth row and around the inverter and transformer to stabilize the soil. However, this issue delayed the installation by a few weeks and caused an increase in the overall price.

5. Building and Operating

After site prep, the installation started on February 16, 2015, and interconnection tests were completed in May. There are four 600-V 500-kW inverters that feed into a transformer, which connects to a 25-kV distribution line. PowerSecure acted as the prime EPC for deployment.

CoServ protected the equipment on site by placing a truck with a mannequin inside to scare off potential criminals. A fence was also installed. Although CoServ cannot say for sure whether this method deterred any potential thieves, no equipment was stolen during the installation process.

Soon after interconnection, the system experienced a defective DC breaker issue and had to shut down for a week while CoServ waited for new breakers to arrive. Employees found that 6 of 16 breakers failed testing because they were not torqued adequately. The team replaced or repaired the affected breakers to prevent future system failures.

CoServ also conducted a special training for firefighters, using content it developed itself. The training discussed safety, potential fire hazards, and how to address them properly during emergency situations. The goal of the training was to make firefighters aware of potential hazards that solar panels could pose in case of emergencies.

CoServ planted Bermuda grass, but the area is still dominated by weeds. Contractors are brought in 3 to 4 times a year to mow the array. On one visit, unfortunately, a mower damaged one of the inverter junction boxes.

The biggest operational issue so far arose in May 2017 when one of the 4 central inverters failed with severe internal damage; the reason is unknown. Working with AE, it took more than 2 months for a technician to come out and repair the inverter. Moving forward, CoServ plans to procure and inventory key spare parts on site to prevent another prolonged outage.

6. **Other Technical Details**
   a. **System Impact Analysis**

Before building the array, CoServ performed a system impact analysis using Milsoft and determined the array would have not have a negative impact on its system.

   b. **System End-of-Life Plan if Applicable**

CoServ does not have a system end-of-life plan at this time.

7. **System Photos**

https://www.dropbox.com/sh/9gh4a814z7anl0r/AAARioUDO_YrvUTkoUXxnqb5a?dl=0

Financial Details

1. **Business Model/Ownership**

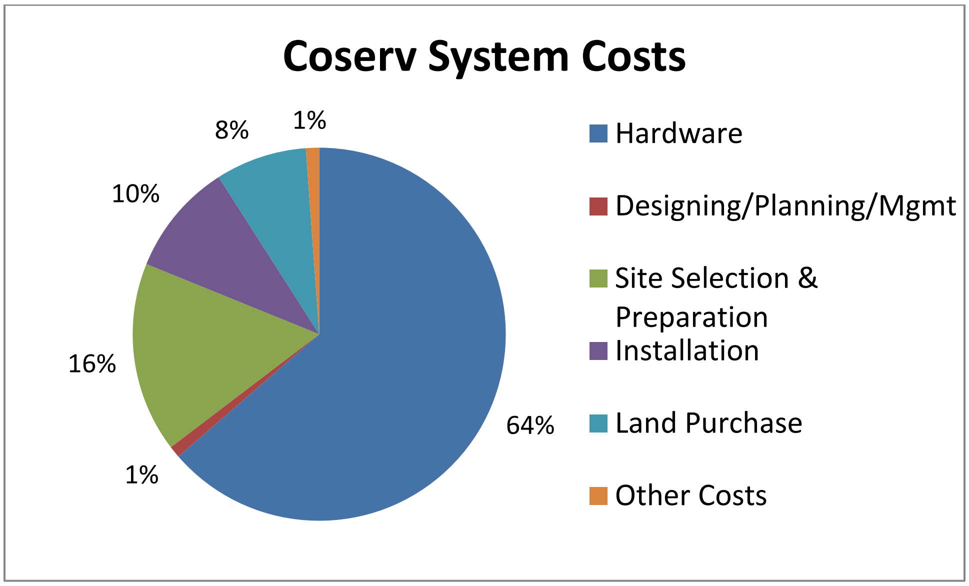
CoServ owns the system through one of its subsidiaries and makes the output available to its members through the community solar program described below. There is a PPA between CoServ and its subsidiary for the purchase of the solar power from the subsidiary. The program is structured to provide a reasonable internal rate of return (IRR) and have a positive net-present value (NPV) for its estimated 30-year life.

2. **Financing**

A CoServ holding company has a federal income tax liability due to CoServ's for-profit natural gas distribution company subsidiary. CoServ's holding company internally funded the project and provided financing for it to CoServ's renewable energy subsidiary, Renewable Energy Alternatives. The federal solar tax credits are realized at the holding company subsidiary.

3. **System Costs**
    a. **Total Cost: $5.7 million**

    b. **Cost per Watt-DC: $2.16**



Overall, the cost of the project was lower than CoServ anticipated because of cheaper solar modules and the discounted inverters from AE.

Legal and Regulatory Challenges

CoServ avoided installing within city or town jurisdictions due to zoning and development requirements. CoServ filed for permits with the county and completed a storm water pollution prevention plan (SWPPP). In addition, it had to register the array with the Electric Reliability Council of Texas (ERCOT).

Outreach and Engagement

1. **Community Solar, if Applicable**

CoServ offers community solar participation by selling blocks of power from the solar array. Customers can opt to join a special solar rate that allows them to purchase a 200-, 400-, 600-, or 800-kWh block of solar energy each month for 12.5 cents/kWh. The program runs month to month without any long-term commitment, and all usage in excess of the purchased solar block is charged at the standard residential retail rate. The average residential rate is approximately 10 cents/kWh. This program offers members several advantages: no up-front costs, no long-term leases or contracts, and no maintenance or termination fees. Although direct subscribers to the solar output fluctuate monthly, the solar facility is sustaining a subscription rate of 45–50%.

2. Member Engagement

CoServ used multiple communication channels and media outlets to engage with their members over this project. In addition to an announcement by its CEO on Earth Day, several blog posts, magazine articles, and social media posts, CoServ has created videos of the project that helped market it. CoServ has seen a boost to its renewable energy reputation and has leveraged the narrative of turning a peanut farm into a solar farm.

CoServ also worked with Draker to give members access to real-time production stats through an online portal: https://solarems.net/kiosks/348. In addition to showing how much energy the array is producing, CoServ's site gives comparisons regarding how many homes the array is able to power, how much CO_2 is avoided, and how that amount translates to other metrics. Examples of metrics include car mileage, barrels of oil, and trees.

3. Employee Training, Time Requirements, and Engagement

Employees were informed and educated during the design stage about the plans to construct the solar farm. CoServ also kept employees updated as milestones were met, and employee tours of the site were provided in the first few months of operation. Most of the work was handled by the EPC. Only 2 employees were heavily impacted during construction; they worked on the project nearly full-time. Now that the array is complete, one employee is needed a few hours a week to monitor and manage the solar facility as well as handle maintenance issues that arise.

4. Board Engagement

CoServ's executive team has kept the board informed about solar technology for several years. In 2010, the board approved installation of a small solar array at CoServ headquarters to gain experience with solar. As the cost of solar continued to decline, the executive team presented a proposal to the board to construct a larger solar facility, along with a solar rate offering for CoServ members, and received board approval for the project. So far, the board is very satisfied with the project—especially because of the high interest in renewables shown by members, many of whom are moving to North Texas from California and other areas where solar power is commonplace.

Lessons Learned

CoServ's lessons learned and advice for other co-ops are as follows:

- Before installing the PV array, CoServ installed and completed all distribution interconnection facilities, including the distribution transformer and the secondary wiring from the transformer to the inverter pad locations. This accomplishment provided for a timelier installation and final commissioning of the solar facility.
- In retrospect, CoServ determined that the entire lot should have been graveled before beginning the PV installation. Although doing so might have made it slightly more difficult to drive the pilings, it would have saved some erosion control efforts, as well as money over the life of the project.

- For co-ops seeking land for a solar project, CoServ recommends hiring a land broker.
- When building a fence around the lot, leave enough room in the corners between the array and fence for an 18-wheeler to pass through.
- Determine permitting requirements of local jurisdictions in advance of land purchase, and consider siting the project within a jurisdiction with the least burdensome requirements.
- Approach commissioning carefully and with plenty of time.
- Everybody needs to look at their own circumstances and see if a project makes sense. Building, operating, and maintaining are straightforward.

Future Plans

CoServ is actively considering how to incorporate more solar into its portfolio, as costs allow, including looking into a PPA with a larger utility-scale array located outside of its territory.

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http://www.coserv.com/Newsroom/Inside-The-Lines/Archives/first-responders-receive-training-at-coserv-solar-station-1567

Video:
https://www.youtube.com/watch?v=ND1PtFAhKS0
https://www.youtube.com/watch?v=-D1pEgJ42rQ
https://www.youtube.com/watch?v=ainID5sQx18
https://www.youtube.com/watch?v=LPxqAwnN_R8

Eau Claire Energy Cooperative

State: WI
Type: Distribution
Number of Meters: 10,500

Project Summary

Eau Claire Energy Cooperative (ECEC) is a distribution co-op located in west-central Wisconsin servicing 10,640 members through 1,654 miles of distribution lines and 17 substations. The cooperative has 34 full-time employees and has been delivering electricity to members since 1939. Its community had a desire for clean, renewable, and local energy solutions. Its principal goal was increased member engagement.

In 2014, based on definite interest from many ECEC members in the development of a community solar project, it proceeded to conduct surveys and have discussions to engage members. Moving forward with special events, town hall meetings, and more in-depth discussions, the co-op gained extensive knowledge about members' needs. These steps enabled ECEC to offer a viable program and business plan with economies of scale in mind, thus keeping costs down. Continued member engagement, calling the project "MemberSolar," conducting educational tours, bringing in local sheep for "vegetation management control," and enlisting the Member Advisory Council and Youth Ambassadors in the process all created a very positive and inclusive atmosphere in the long term. Even now, with the MemberSolar project fully subscribed, its members continue to discuss the positive merits of the project and it elicits a sense of pride from those involved throughout the process.

ECEC began its PV project early and had established the preliminary engineering design by September 2014. By January, it had finalized financing, opting to use NRCO's tax-equity flip financing, with Federated providing the tax appetite, although ECEC did find this complex transaction difficult to explain to its board. Its permits were completed by May 2015, allowing it to begin construction on a 4-acre former hay field the co-op already owned. Site prep was completed soon afterward, and the racking was installed in August 2015. Unfortunately, there was some delay in getting all of its panels, so the array was not completed until early November, with the system becoming operational in late November 2015.

ECEC's initial offering to its members required a significant up-front payment, along with a long-term contract for the output of a panel. It used all traditional marketing and outreach channels to reach a 60% subscription level but was unable to subscribe the system fully. To complete the subscriptions, it added a monthly subscription with no long-term commitment option and quickly sold out.

Background Information

- **Existing Renewable Assets**

Dairyland Power, its G&T, has a 25-MW solar PV RFP that will be incorporated into its power portfolio.

- **Reasons for Installing Utility Solar**

Member interest and engagement were the primary drivers of this project. Tesla, formerly SolarCity, has been active in ECEC's territory as well, so ECEC knew there was interest in DER offerings and wanted to provide additional options to its membership.

Project Timeline

Permitting Began:	4/21/14
Procurement Began:	8/14/14
Installation Began:	7/31/15
Deployment Completed:	12/15/15

Technical Details

1. Project Size

Initial Project Size:	
Final Project Size MWp:	0.872
Final Project Size MW-AC:	0.75

2. Equipment Installed

Modules: Canadian Solar 500 x 305 W and 2,312 x 315-W panels, total quantity: 2,812
Inverters: 32 3-phase SMA string inverters, 23.5 kW-AC each
Racking: Schletter ground-mount system, fixed, orientation 30 degrees due south
Remote Monitoring: Sunny portal, standard with inverters

3. Procurement

ECEC's EPC contractor handled procurement and experienced delays in obtaining modules during the "ITC crunch" period. The project was delayed by about 2 months because of these supply issues. ECEC recommends adding time allowances for supply chain disturbances, especially if upcoming tax or other incentive programs are ending.

4. Siting and Permitting

The project is sited on 4 acres near the ECEC main office, adjacent to a pole yard, on land that experiences storm water and runoff issues. There were many state planning requirements for erosion and 100-year floods. If ECEC had done graveling and created an impervious surface, it would have been mandated to put in a retention pond. ECEC was also required to get a conditional land use permit because it was using land for a different purpose than originally zoned for. It worked with local officials to get these permits and found the process easy and straightforward. Officials and the town board were supportive, and the co-op's EPC assisted with site land and erosion control through the county.

Because the project was financed through a lease structure arrangement and the project owner was a subsidiary of ECEC (MemberSolar, an LLC created by the co-op), the project was subject to a local ordinance that required a separate road to be built to the PV system. ECEC was able to get this requirement waived by entering into separate 5-year lease agreements for the property with the project owner.

5. **Building and Operating**

ECEC worked with NRCO and opted out of having an internal project manager. NRCO essentially acted as the project manager and assisted in the bid and construction process. Able Energy (www.weknowsolar.com) engineered and constructed the project.

ECEC experienced several unanticipated setbacks, primarily around the procurement of modules. At the time, the ITC was still slated to expire, and many developers were fast-tracking projects and buying up the existing stock of modules. ECEC eventually was able to procure modules, but several months later than it had intended.

Site prep and installation did not encounter problems, mainly because the lot was a former hayfield and driving piles for racking encountered no rock or soil issues. ECEC had contracted with a company to do the O&M for 5 years for $10K/year but canceled the contract in early 2017 over performance issues. ECEC now handles the O&M. For vegetation management, the co-op brings in about 10 sheep to the site during growth months.

The layout of the site is as follows:

- An 8-foot security fence around the entire site, with locked access
- 9 rows of panels for a total of 2,816 panels (305- and 315-W panels)
- Just under 5 acres
- 3 main AC panel boards

ECEC is exploring options for a more member-focused solar monitoring system to provide better engagement options, such as weather overlay, comparison of customer usage to production of capacity purchased, and more meaningful and unique information.

Since becoming operational, the system has performed well. The only issue encountered was an inverter tripping off-line. A local contractor was able to troubleshoot the issue—a setting on fault tolerance proved too sensitive—and restore normal inverter operations.

6. **Other Technical Details**

   a. **System Impact Analysis**

Not performed.

   b. **System End-of-Life Plan if Applicable**

As of summer 2017, ECEC had no plan for the system's end of life.

7. **System Photos**

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Financial Details

1. **Business Model/Ownership**

During the planning stage, ECEC created strategic goals and identified risks. The co-op decided to implement its community solar project through a tax-equity flip structure, with Federated insurance monetizing tax benefits. To provide attractive financing for its consumer-members, it partnered with a local credit union.

The cooperative has an all-requirements contract with Dairyland, which allows up to 1 MW of its own DG. The contract does not avoid the capacity cost over 250 kW, but this cost did not detract ECEC from developing a larger project, partially because of the savings garnered from economies of scale with a larger project.

The array is owned by MemberSolar LLC, a company formed as part of the tax-equity flip.

2. **Financing**

ECEC used NRCO's tax-equity flip structure, with Federated providing the tax appetite, to finance its project. The co-op's experience with NRCO was a favorable one, and it recommends NRCO to others. It previously engaged in discussions with a local investor, but the investor felt its company would benefit more from putting capital back into itself rather than investing it in the solar project.

3. **System Costs**
    a. **Total Cost**: $1.7 million
    b. **Cost per Watt-DC**: $1.95/W-DC

Legal and Regulatory Challenges

ECEC had regular contact with legal counsel to make sure no issues arose with the SEC or other agencies with respect to the way it offered community solar to its members.

Outreach and Engagement

1. **Community Solar if Applicable**

The system was planned as a community array and purposefully built larger than called for by community interest to bring down costs. This approach aided in its risk assessment because even if the array did not sell out, it would still receive 10-cent power. ECEC will sell the output of the 310-W panels in the array to its members for the next 20 years at a price of $650/panel, prorated after February 1, 2016. Members can subscribe to as many panels as they want, up to their average energy needs. Subscriptions may also be donated to charitable organizations, such as churches. The output of the panel is credited to the member each month at the retail rate. In addition, ECEC plans to roll out a pay-as-you-go offering that will allow members to pay $20 per month for the output of 5 panels for that month. This offering is much more affordable and, over a 12-month period, will roughly even out between the production credit and the monthly participation fee. This approach allows members to have an experience similar to that of rooftop solar members. A big impetus for developing a community solar project was member interest in solar power, as evidenced by third-party solar activity in the area.

The co-op originally planned to sell each panel for $693, but the final price was $650 per 310 W of capacity. When designing the project, ECEC planned for 310-W panels, but eventually ended up installing 305- and 315-W panels. However, marketing had already begun promoting the program as using 310-W panels, so the program continued to sell based on a specific capacity rather than the output of one panel. If panels produce more than a consumer-member's usage, the member does not get additional credit. However, excess production could be carried to a future month, with an annual true-up.

After one year of offering the program, it was subscribed up to 61% (August 2017), but has experienced a significant slowdown in sign-ups. The City of Altoona purchased sufficient capacity to provide 75% of the energy that it purchases from ECEC, which amounts to approximately 460 panels, or a $300,000 investment. Eau Claire County has also purchased capacity from the PV system. Subscriptions are also open to C&I members. Its board has been supportive of the project, and even if it takes several years to sell it out, ECEC believes there is value in being able to offer this service to its members. Originally, ECEC thought that many farms would purchase panels, but with the downturn in grain prices, interest has dropped off. ECEC remained optimistic and expected that with its new pricing structure, the PV system would be 100% subscribed by the end of 2017.

Eau Claire began its marketing campaign by targeting "green" members but transitioned to promoting the system based on economics and the ability to lock in the service for 20 years. The co-op also focused on members who had performed energy efficiency upgrades. To get the word out about the project, ECEC used its monthly magazine and bill inserts, spoke at 3 local town hall meetings and other venues, and provided a yard sign to every member who signed up for a panel. To make the up-front costs more manageable, it has partnered with a local credit union for financing, but only a few members have taken advantage of this option. One of the primary barriers ECEC has heard from its membership is that people have other things to do with their money.

The yard sign distribution was a great marketing strategy because the cooperative received photos of the yard signs on the front lawns of the invested members. The marketing angle was that being part of a community project was better than doing it alone. Part of the education process was showing members that community solar cost only half of rooftop solar.

2. Member Engagement

There has been a great deal of member engagement in addition to the community solar offering, including the following:

- Press releases and articles about ECEC's initial participation in the SUNDA project
- Ground-breaking ceremony held with coverage by a local TV station
- Accolades from the local Chamber of Commerce and a closer relationship with the local community because of the project
- Economic development—for example, publicity and promoting a green edge helped relationships with existing C&I members and also became a draw to other C&I businesses
- Good common-ground agreement and positive interaction with consumer-members and the public overall

Eau Claire reported receiving more positive press coverage during 2017 than in its entire 70 years of operation.

In the winter of 2014, the co-op surveyed its members on customer service satisfaction as well as the desire for solar power options. ECEC followed up this survey with a presentation at its annual meeting, which offered the opportunity for real-time feedback and questions. More than 50% of the 450 members present indicated that they were interested in solar. ECEC created a video to inform members about the project and the community solar offering. Its advice is that its most effective marketing tidbit was telling members that the project uses sheep for vegetation management.

3. **Employee Training, Time Requirements, and Engagement**

ECEC ensured that its staff were up to date on the project status through regular communications. Staff were also trained to respond to member inquiries. Frequently asked questions and talking points were developed.

4. **Board Engagement**

ECEC's board was involved from the start in strategic planning, followed by continuous communication and updates. This involvement culminated in the presentation of the business case to the board.

Lessons Learned

It can be challenging to fully subscribe a community solar project. Many co-op projects reach one-third to one-half of their subscriptions fairly quickly and then plateau. Co-ops need to use multiple messaging channels to reach their members and make them aware of the solar offering. Examples include letters, a website, social media, radio advertising, and call center staff.

For a project to run smoothly, it must communicate routinely with all parties. The weekly call with NRCO and the EPC contractor, Able Energy, was key to the success of the project. ECEC had regular contact with legal counsel to make sure no issues arose with the SEC or other agencies. Both the front office and field staff were trained to respond to member inquiries about the project through talking points and a communal FAQ sheet, and the remaining staff received regular project updates.

Future Plans

Although ECEC has no current plans to install additional solar itself, the co-op is working closely with Dairyland Power Cooperative (Dairyland), its G&T. Dairyland has a solar development agreement with SoCore and NRTC to develop PV solar at locations within its member service territories. ECEC, acting as a trusted community figure, is assisting the partnership in the development of additional PV solar systems within its service territory. If ECEC does decide to install more solar, it will likely consider a PPA because of the complexity of setting up a tax-equity flip.

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Video:
https://www.youtube.com/watch?v=EPA9sKmK4T4
https://www.youtube.com/watch?list=PLhDbo3xo3q6uCBPwZP04Qx3hW83dtcYrR&v=XTlPoQkN3e8

Brunswick EMC

State: NC
Type: Distribution
Number of Meters: 90,000

Project Summary

Brunswick EMC (BEMC) is the second largest of 26 electric cooperatives in North Carolina. It provides services to 72,000 members and 90,000 locations in Brunswick County, Columbus County, and small areas of Robeson and Bladen Counties. BEMC owns, operates, and maintains the electrical distribution system at Military Ocean Terminal Sunny Point (MOTSU) through a 50-year privatization contract signed in 2003, but is not MOTSU's utility energy provider (Duke Energy provides MOTSU). MOTSU has many goals it must meet in addition to the federal energy efficiency goal of 30% reduction in energy use. The Army is piloting 5 installations to achieve Net Zero Energy (NZEI)—an installation that produces as much renewable energy on site as it uses, over the course of a year. MOTSU could be an NZEI site for the Army through this project.
BEMC installed a solar facility at MOTSU; the system was energized on September 20, 2016, but final acceptance did not come until April 2017 due to a series of delays. The peak load of MOTSU is 1.2 MW, which is provided by North Carolina Electric Membership Corporation (NCEMC), BEMC's G&T. This load determined the array size. The base had been accruing capital credits with the co-op, but there was no mechanism to retire them in the normal fashion. The deal as structured was fairly complex because it involved 3 parties as well as Farm Credit Leasing, which provided the financing for the project. BEMC will operate and maintain the facility, which is located on the base. Once the tax benefits have been realized, the base will get electricity at no charge.

The inverters used on the project, which were spec'd to allow the addition of battery storage, never worked quite right with the storage. Because the components of the system (panels, inverters, controllers, and monitoring systems) were sourced from multiple sources, it was difficult to pin down where the problem lay and who was responsible for fixing it. Many months were spent discussing the issue with the various vendors and the EPC. Although the system eventually was made to work, a lesson learned was to attempt to source as much of the complete system from a single source. The industry is still maturing, and at the beginning of the project, this approach would not have been particularly feasible, although more common today.

Background Information

- **Existing Renewable Assets Before the SUNDA Project**

BEMC has two 100-kW solar PV farms that operate as membership community solar projects. Its territory also has more than 100 rooftop arrays.

- **Reasons for Installing Utility Solar**

MOTSU reached out to the co-op for a solar array to provide greater energy security for the base.

Project Timeline

Permitting Began:	9/30/14
Procurement Began:	10/1/14
Installation Began:	5/2/16
Deployment Completed:	9/20/16

Technical Details

1. **Project Size**

Final Project Size (MWp):	1.46
Final Project Size (MW-AC):	1.2

2. **Equipment Installed**

The equipment selection was guided by PowerSecure. Based on its recommendations, the following equipment was procured and installed:

Modules: 4640 REC Solar 72-cell 315 Wp
Inverters: Bonfiglioli RPS TL-4Q 600 kW (2)
Racking: Schletter racking, driven piles, orientation due south
Remote Monitoring: communication fiber between Subs, Vista Switches, meters, lighting contactors, and solar site

3. **Procurement**

All procurement was handled by BEMC's EPC, PowerSecure (PS).

4. **Siting and Permitting**

BEMC began working to get approvals for this project as early as April 2014, but the approval process and changing priorities on the military base slowed progress significantly. There were several changes in siting, design, and budget before BEMC eventually broke ground on May 2, 2016.

One notable requirement that caused delay was the explosive safety plan. The intended first site was in an explosive blast zone, so planned deployment was canceled. After losing the first site, the base found a second suitable site of 7 acres within 2 days. The first assessment BEMC performed on the new site was the blast assessment, to ensure that this site would not be lost as well.

After meeting the special explosive assessments, BEMC began working on environmental permitting. It decided to fast-track both the storm water permit and erosion control plan at additional costs of $10,000 and $2,000, respectively. Even using this fast-track process, receiving the storm water permit can take up to 45 days. The storm water permit is for long-term use, whereas the erosion control plan is for the construction phase only. BEMC expected PowerSecure, its EPC, to submit several other permits and forms, including a FERC 566 form, NC Utilities Commission Report to Construct, and Application to Construct Renewable Energy Facility R866. Unfortunately, PowerSecure was unable to finalize them because of the departure of a staff person. BEMC ultimately completed these permits, but did not realize that the NC Utilities Commission expected an update report every year during the project. Once BEMC learned about this requirement, it had no further issues with the commission.

BEMC does not lease the land from Sunny Point, but through its privatization contract provides an agreed upon in-kind payment to the base each month for use of the land.

5. Building and Operating

PowerSecure was selected as the EPC for a fixed price contract of $ 2.9 million. There was an additional $500,000 cost to run the interconnection 2 miles underground to the substation. The array's size was determined by the peak load of MOTSU—1.2 MW.

Several factors made this system slightly more challenging to design and increased costs compared to a typical co-op PV system. The military was interested in being able to add battery storage later, so the inverters had to be configured to allow this addition, as well as including rough-in and stub-ups.[17] As of summer 2017, the plan was to add energy storage incrementally each year to the system. The batteries also require additional control and communications that had to be included. Because of constrained space, the DC-AC ratio is only 1.21 for the array.[18] Additionally, the site is located close to the ocean, meaning that the ground has a higher salt content. As a result, the components require special anti-corrosion coatings, such as hot-dip galvanized racking, to ensure longevity.

BEMC's original project schedule was May 2016 through September 2016, but it took 6 additional months to complete the project. The final commissioning was delayed by 1 month because of Hurricane Matthew in October 2016. The final monitoring and control scheme took 3 months to create. Then a major component (SEL meter) failed in January and did not arrive for 7 weeks, finally arriving around mid-March. Final acceptance of the project occurred on April 7, 2017.

Although BEMC experienced challenges in working with its EPC, it still recommends choosing a turnkey solution for a co-op's first solar project to learn the process for installing solar. However, using what it learned from this experience, BEMC plans to contract its next solar project itself.

In addition to the solar array, BEMC installed an 814-kW battery system along with a Siemens energy management system. After becoming operational, the solar array experienced an inverter issue—whenever clouds covered the array and production dipped below a certain production threshold, resistors in the inverters would burn out. BEMC, with support from Bonfilioli and Siemens, ascertained that when the batteries pull from the solar array and clouds roll by, the drop in production mimics nighttime, causing the contact point between the batteries and array to open and close rapidly, and resistors to fail. BEMC resolved this issue by changing a few settings in the energy management system and communication contact point.

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[17] Term of art for creating a concrete pad with the wiring conduits correctly located for the new equipment.

[18] Typical DC-AC ratios are 1.3–1.4 to maximize the time the inverter is outputting at its full capacity. For a more in-depth discussion of DC-AC ratios, see the Solar Technology Factsheet.

BEMC has gained insight into the array's current operating status via a dashboard created by PowerSecure, connected through a web link. BEMC connected its network to the solar site via fiber so the link is secure within BEMC's network.

6. System Impact Analysis

BEMC performed a system impact analysis using Cyme software and found that there were no significant system impacts likely to result from the solar array. For future expansions, BEMC is working with Leidos to do a system impact analysis.

7. System End-of-Life Plan if Applicable

BEMC has a renewal and replacement plan to replace array, panels, racking, and inverters as needed through 2053. Replacement and retirement of the batteries in the battery energy storage management project will be handled by Siemens.

8. System Photos

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Financial Details

1. Business Model/Ownership

BEMC elected to go with a tax-equity flip model, with Farm Credit Leasing as its tax-equity partner. This approach means that the system is owned by Farm Credit Leasing until the tax benefits expire. To enter into the agreement, BEMC had to form a taxable entity—NCNC energy—as a blocker corporation to join with Farm Credit Leasing. BEMC found that going through the necessary steps to do a tax-equity flip was fairly complex, especially setting it up so Farm Credit became the owner as part of a Special Purpose Entity (SPE) with its blocker organization.

As of summer 2017, all of the energy from the array was being sold to NCEMC until the system is paid off in 9 years. At this point, BEMC will know whether the financial model it created has worked. Assuming that the system is paid off at that time, Sunny Point will have the option either to negotiate a contract with Duke Energy to receive all of the array's output or exit the agreement, in which case BEMC will sell the array's output and credit Sunny Point for using the array. In either case, BEMC will continue to operate and maintain the system.

In addition to the energy contract, BEMC receives a payment from Sunny Point to manage the O&M for the system for 50 years, including mowing, inspections, and maintenance.

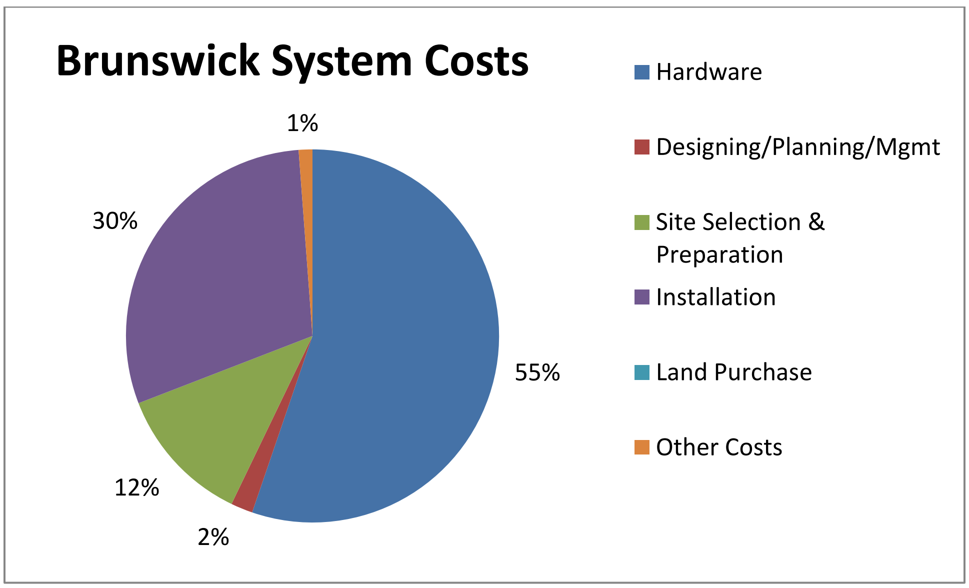
2. Financing

BEMC considered different options for financing before eventually deciding on Farm Credit Leasing. It was very interested in pursuing a tax-equity flip (see Volume I of the PV Field Manual for more details) because North Carolina offers additional tax incentives of up to 35% of the project's value. Finding a suitable tax-equity flip partner (a company with a tax appetite, able to monetize all available solar incentives, and realistic about the margins of a utility solar project) was a longer and more tedious process than BEMC anticipated. It met with several potential investors for a tax-equity flip, including BB&T Bank, which came up with several different proposals. Before working with Farm Credit, BEMC met with several other potential investors over the course of 2 years but ultimately rejected their offers. BEMC experienced difficulty finding a suitable tax-equity investor and, although Farm Credit leasing has worked well, it could not take advantage of the North Carolina tax credit for solar.

3. **System Costs**
   a. **Total Cost: $3.64 million**

   b. **Cost per Watt-DC: $2.49**

   c. **Chart of Proportional Costs:**



Legal and Regulatory Challenges

To date, this project has posed no significant legal or regulatory challenges to BEMC. Although it entails a number of tedious tasks, so far the work has been comparable to closing on a property or loan with farm credit.

Outreach and Engagement

1. **Community Solar if Applicable**

Residential and other C&I members do not participate, as the array was purpose-built to serve the Sunny Point military base. BEMC maintains two other community solar arrays into which members can buy.

2. **Member Engagement**

In contrast to BEMC's other solar systems, most members are not aware of this project. MOTSU specifically requested that no promotional material be developed for the array, although it is considering putting up information at the array's fence.

3. **Employee Training, Time Requirements, and Engagement**

BEMC used its own staff for project management and engineering support; PowerSecure provided crews for racks, wiring, and panel installation as well as the engineers who designed the system and installed the inverters. PowerSecure is still working on final communication deliveries. BEMC crew installed the interconnection underground line and all fiber from the substation to the project site. The BEMC substation relay/SCADA team did splicing and programming of real-time automation controller (RTAC) at the substation.

To educate BEMC's employees, PowerSecure provided one hour of on-site training that covered the basics related to the restart of the inverters as well as safety with DC voltage and recombiners. BEMC is looking for more details on the installation for the next project—specifically on DC wiring and troubleshooting the inverter and recombiners. When equipment fails in the system, BEMC uses it as an opportunity to train its staff to perform repairs. To date, its power-line carrier communications, inverter screens, and uninterruptible power supply have failed and been repaired.

Employees working on other projects during this time were not greatly impacted by the construction of the array.

4. **Board Engagement**

BEMC approached its board with this project as it would any other large construction project. The only major difference was that the flip-equity model had to be approved; after a detailed explanation, the board had no issue with it. BEMC planned to bring the board to the project site sometime in fall 2017 when the battery storage was complete.

Lessons Learned

Building and Operating Lessons Learned

- When negotiating EPC contracts before all the approvals and permitting are finalized, be sure there is a clause allowing the contract to be repriced if hardware prices change. At this time, panel and inverter prices are still trending downward; if a project is delayed by several months to more than a year, the hardware price may drop 15% or more. It would be unwise to be locked into a contract that reflects old hardware pricing.
- Allow several months for final commissioning, monitoring, and control to show proof of production to stakeholders.

Working with a military base

- Get buy-in from the top down. Ask the base to call other military installations that have developed successful projects through privatization. Most bases find it hard to comprehend a

no-cost contract modification, but there are ways for a co-op to finance the project for the government through a PPA, tax-equity flip, or other financial mechanism. The government may find up-front funding, which people may find easier to understand because the normal protocol is to fund a modification.
- Create educational tools for key base personnel—most of them do not work with or understand electrical distribution very well.

If it were starting over, BEMC would do the following:

- Subcontract out more of the project, in addition to using local crews to handle the racking and module installation.
- Order material directly from a manufacturer and/or through a vendor participating in the NRECA National Discount Program. For example, the co-op would use Siemens for inverter/s, racking directly, and modules directly. Hire another company for wiring.
- Select a different inverter manufacturer, possibly “smaller” combiners, allowing the co-op to query problems at a micro level.
- Ensure dashboard/query software is provided by the inverter manufacturer to allow immediate results verification and system monitoring online.

The biggest unanticipated challenges were as follows:

- Finishing the project on time. BEMC cannot say enough about its disappointment in using a turnkey provider for a project of this size. Other companies may work for small projects, but BEMC would recommend a larger company with more solar experience as its primary focus next time.
- BEMC expected to see a dashboard view of the system as soon as fiber was connected from the site to black fiber back to the Internet. It purchased extra equipment so it could use cell modem technology, which was not the original plan. BEMC’s EPC did create a dashboard, but it was implemented several months behind schedule.
- The cost of BEMC’s project, at 1.2 MW, was higher than expected based on estimated projections from NRECA’s cost estimate tool, but much of the cost increase was due to project delays.

Future Plans

Sunny Point is giving BEMC 12 more acres of land to create more solar, with the goal of being completely off the grid in 10 years, and has begun clearing the land. At this point, BEMC does not have any plans to add more solar for its general membership beyond the two 100-kW community solar projects already built.

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Green Power EMC

State: GA
Type: Distribution
Number of Meters: G&T, 38 distribution co-op members

Project Summary

Green Power EMC is a generation cooperative located in Tucker, GA. Green Power provides renewable options to its distribution co-op members (the same co-ops that are members of Oglethorpe Power Corporation). Originally, Green Power proposed a 1-MW solar array for the SUNDA project. However, its member distribution cooperatives determined that additional projects in their local service territories would help support community solar offerings to their residential members. In addition, the price of solar equipment declined during the preplanning activities, helping to magnify interest among distribution cooperatives. As hardware prices continued to fall, the interest from the distribution co-ops became much greater than originally anticipated; Green Power EMC is now installing more than 15 MWac at 9 co-ops and 12 sites around Georgia. In Phase II of the SUNDA project, it installed 6.6 MW; in 2017, Green Power installed almost 9 MW more. All of these sites provide community solar to the members in blocks of green kWh for which members subscribe.

Background Information

- **Existing Renewable Assets**

Georgia's co-ops have about 240 MWac of solar projects in operation and have contracted for another 200 MWac to be installed in the next few years. In addition, these cooperatives have an additional 36 MW of non-solar renewable energy, including run-of-river hydro, landfill gas, and waste biomass.

Created in 2001, Green Power EMC has been the primary source for renewable energy production projects as well as renewable energy education and public relations for Georgia's Electric Membership Corporations (EMCs). In Georgia, 38 of 41 distribution cooperatives are members of Green Power EMC and participate in at least one solar project.

- **Renewable Policy**

Georgia has no requirements, goals, or state tax incentives compelling co-ops to source electricity from renewable sources. However, the Georgia Public Service Commission has encouraged and provided incentives to Georgia's IOU, Georgia Power Company, to purchase solar energy and construct solar facilities. This combined activity has helped bring development activity to Georgia, creating a favorable market opportunity.

- **Reasons for Installing Utility Solar**

Utility-scale solar offers lower renewable energy cost than smaller distributed energy resources in Georgia. Green Power EMC's distribution cooperative members want to provide cost-effective renewable resources to meet the interest of their end-use members. Utility-scale solar projects in Georgia offer a unique opportunity to meet these interests. In addition, distribution cooperatives are finding that strategic amounts of solar generation capacity and energy can add value to wholesale supply portfolios.

Permitting Began: May 2014
Procurement Began: June 2015
Installation Began: March 2016
Deployment Completed: July 2017

Technical Details

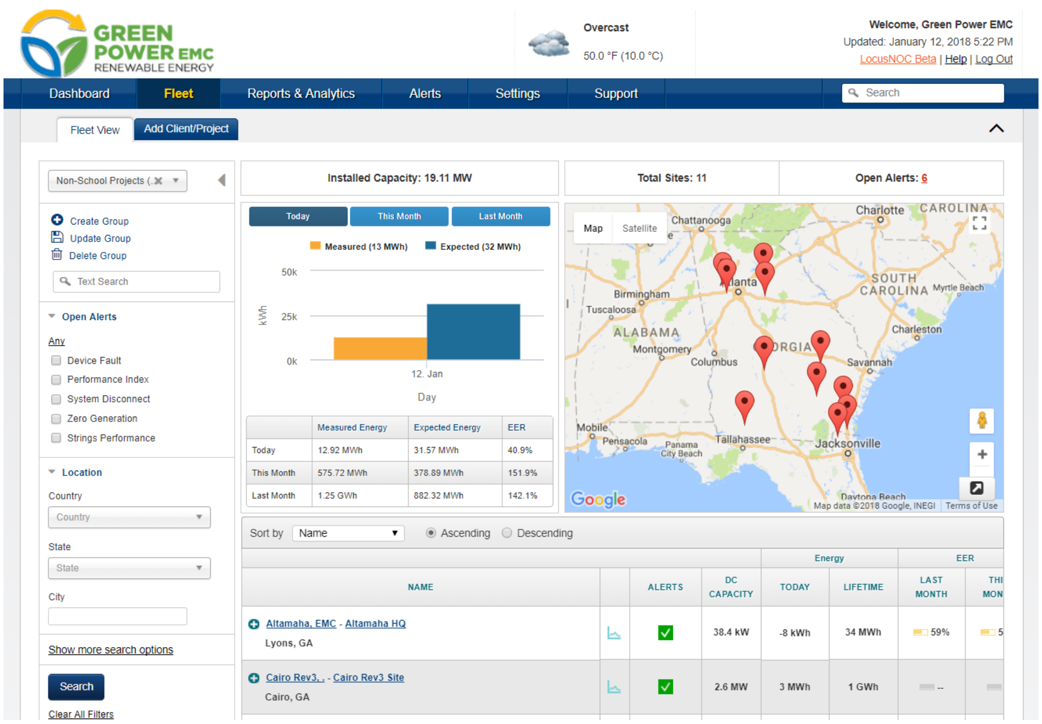
1. Project Size and Equipment Installed

Green Power EMC used two different EPC contractors for its projects. It used string inverters and polysilicon solar modules in its design. All racking systems were fixed tilt, generally facing due south. The azimuth-tilt angle varied from about 25% to 15%, depending on expected wind loading, soil type, and land utilization.

Co-op Name (Host)	***Site Name (if different)***	***System Size AC MW***	***System Size DC MW***	***Panel Make and Qty***	***Inverter Make and Qty***	***Date Operational***
Okefenokee EMC	Glynn County	1.8	2.42	Canadian Solar 320 W (7,560)	Sungrow, 60 KW (31)	Sept. '16
Okefenokee EMC	Kingsland	0.108	0.138	Canadian Solar 320 W (432)	Sungrow, 36 KW (3)	Sept. '16
Okefenokee EMC	Hilliard, FL	0.108	0.138	Canadian Solar 320 W (432)	Sungrow, 36 KW (3)	Sept. '16
Middle Georgia EMC	Vienna	0.936	1.2	Canadian Solar 325W (3,744)	Sungrow, 36 KW (26)	Sept. '16
Satilla REMC	Alma	1	1.36	Canadian Solar 320 W (4,256)	Sungrow, 36 KW (28)	Sept. '16
Snapping Shoals EMC	Mansfield/ Pony Express	2.7	3.35	CSUN 310 W (10,800)	Chint Power Systems, 36 KW (75)	July '16
GreyStone Power	Hiram	1	1.362			Oct. '16
Altamaha EMC		0.25	0.038			Nov. '16
Irwin EMC		1	1.3	Jinko Solar 325 W (3,952)	Sungrow 60 kW (16)	Dec. '17
Jackson EMC(PPA)	Barrow Co	2	2.6	Huawei	Huawei, 25 kW	Jul. '17
Grady EMC (PPA)	Cairo Solar	2	2.6	Huawei	Huawei, 25 kW	Jun. '17
Greystone Power (PPA)	Turnipseed	3	3.9	Huawei	Huawei, 25 kW	Aug. '17

Remote Monitoring

All projects employ Locus Energy monitoring systems. This system provides weather data, revenue-grade metering, and inverter monitoring (and control for certain projects).



2. Procurement

Green Power EMC used EPC contracts.

3. Siting and Permitting

The host EMC ensured that the property, leased by Green Power, was prepared to accept the solar projects. Any site permitting required to prepare the site was accomplished by the EMC. Construction permits necessary to install the solar projects were included in the EPC contract.

The co-op found that each community was unique in how it approached the installation of a solar facility. In most cases, permitting was not a significant issue. However, the process was new to most of the communities and required different levels of engagement with the local community and authorities.

4. Building and Operating Lessons Learned

The solar design was provided by the EPC contractor.

The EPC used fixed-tilt designs with string inverters.

All facilities were fixed-tilt designs using string inverters. Most sites used 36-kW string inverters, whereas the Okefenokee (Glynn) used 60-kW string inverters. Sites near the coast used a 15-degree tilt (storm force wind requirement); others used a 20-degree tilt. The systems were designed with a target 1.3 DC/AC ratio.

5. **Other Technical Details**
   a. **System Impact Analysis**

Affected distribution and transmission systems were studied to ensure that reverse power flow, expected from solar facilities, was acceptable and would not significantly disrupt service to others that received electrical service. Efforts were made to ensure that reverse power flow to the transmission system would be minimized to help reduce interconnection costs for changes to system protection.

6. **System Photos**

https://www.dropbox.com/sh/8m488x83dyhb2f6/AACmtMyxkHR1csJDbxNQ4mYaa?dl=0

Financial Details

1. **Business Model/ Ownership**

Green Power EMC employed equipment lease and PPA business structures for its projects. It purchases 100% of the energy from all projects utilizing PPAs and sells the energy to member distribution cooperatives by contract. For a few projects, it uses a PPA (no lease) with a purchase option that provides a path to ownership.

All RUS borrowers received approval from RUS—required for any long-term power supply agreements. This process typically takes 60–90 days.

2. **Financing**

Green Power EMC used equipment leases through Farm Credit Leasing for several projects, and long-term PPAs for others.

3. **System Costs**
   a. **Total Cost: $25,000,000 (approximate)**

   b. **Average Cost per Watt-DC: $1.35**

   c. **Chart of Proportional Costs**

Modules	45%
Inverters	8.5%
Property/Property Prep	7.5%
Labor/Balance of System Materials	29%
Racking	10%

Legal and Regulatory Challenges

N/A.

Outreach and Engagement

1. **Community Solar if Applicable**

Most participating distribution cooperatives offered end-use members opportunities to participate in a community solar program called "Cooperative Solar." Cooperative Solar generally provides the end-use customer with energy from a subscribed amount of solar capacity; the fee typically ranges from $20–$25/per month. Customers receive an energy credit on their bill each month, based on a pro rata share of the energy generated by the solar facility.

2. **Member Engagement**

The G&T engaged through Green Power EMC to develop community solar at member distribution co-ops, using procurement scale to keep costs down. The Cooperative Solar program helps members purchase solar energy at a reasonable cost with no contract or long-term commitment. The program also assists the co-ops maintain their roles as trusted energy advisors for their members.

3. **Employee Training, Time Requirements, and Engagement**

Green Power EMC has provided solar technology training for about 1,000 distribution cooperative staff, providing 3 levels of training, including (1) introductory, (2) technical training, and (3) home solar audits. In addition, the projects noted in this report are used to help staff understand best practices in design, operation, and maintenance for new solar development. Training efforts are ongoing.

4. **Board Engagement**

Each distribution cooperative's decision to host and enter into long-term power supply agreements required board approval. Many of the boards receive routine reports on the performance of their respective projects.

Lessons Learned

1. Financial transactions and PPA transactions are complicated and take time and effort.
2. A collaborative approach through the G&T to achieve greater economies of scale can be beneficial, save costs, and focus expertise. However, care must be taken to be flexible in meeting individual EMC needs/interests.
3. Coordination during the construction process is time-consuming and requires organization and support. Careful planning and frequent communication with all parties are essential.
4. Green Power EMC employed an "owner's engineer" to review the design and installation on a limited basis. This investment was the best money spent; although the contractors were very good, the co-op found many improvements developed through the owner's engineer that likely will prove to save money in long-term O&M.

Additional Needs Identified

1. There was not much experience or standards available from the industry for O&M of these facilities. The co-op could use a cooperative industry users group to share lessons learned.
2. Data monitoring systems are very important for troubleshooting and ensuring maximum performance.
3. Data monitoring systems are difficult to maintain.
4. Designing and installing systems should keep in mind balancing up-front cost and long-term maintenance.

Future Plans

Green Power EMC will continue to monitor and extract as much financial and qualitative value as possible from the current projects. It also will continue to evaluate opportunities to meet its distribution cooperative renewable energy interests, including through project development, training, and end-use member engagement.

More Information

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Press Release:

https://news.jacksonemc.com/green-power-emc-dedicates-new-solar-facility/

Video:

https://vimeo.com/164088708

Anza Electric Cooperative

State: CA
Type: Distribution
Number of Meters: 5,000

Project Summary

Anza Electric Cooperative is a small distribution cooperative in southeastern California that serves 3,900 homes, schools, and businesses, along with 20 irrigation loads. Anza's peak load is 12.6 MW, which comes from a single radial feeder with a capacity of 14 MW. The feeder is owned by Southern California Edison (SCE), and Anza purchases its power from Arizona Electric Power Cooperative (AEPCO). AEPCO is planning to increase the feeder to 19 MW, but it will be a long process, requiring 8 structures to be reconductored. Even with this planned increase, capacity concerns were among the primary incentives for installing solar. Furthermore, this power is largely produced in coal-burning power plants in Arizona, and the cost to import this energy to California is high.

Anza originally planned to install 1 MW near its headquarters and main substation in Anza, CA, approximately 100 miles east-southeast of Los Angeles. In the design phase, Anza determined that the work required to permit the site for the maximum 4 MW capacity was identical to that required for 1 MW, and the economics of the power produced favored a larger installation. Because 4 MW was more than its board was willing to authorize in its first venture into solar was selected, to install 2 MW immediately, followed by 2 MW in a year or two. When the site is fully built, it should provide 14% of the total annual energy need.

Anza started its project late in 2013, but siting and permitting issues prevented it from breaking ground until October 2016; commissioning was completed July 2017. Although some of the permitting issues are unique to California, others are more universal. The selected site had issues with property tax status, water rights, and an endangered species that was found and required additional remediation. Local regulations required a special fire road to be added to the design. Each of these issues added time and cost; several could have been avoided by considering multiple sites with the aid of a land agent early in the process. The convenience of being next to the substation and the co-op headquarters ultimately may outweigh the difficulties faced, however.

Anza faced a difficult decision when deciding which direction to orient their panels. Facing the panels west provided the best economic value because the peak load typically occurs between 4 and 7 p.m., and Anza pays demand charges to its G&T. However, facing the panels due south would generate more energy. Anza decided to orient the panels solar south as a hedge against any policy change by its G&T.

Background Information

- **Existing Renewable Assets**

Small 17-kW solar array on co-op headquarters in southeastern CA.

- **Reasons for Installing Utility Solar**

Ironically, a small 17-kW solar system was constructed on the co-op's office roof to educate members about the impacts of rooftop solar. While the co-op anticipated members to be dissuaded, the project generated interest among members.

Solar is often proposed as a solution to high electricity and transmission costs in California. Cooperatives have lower prices than IOUs, but the state still has among the top 10 highest rates of cents/kWh. In addition, California has regulatory requirements for utilities, including cap and trade rules, as well as a state renewable portfolio standard (RPS). For cap and trade, Anza must find ways to reduce its greenhouse gas emissions. California has set a state RPS of 33% by 2020, 50% by 2030, and possibly 100% by 2045, depending on new legislation. As a federal borrower and a cooperative under RUS guidelines, Anza may be required to reach these targets along with other California utilities.

Project Timeline

Permitting Began:	12/15/13
Procurement Began:	10/15/14
Installation Began:	10/15/16
Deployment Completed:	7/31/17

Technical Details

1. **Project Size**

Final Project Size (MWp):	2.4
Final Project Size (MW-AC):	2

2. **Equipment installed**

Modules: Canadian Solar 330 W, 72-cell panels, quantity: 8,760
Inverters: SMA string inverters 30 kW, quantity: 67
Racking: Schletter driven-post pilings, oriented solar south with a 25-degree tilt
Remote Monitoring: Locus monitoring. Available as of summer 2017 to co-op staff and thereafter available online and in the lobby to members

Equipment was selected based on availability and manufacturer reputation.

3. **Procurement**

AEPCO was responsible for procuring all project materials in conjunction with Cenergy, its EPC. AEPCO experienced no delays in getting the equipment but was still subject to project delays from siting and permitting. One unexpected benefit of the project delays was that equipment prices continued to fall.

4. **Siting and Permitting**

Anza started its project late in 2013, but siting and permitting issues prevented it from breaking ground until October 15, 2016. The array was finally installed and commissioned in July 2017 after numerous delays, making it the lengthiest SUNDA project.

The location is “high desert,” with an altitude of approximately 4,000 feet. This site is excellent for solar PV, with high insolation and relatively low temperatures compared with the “low desert.” Despite the region’s above-average solar resource, Anza experienced significant challenges with siting and permitting the land. In addition to the property’s tax status, the land is encumbered by a water rights law suit with a local Native American tribe that created unusual issues regarding the timing and/or ability to install the array. For background, an agricultural company originally owned the land, and the tribe expected this company to give it the land as part of water negotiations. The tribe used the land to set pricing, so it had to renegotiate the contract with the G&T. Additionally, the local fire department required a special road (of metal and glass for an unmanned site) for putting out fires.

During a geotechnical study, the Los Angeles pocket mouse, an endangered species, was found at the site, requiring Anza to take mitigating actions. The initial requirement was to purchase 3 times the amount of project land somewhere else, but Anza was able to negotiate the requirement down to an equal amount of land. As of January 2017, pocket mouse restoration had added an additional $140,000 in project costs.

5. Building and Operating Lessons Learned

The EPC selected for the project was Cenergy Power of Carlsbad, CA. Cenergy was picked by AEPCO, which ran a competitive bidding process; Cenergy was the lowest qualified bid. When fully constructed, the array will provide 16% of Anza’s total energy demand.

A ground breaking ceremony was held on October 14, 2016. Anza’s system was supposed to be fully installed by the end of 2016. However, the area has experienced heavy rains after 5 years of drought, so installation has been delayed repeatedly.

The system is owned and operated by AEPCO.

6. Other Technical Details

a. **System Impact Analysis**

N/A.

b. **System End-of-Life Plan if Applicable**

No plan exists as yet, but Anza expects a 35–50 year system life based on the performance of its General Manager’s home solar array in the desert climate. For its financial analysis, the lifetime was modeled as 25 years.

7. System Photos

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Financial Details

1. Business Model/ Ownership

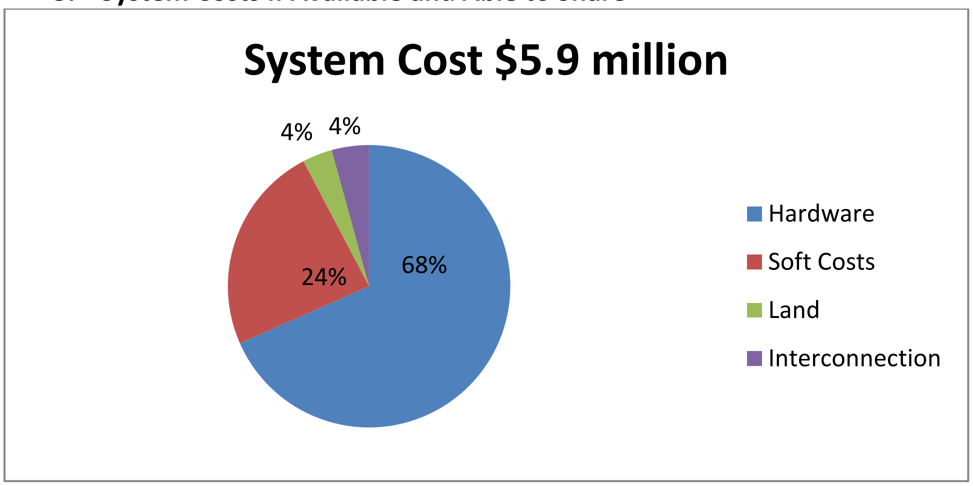
AEPCO, Anza's G&T, owns the array; Anza buys 100% of the output and receives the RECs. Anza pays 5.6 cents/kWh with no escalator over the life of the system. Anza's wholesale costs are 7.5 cents.

Project costs were higher than anticipated, largely due to cost overruns on permitting.

2. Financing

AEPCO used a taxable entity for the tax-equity flip structure. It worked with both CFC and CoBank.

3. System Costs if Available and Able to Share



Legal and Regulatory Challenges

Anza faced many legal and regulatory challenges, especially county codes and a very lengthy review process. To deal with these issues, Anza recommends bringing in an experienced land-use specialist local to the area. It also recommends investigating any relevant state and local mandates.

Outreach and Engagement

1. **Community Solar if Applicable**

Anza is still developing its community solar program. As of summer 2017, members received a discount when they joined the program; their rates then were connected to peak demand loads. If members can switch their peak usage to the middle of the day, for example, they will save money. When the Virtual Net Energy Metering (Virtual NEM) program is finished, it will allow greater connection and control between members and their meters.

2. Member Engagement

Anza has surveyed its members over the years regarding interest in solar and willingness to pay for solar programs. It found that a community solar project was of high interest to the membership. In addition to the formal survey feedback, Anza receives many unsolicited comments in support of solar.

In 2011, Anza developed a pilot project of 17 kW that was announced and offered at its annual meeting. The 30 shares sold out in 30 minutes. Anza expects its community solar subscription rate to result in a very high uptake.

To make project announcements and updates, Anza used the gamut of social media (which worked well for quick announcements), newsletters, and meetings.

3. Employee Training, Time Requirements, and Engagement

All installation work was done by contractors, but the project still took up a great deal of Anza's General Manager's time. Other employees were not impacted—Cenergy was very experienced and self-contained, took care of most of the details; co-op staff stayed informed through weekly updates on the status of the project.

4. Board Engagement

Anza's General Manager presented the board with a financial analysis of state regulations and cost savings via cap and trade from developing this solar array. The board agreed with his assessment, and the project moved forward. The board was very engaged throughout the project and received regular updates at monthly meetings.

Lessons Learned

- The primary lessoned learned by Anza is that it probably always pays off to hire a land agent to help find a suitable location for a solar installation. Anza selected its piece of land because it was adjacent to their headquarters and primary substation, and could be obtained at a reasonable price. However, the land was encumbered by zoning and land use issues, and Anza faced scrutiny on the Native American issues and endangered species habitat fronts. A knowledgeable land agent might have been able to find a suitable piece of land that could have been permitted more easily and, by familiarity with the permitting processes and the people in those agencies, might have been able to achieve better results faster.
- The second lesson learned from the Anza installation is that sometimes the permitting process can become very drawn out. This issue can be a function of the local rules and permit requirements; California is one of the most difficult states for such permitting. It can also depend on the parcel of land. It is always wise to select both a primary site and at least one alternate to present when applying for permits.
- Do not buy property on a state highway—it brings additional land requirements with it.
- Engage elected officials early and often; they can help with siting and permitting requirements.

Future Plans

Anza has enough space for an additional 2 MW-AC and is exploring installing an extension to its PV and possible battery storage systems in the future.

More Information

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Website:
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Press Release:
https://www.anzaelectric.org/content/aec-ranked-second-nation-solar-deployment

Appalachian Electric Cooperative

State: TN
Type: Distribution
Number of Meters: 45,000

Project Summary

Appalachian Electric Cooperative (AEC) is a rural electric cooperative established in 1940 to provide electric service to portions of Jefferson, Grainger, Hamblen, and Sevier counties in east Tennessee. It is a non-profit cooperative, organized, owned, and controlled by the 45,000 members it serves. The Tennessee Valley Authority (TVA) solicited proposals from Valley distributors for a pilot community solar project in 2015. TVA offered to provide partial funding for winning proposals. Appalachian was motivated to pursue solar PV in response to 20% of its members having a high interest in renewables, and by opportunities to participate in renewable energy. In addition, it was motivated by a sense of stewardship for the environment and a desire to use the project for educational outreach to its members.

AEC had land adjoining its substation outside of New Market, TN, which it owned, and was able to use 7 acres out of a 10-acre parcel to build the array. The remaining 3 acres are heavily wooded and would have required more intensive site prep. The county had never had a solar project, so when AEC went before the zoning board for a permit, it helped educate the county board members about solar and prepare guidelines and an ordinance for solar farms. AEC contracted with NRCO to deliver a turnkey solution for the project. On August 1, 2017, AEC launched its Co-op Community Solar program. Members can subscribe to solar power and receive a bill credit.

For the most part, the AEC deployment has been a picture-perfect solar project. However, unbeknownst to anyone at the time, Stion, the solar panel provider and maker of a novel, non-industry-standard CIGS-based solar panel, was on the verge of discontinuing operations. This situation had no immediate impact on AEC because it had already installed its array, but ongoing support and availability of replacement components may be an issue in the future. This issue can occur for products from any manufacturer but is exacerbated by the unique nature and electrical specifications of the Stion panels. On the plus side, the use of 28-kW string inverters would make it fairly easy to switch to standard solar panels on a string-by-string basis, using the remaining CIGS panels as spares for the rest of the array.

On August 1, 2017, AEC launched its Co-op Community Solar program. Members can subscribe to solar power and receive a bill credit.

Background Information

- **Reasons for Installing Utility Solar**

In 2015, TVA solicited proposals from Valley distributors for a pilot community solar project. TVA offered to provide partial funding for winning proposals.

The year before, AEC's Touchstone Energy survey of members revealed that more than 20% had a high interest in solar and renewables. The combination of these two factors led to AEC's decision to put in a proposal.

Project Timeline

Permitting Began:	10/1/15
Procurement Began:	5/1/16
Installation Began:	7/17/16
Deployment Completed:	12/15/16

Technical Details

1. Project Size

Final Project Size (MWp):	1.373
Final Project Size (MW-AC):	1.316

2. Equipment installed

Modules: Stion panels (thin-film), 145-Wp. quantity: 9,471
Inverters: Selectria PVI 28TL. quantity: 47
Racking: Solway GM2 PV ground mount (by Brittmore Group), 20-degree tilt
Remote Monitoring: eGauge for the member portal (on website), and Locus Data for the monitoring system

3. Procurement

AEC solicited pre-bid proposals, seeking a company that would partner with it to lead the effort in preparing a proposal for TVA and, if successful, manage the construction of the project.
TVA had a list of things to be covered in its proposal, including specifics on the design of the community solar offering; how the bidders proposed to handle the RECs, which would be transferred from TVA to the bidders; and how AEC would add value to the project—in this case, largely through an education program.

As AEC went out to bid, its criteria for a winning proposal were not primarily based on price but on the innovation of the bidders' approach to meeting TVA's requirements. AEC received bids from Silicon Ranch of Nashville, ARiES Energy of Knoxville (a subsidiary of PHG Energy of Nashville), and one or two other firms. After a careful selection process, AEC chose ARiES.

The proposal with which ARiES helped AEC was one of two selected for funding by TVA (Chattanooga Electricity Board was the other winner). TVA provided $900,000 in grant funding, which made the project viable.

4. Siting and Permitting

AEC had land adjoining its substation outside of New Market, TN, which it owned, and was able to use 7 acres out of a 10-acre parcel on which to build the array. The remaining 3 acres were heavily wooded and would have required more intensive site prep. The county had never had a solar project, so when AEC went before the county zoning board for a permit, it helped educate the board members about solar and prepared guidelines and an ordinance for solar farms.

AEC visited all of the neighbors next to the site of the solar farm—and all of them were supportive.

5. Building and Operating Lessons Learned

Under its contract, ARiES was obligated to deliver the completed project at a cost of $2.80/W. ARiES's responsibility included securing all suppliers and managing all the subcontracts. AEC did not get into the details of approval; all the co-op wanted was to meet the performance requirements set out by TVA based on the number of kilowatts produced in the first year.

NRCO served as contract managers for the project. AEC highly recommends obtaining the resources NRCO brought to the project—NRCO was extremely good at making sure ARiES met the contract requirements. NRCO brought in Burns and McDonnell (B&V)—experts in ensuring that everything was done to spec, including having the right equipment, the correct structural details for the racking system, and ensuring the system was properly rated. Although AEC did encounter some delay while Burns and McDonnell waited on the test results before approving and releasing the system, it considers that the time was well spent in ensuring that everything was correct.

The project experienced some rain and equipment delays, including for solar panels, for about 2 to 3 months because of supply chain issues outside of its control. Another issue AEC experienced with its panels was with the delivery packaging. If the pallet of solar panels flopped over, it could break 6 to 8 modules in the process. Other delays were caused by late payment issues because payments and approvals had to pass through several organizations. After contractors completed the work, NRCO would bring in B&V to check it; then AEC would pay ARiES, which would pay the contractors. Fortunately, NRCO built in ample time for delay in the schedule to allow for approval of the equipment. In addition, ARiES used a robotic mounting system to install the PV panels, which reduced the installation time required. Unlike many silicon panels, which are bolted into place, these thin-film modules were glued onto the mounts. In the end, AEC managed to complete its project a few weeks before the TVA-imposed deadline of December 31, 2016.

The facility is expected to generate more than 1.8 million kWh in its first year of operation. Based on average kWh use by AEC's residential members, the array will produce enough clean, renewable energy to supply all the power needs of approximately 130 homes for an entire year.

6. Other Technical Details

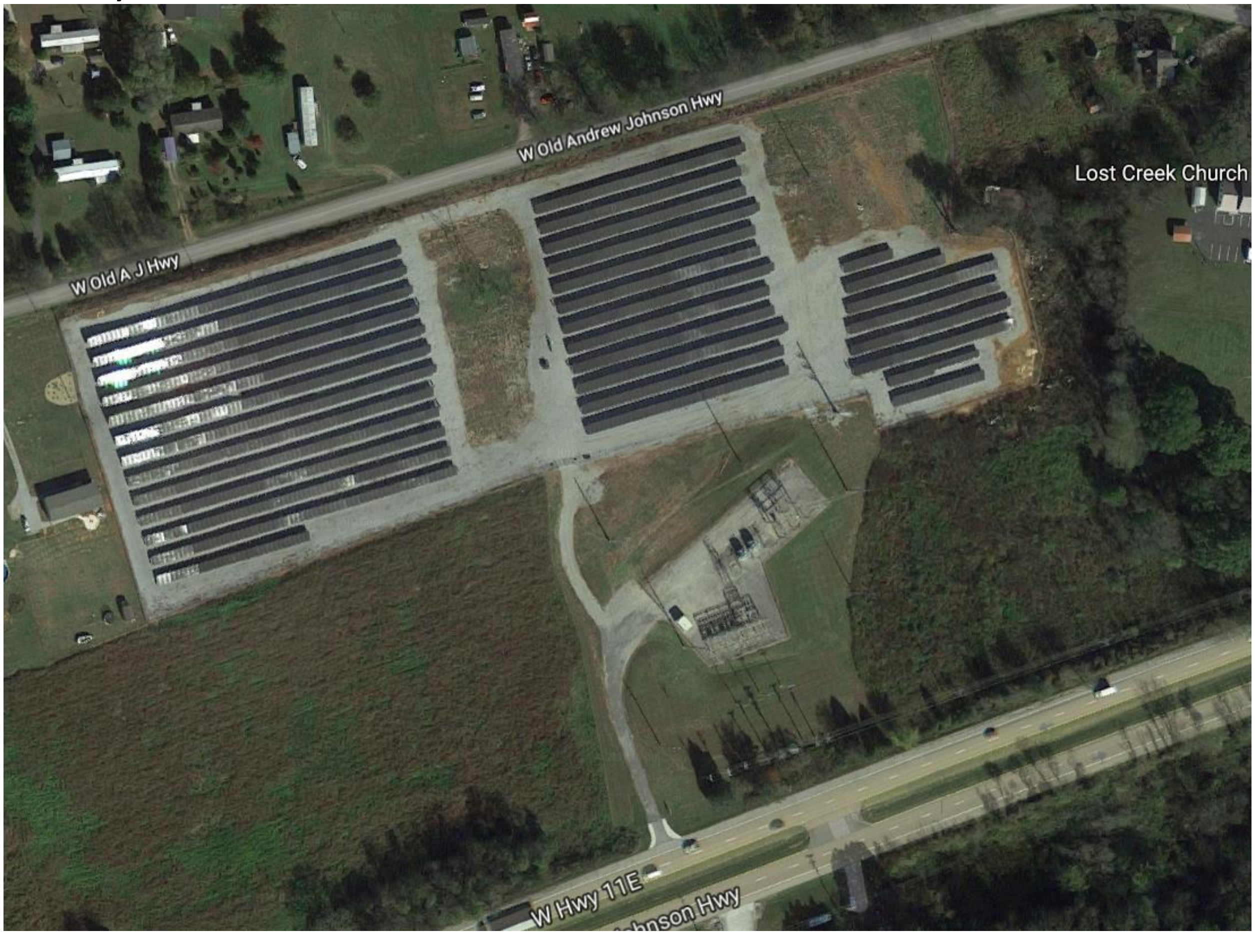
a. **System Impact Analysis**

AEC performed a coordination study to ensure that its protection would work. The minimum load on the substation is 6–8 MW, so AEC had no serious worries about the solar array negatively impacting the system.

b. **System End-of-Life Plan if Applicable**

AEC has no system end-of-life plan right now, but because its system uses string-inverters, it plans to replace and upgrade the system as parts break over time.

7. **System Photos**



Financial Details

1. **Business Model/ Ownership**

AEC made the decision to go with a tax-equity flip model to finance and build the project, which was included in its proposal. That model was unique to the Valley (TVA service area) at that time. Once AEC began, it found that it faced an extremely laborious learning curve. No one in the area had done this kind of project before; there was no roadmap to follow to make it work within the rules of operating as a TVA distributor.

AEC struggled with the tax-equity flip model until it discovered that Federated Insurance was available as a tax credit partner through NRCO. NRCO had a plan mapped out and made the process very understandable and simple for AEC, which worked with NRCO and Federated to form an LLC as the blocker corporation for the TEF. The tax-equity plan covered 42–43% of the capital cost of the project.

AEC sells all of the output of the array to TVA at avoided cost, plus 2.73 cents, with an annual escalator of 5 %; currently, it averages $0.41/kWh. AEC is obligated by its contract with TVA to meet minimum output requirements—1,475 MWh for the first year, then declining based on the system's natural derating over time. If AEC cannot meet this production level, it will jeopardize the grant it received.

If community members begin to scale back their rate of buying into the community solar program, the blocker corporation still will break even. Current interest suggests that the project will reach its goal. To help consumers finance their purchases, they can participate in a lease-based program or a long-term subscription through Appalachian Power Project, with pre-pay or financing as options. InnerVision will assist with subscription agreements and marketing. Not only will this partnership further the project, but it also will provide insight about AEC's rate structure.

Project costs will be fully funded through revenue generated via a PPA with TVA. There will be no impact on AEC's retail rates as a result of Co-op Community Solar. AEC also applied for a REAP grant for $500,000 but did not receive it.

2. Financing

AEC found the accounting piece of the project to be challenging. It had to set up several business entities and then work with TVA to approve everything. This process does not proceed in an orderly, step-by-step manner. The tools developed by SUNDA provide detailed roadmaps for most projects, but similar materials for TVA did not exist for this project.

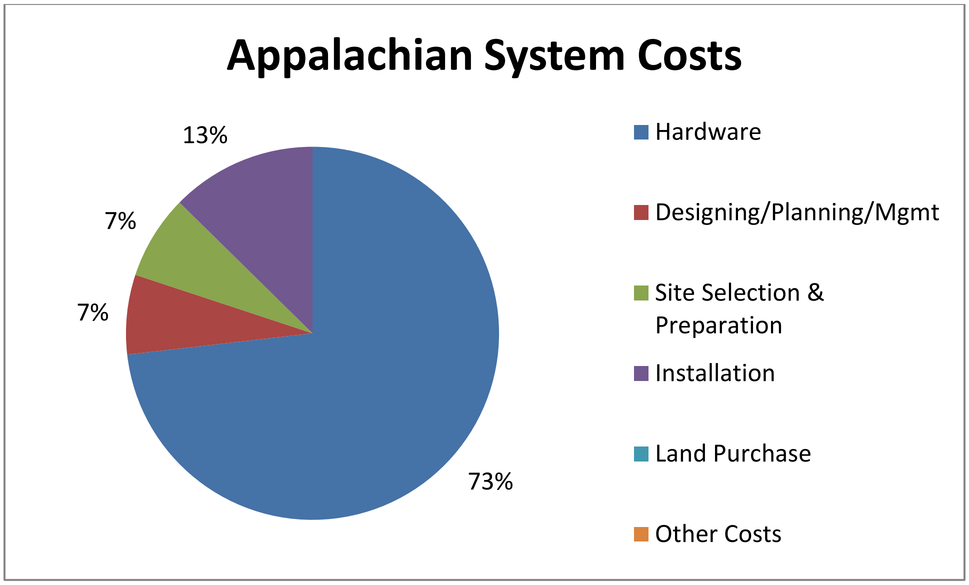
Co-op Community Solar was made possible in part through a grant provided by TVA; it is one of only two pilot programs to have received this funding in the entire Valley region.

3. System Costs

a. **Total Cost: $2.75 million**

b. **Cost per Watt-DC: $2.01**

c. **Chart of Proportional Costs:**



Legal and Regulatory Challenges

AEC did not experience any significant legal or regulatory challenges during this project.

Outreach and Engagement

1. **Community Solar if Applicable**

AEC has marketed its community solar program heavily, and participation rates have begun to pick up. AEC offers several different ways for its members to participate:

- Subscribe Solar—Members subscribe to the generation of solar panels and receive a credit on their AEC statement bill. The cost to subscribe is $125 for a 145-W panel. Members can purchase up to 34 panels. The estimated return on investment is 11.5 years, and each subscription agreement stays in place for 20 years.
- Share Solar—Members gift the subscription of solar generation to any non-profit organization or educational institution served by AEC. A Co-op Community Solar subscription in honor or in memory of someone is a meaningful gift that conveys a lasting legacy of respect for the environment. The cost is the same as Subscribe Solar—$125.
- Support Solar—If the primary interest is in promoting environmental sustainability through renewable generation, members can make a contribution to Community Solar to ensure the future viability of that energy source with no expectation of financial benefit. Members may contribute any amount.
- Select Solar—Members can purchase a monthly block of solar energy and receive a credit on their bill. Each block costs $10 and provides the member with a credit for the solar energy produced from a few panels in the array. The credit members receive will vary month to month, based on the actual output of the array. This option is structured so members will more or less break even over the course of the year. There is a minimum 12-month commitment to participate.

AEC's goal is to provide flexible offerings that meet all of their members' needs. The solar credit they receive changes over the life of the program, starting out at ~6.5 cents/kWh and decreasing to 3.0 cents/kWh by Year 20. Over the life of the program, it will average 4.5 cents/kWh. All residential and commercial members of AEC are eligible to participate. Half of the 9,471 panels are available for subscription by residential members and half are set aside for commercial members. There is a 5,000-W cap per member for each residential subscription, and a 10,000-W cap that applies to commercial subscriptions. Subscriptions are available on a first-come, first-served basis. As of summer 2017, more than 100 members had subscribed (about 10% of total availability); it is the only solar program in east Tennessee.

2. Member Engagement

Members wondered whether their electric rates would go up as a result of the construction and operation of the Co-op Community Solar facility? Project costs are fully funded through revenue generated via grants and a PPA with TVA. There are no associated impacts to AEC's retail electric rates.

3. Employee Training, Time requirements, and Engagement

AEC provided training to its customer service representatives (CSRs), but the project did not impact employees greatly because most work was completed by ARiES and NRCO.

4. Board Engagement

AEC kept its board updated through regular status reports at board meetings.

Lessons Learned

- AEC regrets not knowing about the services offered by NRCO and Federated earlier. Until it did, the co-op felt as if it had been swimming upstream. It was a huge step—it could have handled this project more easily from the beginning. Working through the interface with TVA for the first time was cumbersome.
- AEC's membership is not subscribing at the rate it expected. It is not even at 10% of the panels being subscribed. AEC's all-requirements contract with TVA presents challenges for it. The cooperative sells power to TVA (at avoided cost) and buys it back. It can be difficult to make the numbers attractive because of the TVA rate (4.5 cents/kWh). AEC worked hard to make the price attractive, including taking a 20-year average, front loaded to give participants a quicker return. AEC sells panels for $125; subscribers then receive production credit at the TVA rate. It works out to an 11-year payback—more competitive than a rooftop system (16 years). AEC has fielded thousands of calls after members learn about the payback time, because many of them think solar is a money-making proposition from day one. AEC believes that there is more flexibility outside of the Valley.
- The member response has been disappointing, and AEC would now engage its membership differently, perhaps pre-subscribing the panels or securing subscriptions and then building.
- If planning for a tax-equity flip, pick a partner with extensive experience. AEC was fortunate to find NRCO and Federated after being unable to secure a large enough investor.
- Language must be used with care in offering community solar so as not to imply that members have any ownership rights to the panels or power produced.

Future Plans

Several other TVA co-ops are planning or interested in installing solar. AEC is interested in adding storage if the community solar project goes well. In addition, AEC wants to develop a program specifically for its C&I customers.

More Information

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Video:
https://www.youtube.com/watch?v=k3qjuDOxw58

Middle Tennessee Electric Membership Corporation

State: TN
Type: Distribution
Number of Meters: 222,000

Project Summary

Middle Tennessee Electric Membership Corporation (MTEMC) distributes electricity to about 222,000 residential and business members in a 4-county area directly south of metropolitan Nashville. It completed construction of a 1-MW array in November 2016, providing access to members who might otherwise be excluded from owning and installing their own solar electricity generation.

MTEMC's primary driver for this project was members' demand for more solar options. Obstacles like improper roof orientation, excessive roof shading, restrictive subdivision covenants, or landlord prohibitions are often barriers to homeowners and renters who want to install solar systems.

MTEMC is regulated by TVA and has no state RPS mandate to meet. It built the array on 5 acres of a flat 16-acre site in a floodplain that it already owned. One challenging aspect of the site was its rocky terrain. MTEMC worked with Radiance Solar, a turnkey EPC, which was not happy with all of the drilling required by the rocky soil. Hitting rock delayed the original schedule and added to the original cost, but remained within the anticipated change order allowance. MTEMC advises allowing for extra time for those types of situations.

The system was developed to provide community solar options for its membership because MTEMC is limited in the amount of solar production it is allowed under its TVA contract; for this reason, it has not pursued a goal of achieving 100% subscription levels. It uses its solar array to provide those members who express an interest in solar with an attractive option but wants to be sure that it still maintains enough unsubscribed panels to have that option.

Background Information

1. **Existing Renewable Assets**

Middle Tennessee has more than 150 residential PV solar systems (1 MW total) on its system as well as 5 MW of non-residential PV, which includes at least three 1-MW systems.

2. **Reasons for Installing Utility Solar**

MTEMC's primary driver for this project was its members' demand for more solar options. Obstacles like improper roof orientation, excessive roof shading, restrictive subdivision covenants, or landlord prohibitions are often barriers to homeowners and renters who want to install solar systems.
MTEMC is regulated by TVA and has no state RPS mandate to meet.

Project Timeline

Permitting Began: 5/31/16
Procurement Began: 7/5/16
Installation Began: 8/18/16
Deployment Completed: 11/11/16

Technical Details

1. Project Size

Final Project Size (MWp): 1
Final Project Size (MW-AC): 0.72

2. Equipment Installed

Modules: Canadian Solar CS6x, 320-W panels
Inverters: String inverters: Sungrow 60-kW string inverters, quantity: 12
Racking: Brilliant Rack, ground mount, fixed orientation 15 degrees, due south
Remote Monitoring: Locus energy on the back end for utility purposes as well as a public-facing site supported by Locus

3. Procurement

All project materials were procured by Radiance Solar, MTEMC's EPC for the project. MTEMC selected its EPC through a competitive RFP and then used the equipment the EPC recommended. Radiance Solar experienced no significant difficulties or delays in getting materials for the project.

4. Siting and Permitting

MTEMC built the array on 5 acres of a flat 16-acre site that it already owned. The remaining space is either in a floodplain or will be used for a future substation and transmission lines.

One challenging aspect of the site was its rocky terrain. MTEMC managed this issue by working with NRCO on a specialized design based on the latter's experience in drilling in similar conditions. The developer was not enthusiastic about drilling, but the plan succeeded. The site is also partially in a flood plain. Only by condemning the site was MTEMC able to build, though it was careful to continue following local construction ordinances.

5. Building and Operating

MTEMC worked with Radiance Solar as the EPC for its project and had no major impacts on its construction schedule. Hitting rock delayed the original schedule and added to the cost, but remained within the anticipated change order allowance. MTEMC advises allowing for extra time for those types of situations. The original target completion date was October 2016, with a hard construction deadline of December 31. Even with the delay it experienced, it finished construction in November. The public-facing website shows that near real-time production went live in January 2017.

6. Other Technical Details

a. **System Impact Analysis**

MTEMC performed a system impact analysis using WindMil software with historic feeder data. This analysis took about a full day's time to perform, including a learning curve. MTEMC's engineer was surprised to see the lack of voltage-related issues to this feeder, as the co-op originally had worried about voltage regulation. However, the model did not indicate cause for concern. The engineer is currently monitoring the site to ensure the model matches real-world conditions; from early evaluations, it appears to be working. MTEMC has found that having a 795 AAC wire on a 25-kV line helps to ensure a strong backbone on this feeder.

b. **System End-of-Life Plan if Applicable:**

MTEMC currently has no plans for system retirement because there are too many unknowns at this point to have concrete plans.

7. **System Photos**

https://www.dropbox.com/sh/4d4454q8j1mlmk3/AACuGsjoLfcifTMDBCw1VJCla?dl=0

Financial Details

1. **Business Model/ Ownership**

The system is owned by a subsidiary of MTEMC and Federated. As a community solar array, members can participate in the program; full details are provided below. To stay within its all-requirements contract with TVA, MTEMC sells all the output of the array to TVA, which then sells it back to MTEMC at the wholesale power rate. MTEMC keeps all RECs generated from the project and has arranged to have TVA retire them on its members' behalf.

2. **Financing**

MTEMC used a tax-equity flip to finance the project and found it to be relatively straightforward. MTEMC credits NRCO, its consulting partner, along with Federated Insurance, its tax partner, for making a complicated financial vehicle understandable. Its real challenge was finding an appropriate structure with TVA; contracting with the latter took considerable time.

3. **System Costs if Available and Able to Share**

   n/a

Legal and Regulatory Challenges

MTEMC experienced no notable legal or regulatory challenges.

Outreach and Engagement

1. **Community Solar if Applicable**

MTEMC residential members can participate in the community solar program for a monthly fee of $20 per energy block, which allows them access to the equivalent amount of generated capacity of approximately 5.5 solar panels. In some months, generated capacity may be less than the monthly participation cost; in others, it may exceed that cost. Members will see the monthly participation fee on their monthly bill, as well as their portion of the equivalent generation.

Currently, MTEMC is throttling demand for the project to ensure that more members have an opportunity to participate. Only residential members can participate and each is limited to 2 blocks (of the 549 blocks available) while MTEMC markets the program. At some point, if the system is still not fully subscribed by Summer 2018, the co-op will start opening it up—first for repeat residential and then C&I members. Members are free to leave or rejoin the program at any time for no fee. Although it is possible that members could intentionally leave the program in the winter and rejoin in the summer, MTEMC is not worried about this possibility because the real benefit to the member is small and the program is structured to be revenue neutral even if no one subscribes. MTEMC recommends this type of model because it reduces risk for the co-op and allows participation from members without a large up-front cost.

Members start the sign-up process for the program by using an online webform, but to officially join, they must have a one-on-one conversation with an MTEMC employee via phone or email so they completely understand what they will be receiving.

Six weeks after launching the program, the system was more than 50% subscribed; as of August 2017, 431 of the 549 blocks had been sold (78%).

2. Member Engagement

Despite being a community solar program, MTEMC has been guarded about launching a full marketing campaign because it cannot guarantee further build-out of the system if it becomes fully subscribed. Its member engagement includes magazines, limited social media, and the public-facing website with real-time monitoring. MTEMC has avoided a large marketing campaign because the system has already come so close to selling out through its limited marketing and word of mouth. The tag line for the project is "Local. Green. It's Solar Made Simple."

MTEMC has held 3 different events at its solar site. The first was an Open House on May 11, 2017, with everyone invited to "Come See Your Panel!" It had 45 people come by in the afternoon and received 6 new participants from that event. On June 8, 2017, MTEMC hosted a group of 22 Rutherford County STEM teachers. The tour was organized by the Rutherford County Chamber of Commerce BEP program. Also, during the following week on June 16, it partnered with BEP again to host 35 Rutherford County middle school STEM students during their STEM Camp. MTEMC planned to hold another open house event in fall 2017.

3. Employee Engagement and Training

MTEMC found that for its member service and communications team, this project entailed a standard "new program" role for them. CSRs received training and talking points; anything beyond that level was funneled to one central person. From the engineering and operations side, it was just another utility project.

The project had no substantial impact on staffing requirements for MTEMC because it effectively used its turnkey partners to handle construction and financing.

4. Board Engagement

MTEMC's board was very supportive of the solar project and viewed it as an opportunity to meet member expectations in a changing energy industry landscape. It received informal updates during the monthly board meetings and a formal report every quarter.

Lessons Learned

- Contracting was the most time-intensive part of this project; 90% of it was paperwork. Once construction began, the array was completed in less than 2 months.
- C&I customers are relatively unaware of solar, but the purpose of part of this project was to prepare them for a more solar world. Other TVA programs are available to C&I customers through the co-op.
- Do not make a contract commitment with members. Two people already have dropped out. One person lost her job, and the other had moved from California and misunderstood the program. Not requiring a contract may reduce hard feelings directed toward the cooperative or the specific program.

Future Plans

MTEMC tentatively planned to apply for an additional 2 MW of capacity in 2017 under a TVA program. MTEMC also continues to explore options for energy storage.

More Information

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Press Release:
https://www.mtemc.com/content/mtemcs-cooperative-solar-program-year-review

Video:
https://www.youtube.com/watch?v=Bbr0qoBLYgs

Kansas Electric Power Cooperative

State: KS
Type: G&T
Number of Distribution Members: 19

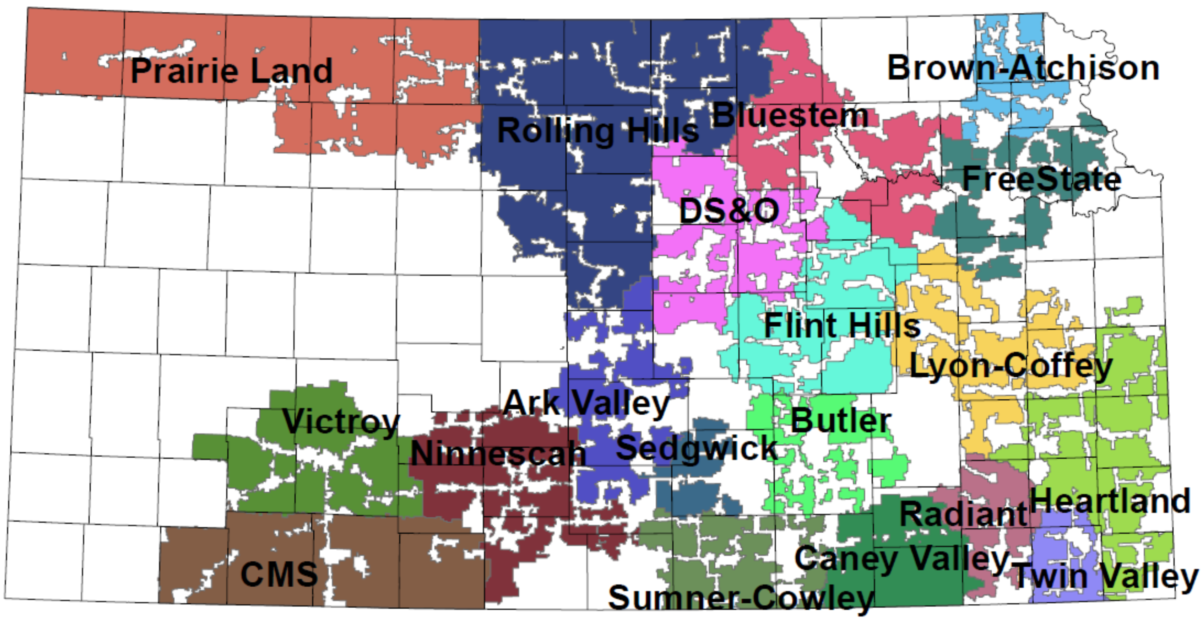
Project Summary

Kansas Electric Power Cooperative, Inc. (KEPCo) is a G&T cooperative headquartered in Topeka, Kansas. It is KEPCo's responsibility to procure an adequate and reliable power supply for its 19 distribution rural electric cooperative members. Based on member interest expressed during its regular meetings, KEPCo explored various renewable power supply options and decided to install its own solar array using guidelines from the SUNDA project.

KEPCo began exploring the possibility of a solar project because its member cooperatives and their members had an interest in renewable generation—particularly solar PV. It spent about 2 years educating staff and the board about solar energy, culminating in the decision to move forward with the project. The Prairie Sky solar farm is a 1-MW-AC, fixed-tilt PV project with an azimuth of 235 degrees. Underneath the array, and up to 20 feet around it, KEPCo has planted buffalo grass, a warm-season, low-growing, low-maintenance plant that will take 3 years to fully establish. For the remaining area, KEPCo has planted a native prairie grass recommended by the local agricultural extension agent. This project is located “behind the meter” of a KEPCo delivery point, and its production (energy and capacity) reduces the power purchase from a local IOU.

This project is a very small part of KEPCo’s overall power supply portfolio (< 0.1% of its annual energy requirements). Its choice to develop and implement this project in house was aimed at maximizing the learning opportunity for staff. It felt that the experience of developing and implementing this relatively small project would best prepare them for future, potentially larger, projects. KEPCo also felt that its project benefited greatly from the resources developed by the SUNDA team and its outreach efforts. Ultimately, it chose to become an official SUNDA team member for the sole purpose of “paying forward” the benefits it derived from the SUNDA project. Its project has performed very well over the first year, though it encountered a few inverter issues, which have now been resolved. Though 2017 has been a cloudier year than usual, the project is very close to meeting the “weather-adjusted” energy production forecast and has exceeded the forecast for peak demand reduction.

KEPCo believes the most important outcome from the project was the staff development that resulted from it. Almost every staff member at KEPCo was involved with the project in one way or another. This close involvement elevated the co-op’s stature with its 19 distribution co-op members and their consumer-members. KEPCo subsequently has been working with one of its distribution co-op members by helping it with an RFQ for its own solar project. The Prairie Sky Solar Farm is a 1-MW solar electricity-generating facility located in Butler County, Kansas, which was placed into commercial operation on February 22, 2017. The solar array consists of 4,560 photovoltaic panels on 8.5 acres of land.



Background Information

- **Existing Renewable Assets**

KEPCo does not own any other renewable assets, but it does purchase power from 2 power marketing administrations—Southwestern Power Administration (SWPA) and Western Area Power Administration (WAPA), which are supplied by hydropower. Additionally, its power purchase from regional utilities allows it to take advantage of pre-existing wind farms.

KEPCo has an all-requirements contract with its 19 member co-ops that includes a 5% carve-out for self-generation.

- **Reasons for Installing Utility Solar**

KEPCo wanted to both respond to member interest in solar and gain experience with solar arrays.

Project Timeline

Permitting Began:	1/31/2016
Procurement Began:	5/31/2016
Installation Began:	10/31/2016
Deployment Completed:	2/22/2017

Technical Details

1. **Project Size**

Final Project Size (MWp): 1.4

Final Project Size (MW-AC): 1

2. **Equipment Installed**

Modules: 4560 REC Americas 310-Wp Peak Energy 72 series
Inverters: 40 Schneider Electric string inverters
Racking: UNIRAC ground mounted, fixed-tilt racking structure
30-degree tilt and 235-degree azimuth
Remote Monitoring: Draker PV2000 G5 data acquisition monitoring system

3. **Procurement**

KEPCo secured all of the major items and equipment needed for this project. It solicited competitive bids and negotiated the final contract with assistance from PowerSecure, an EPC firm. In all, the procurement process took 60–90 days, from the beginning of talks about soliciting information to sending out the solicitation. Despite installing this system in 2016, KEPCo was not affected by the ITC crunch.

4. **Siting and Permitting**

KEPCo purchased a 22-acre parcel of land northeast of Andover, KS that previously had been a farm. The land is next to a substation and made an ideal location for a solar array. The array is set on 8.5 acres, which allows for plenty of space for a road, fence, and a staging area. The land had been used as a farm, which meant it was already generally flat and free of trees. The remaining site prep included some dirt work to level out sections, a retention berm to keep run-off out of neighbors' yards, and planting new ground cover. Underneath the array and up to 20 feet around it, KEPCo planted buffalo grass, a warm-season, low-grow, low-maintenance plant that will take 3 years to fully establish. Everywhere else, it planted a native prairie grass recommended by the local agricultural extension agent.

Siting and permitting went very smoothly for KEPCo's project. It credits this smooth operation to engaging a local attorney with a long history in the area (30+ years) early in the process.

5. **Building and Operating Lessons Learned**

The engineering and procurement for this project was done by KEPCo Services, Inc., a subsidiary of KEPCo, with assistance from PowerSecure Solar; the project was constructed by ElectriComm, Inc.

The array's tilt and orientation were chosen to increase peak energy production at the time of KEPCo's coincident peak demand while maintaining a high level of annual energy production. KEPCo chose these specifications because the output of this facility will be used to offset a power purchase under an agreement that includes demand and energy components.

The array is situated in a remote location two hours away from KEPCo's office, necessitating a very hands-off O&M approach. No one from KEPCo is stationed on site, though there is a Draker remote monitoring system to alert KEPCo when equipment is not functioning correctly. To reduce outage times, KEPCo stores spare parts at the array, including two string inverters. In addition, KEPCo has two options for local maintenance—the distribution co-op interconnected to the system and a retired engineer living nearby. KEPCo routinely hires the local engineer to mow the array and do simple troubleshooting as needed.

For security, KEPCo fenced in the array and added security cameras and lights. However, the lights go on only if workers are present.

KEPCo is also planning to train local emergency responders, including the sheriff and fire departments, on solar basics, in case they have to a respond to call at the array. Topics will include how the plant works, where the main disconnect is located, and how to stay safe while fighting a fire around solar panels.

To date, the array has operated well, with only a few inverter and surge protection issues. Several inverters have gone into a derate mode because of their proximity to a substation voltage regulation. Because the substation boosted voltage by 3%, the solar array needed to boost its output voltage to ensure power was flowing onto the grid. This need caused the inverters to go into derate mode. KEPCo solved this issue by changing the taps on the transformers by 2.5%. The solar farm also suffered a communications module failure on 11 inverters after a thunderstorm because of insufficient surge protection on the cables. Finally, a breaker tripped repeatedly because its lugs had not been tightened. KEPCo found that several other breakers also had loose lugs.

6. **Other Technical Details**
    a. **System Impact Analysis**

KEPCO did not perform a system impact analysis.

   b. **System End-of-Life Plan if Applicable**

No formal plan at this time.

7. **System Photos**

C:\Users\tjk1\Dropbox\SUNDA Conglomerate\SUNDA Team\Education and Outreach\Project Specific PR\KEPCo

Financial Details

1. **Business Model/ Ownership**

KEPCo owns the system. The primary motivation for doing this project was member interest, but KEPCo also found that the costs were competitive. Before soliciting bids, KEPCo used the SUNDA cost tool to estimate total project cost and found the results very helpful in early decision making. The SUNDA tool estimated a cost of $2.3 million, whereas the final cost was $2.4 million.

The system was installed behind the meter and offsets a power purchase. KEPCo wanted to see how the levelized cost over the life of project compared to the normal power purchase price. It found a slight cost savings to install the project. Over its expected 25-year life, KEPCo believes the levelized cost of energy will be less than the power purchase cost, especially because it anticipates the power purchase cost to increase. For perspective, this array will provide one-tenth of 1% of its annual energy, so even if the energy was predicted to be more expensive, KEPCo likely still would have done the project.

The system is insured by Federated.

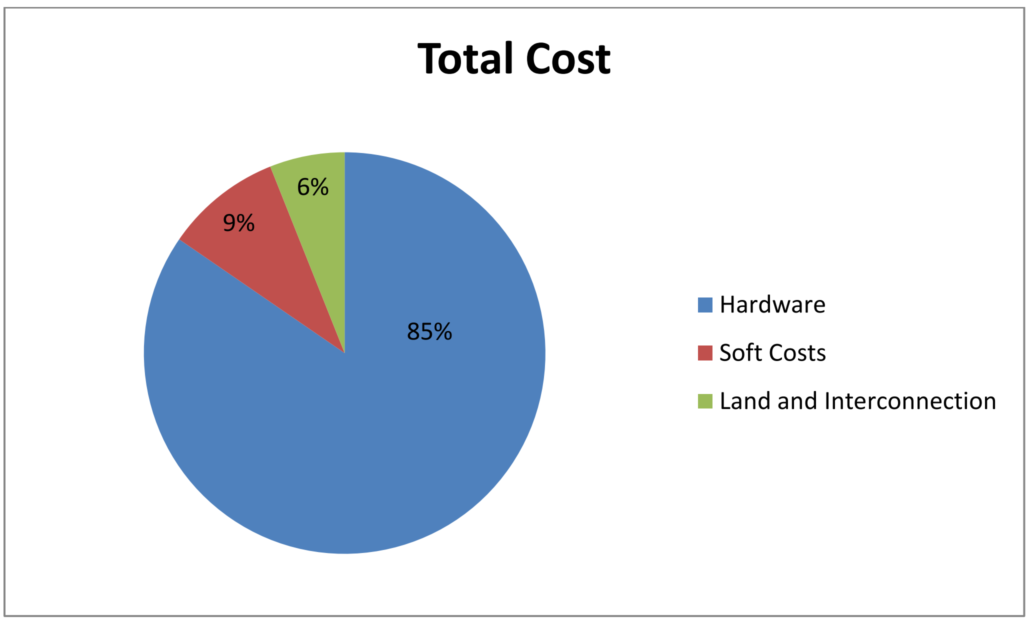
2. **Financing**

KEPCo financed its system using New Clean Renewable Energy Bonds (NCREBs), with NRUCFC as its financing partner. There was a learning curve to find out what each group needed for documentation. KEPCo considered the tax-equity flip but decided the size of the project made the soft costs associated with a flip too high.

3. **System Costs**
    a. **Total Cost:** $2.4 million

    b. **Cost per Watt-DC:** $1.71/Watt-dc

    c. **Chart of Proportional Costs:**



Legal and Regulatory Challenges

KEPCo experienced no significant legal or regulatory challenges with its project. Siting and permitting went very smoothly. It credits this fact to engaging a local attorney with a long history in the area (30+ years) early in the process.

Outreach and Engagement

1. **Community Solar if Applicable**

N/A

2. **Member Engagement**

KEPCo will allocate the RECs associated with its project to its 19 members on a load ratio share basis. It started developing a 100-kWh block marketing plan to roll out to its end-use members, but this program has stalled.

KEPCo's original plan was to work with its membership to roll out a community solar-type program by allocating the RECs associated with its project to the 19 members on a load ratio share basis. It began developing a 100-kWh block marketing plan for those members to roll out to its end-use members; however, the members decided they were not interested in this program. The primary reason is that when split 19 ways, there is not a great deal of solar energy for each member to offer its end-use members. The distribution co-ops still have the option of doing what they want with their share, but so far, no member has set up a community solar program, given the high overhead costs.

The reception of the project has been uniformly positive but tends to come from those segments of the membership that are excited about renewables. Upon request, KEPCo has given tours of the facility to interested groups, including a high school environmental class, local electricians, and engineers.

For public outreach, KEPCo's array was featured in the statewide association magazine. It also hosted a ribbon-cutting ceremony with the governor present, put out a press release, did a radio interview, and set up a public-facing website. Moving forward, it plans to establish a relationship with the local fire department to run safety trainings.

3. **Employee Training, Time Requirements, and Engagement**

KEPCo encountered no surprise staffing challenges in this project because its staff was well prepared and approached this project using project management methods similar to those that have proven successful in the past for KEPCo's large projects.

4. **Board Engagement**

This project developed over a 1- to 2-year period of occasional board informational and educational presentations by both staff and third parties. The board kept up to date on the project as it progressed.

Lessons Learned

- KEPCo purposefully chose to do a fixed-tilt project to keep it simple after deciding it was not ready to dive into a tracking system. For its next system, single-axis tracking will be strongly considered because it reaches maximum production faster and remains at that point longer.
- The existing site has continuous rows, with a 6-inch gap between rows, making it hard to get between them. Each row has a 30-inch clearance off the ground. Future arrays will have a large enough gap for someone to walk through.

- When designing the site layout, KEPCo created an area on the north side of it to store extra equipment and so trucks could drive in, but it is twice as large as needed. Conversely, it did not include a path down the center of the array. In the future, KEPCo would include a 20-foot driving gap to make construction and maintenance easier.
- Its vegetation plan calls for buffalo grass to be planted in non-gravel areas. However, buffalo grass is a warm-season grass that needs 6 hours of light a day. KEPCo is worried there will not be enough sunlight to sustain the grass but is hopeful that it will spread under the panels over time and displace the weeds that were growing there as of summer 2017.
- The best contact for finding out what vegetation to use is the local agricultural extension agent.
- The two biggest questions KEPCo hears from the public are the following:
    1. Q: What about hail? A: Some level of hail will do some damage, but KEPCo has insurance for the array.
    2. Q: What about dust? A: Rain washes it off regularly.
- First-year maintenance is much higher than in future years because of the vegetation management and inverter issues.

Future Plans

KEPCo has no formally approved solar projects but continues to explore options for additional projects, given the competitive cost. It plans to do more work on community solar but there are complications around how to do it in a way that avoids too much overhead on a small amount of capacity. KEPCo is considering doing what GRE, Hoosier, and other G&Ts have done by building a solar array for each member in the 1- to 1.5-MW range. By providing project management and oversight as well as greater scale, KEPCo believe it can secure attractive pricing.

More Information

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http://www.kepco.org/content/prairie-sky-solar-farm

Press Release/News Reports:
http://www.kansas.com/news/business/article138530283.html

https://issuu.com/nationalcountrymarket/docs/kcl0417

Video:
https://www.youtube.com/watch?v=BoyTgYIW6n0

Poudre Valley Rural Electric Association

State: CO
Type: Distribution
Number of Meters: 41,000

Project Summary

Poudre Valley Rural Electric Association, Inc. (PVREA) is a distribution cooperative owned by the members it serves. PVREA was founded in 1939 by its members to provide reliable electricity in Northern Colorado. Today, PVREA covers 2,000 square miles of service territory in Larimer, Weld, and Boulder counties, and more than 4,000 miles of overhead and underground transmission line combined, serving more than 41,000 homes and businesses.

PVREA has several existing solar assets, including community solar, but decided there was enough demand, especially from its low-income members, to install another project. PVREA partnered with GRID Alternatives (GRID) and the Colorado Energy Office (CEO) to build a 1.95-MWp array outside of Fort Collins, Colorado that finished construction in September 2017.

Like many cooperatives, PVREA was driven to develop the Coyote Ridge Community Solar Project by member interest in cost-effective, local solar generation. Through previous third-party community and utility-scale projects, PVREA understood that solar at sufficient scale could be competitive with existing wholesale rates. The desire to develop community solar relationships as a cooperative offering and provide lower-cost options for non-profits and low-to-moderate income members drove PVREA to embrace an owner-operated model. The Coyote Ridge Community Solar project is designed to be accessible for all members, coupled with the bold requirement of being cost neutral (at worst) for PVREA as a whole.

With the community solar framework and its first-ever “in-house” solar project, PVREA certainly encountered challenges. Among the most daunting were the evaluations of financing options, including ensuring that the leaseback model was feasible with its existing taxable subsidiary. During construction, the project team encountered a tremendous challenge in meeting the October 1, 2017 in-service date because of delayed delivery of the racking. When the product was received, additional overtime and hurry-up charges were needed for its EPC (GRID Alternatives). Finally, the bill design for community solar participants proved very complicated. Simply and effectively showing community solar participant cost and value through PVREA’s existing billing structure was cumbersome. Overall, each challenge has presented useful learning opportunities and provided valuable insight for future efforts.

During the course of this project, there were some challenges in procuring the panels and racking system, in part driven by the impending solar tariff and ensuing product shortages. The increasing demand caused by the proposed tariff changed the market dynamics, caused delivery delays, and the discounts and donations previously offered to PVREA were rescinded after project initiation. As the solar market matures, these types of wild swings should decrease and allow easier and more accurate forecasting of project costs.

Background Information

- **Existing Renewable Assets**

PVREA has several existing solar farms and arrays:

Community Solar:

- Highlands Community Solar Farm—a 116-kWp array, 494 panels, built in August 2012; the first community solar farm in Northern Colorado, constructed at PVREA's headquarters
- Willox Solar Farm—a 662-kWp array, completed in partnership with Clean Energy Collective

Non-Community Solar:

- Skylark Solar Facility—6 MWp
- Valley View Solar Facility—4 MWp
- Platte Valley Solar Farm—3.5 MWp

Other:
Carter Lake Hydropower Facility (partial off-taker)

Reasons for Installing Utility Solar Community engagement was a key reason for implementing solar, as well as a desire to serve their entire membership. Community solar was already available to PVREA members, but not as accessible for low- and middle-income members. By working with Grid Alternatives, PVREA was able to build their PV For All facility and program.

Project Timeline

Permitting Began: November 2016
Procurement Began: April 2017
Installation Began: June 2017
Deployment Completed: September 29, 2017

Technical Details

1. **Project Size**

Project Size MWp: 1.95
Project Size MW-AC: 1.5

2. **Equipment Installed**

Modules: Talesun 320-W panels, quantity: 6,102
Inverters: Solectria, 60 kW, quantity: 26
Racking: Solar FlexRack, single-axis tracker
Remote Monitoring: Locus (enhanced monitoring platform, includes wind and snow monitor for protection)

3. Procurement

GRID acted as the project EPC and handled the logistics of procurement, with input from PVREA. PVREA faced two primary challenges during procurement, obtaining its modules and racking. The project was choosing modules right as the solar tariff discussion was emerging in June 2017 around the SolarWorld explanation. This cost PVREA money as module prices rose and an offer was rescinded for equipment discounts and donations due to PVREA's non-profit status. Eventually, PVREA/GRID chose Talisun modules based on their price and availability, and the modules were delivered on time.

After delivery delays with the preferred racking system, FlexRack resolved issues by moving equipment production from abroad to the U.S., assisted in the racking deployment and even provided lunch on several occasions.

All other equipment was delivered on time without notable challenges.

4. Siting and Permitting

PVREA faced several challenges finding the right site for its project. First, the best land (flat, cheap, near load, and with fewer permitting requirements) for solar in PVREA's territory has already been claimed, either by its own previous projects or commercial developers. Second, PVREA is bound by its contract with Tri-State G&T (specifically policies 115 & 117) to ensure that local generation on its distribution lines does not backfeed the transmission system. This means that the array needs to be located close to a sufficient load with greater demand than the solar array's production.

With these limitations in mind, PVREA explored 4 possible sites, all located near different substations. PVREA eventually found 2 unsuitable and moved forward with other 2 sites. PVREA recommends exploring multiple options simultaneously because sites often have issues or problems that are not immediately apparent. It found the cost of "reserving" a site to be low enough to be a useful risk-mitigation strategy. The chosen site is a 20-acre parcel owned by Larimer County just south of the county landfill. The landfill was a good fit because it is located in a high load growth area, and the connecting power lines were upgraded for a landfill gas system that was never constructed. However, the land has a 12% slope and gradual undulations across the landscape that needed to be smoothed over. The landfill actually needed dirt for part of its operations and agreed to scrape away as much as it could from the site. Once the landfill was done reshaping the land, PVREA decided that half the land was suitable for solar, whereas the rest acts a buffer due to its shale slopes.

PVREA signed a long-term 25-year lease with Larimer County that includes options to extend the contract. As a sign of good faith, PVREA pre-paid the lease as well. Once the land was acquired, PVREA had to get a 1041 permit to build its array because the project would cover more than 5 acres (in other counties, the requirement is only for projects greater than 240 MW). The 1041 is a Colorado-specific permitting process that grants local governments immense leeway in deciding what requirements building projects must meet. It is the same permitting process that coal-fired power plants must go through and can be a very costly and lengthy ordeal. Fortunately, Larimer County understood the hardship, and the landfill had already performed all the required studies on the land for its own permit.

With GRID's help, PVREA was able to find how its project would fit within the parameters set by the landfill studies and get the 100-page permit application approved by the planning commission. PVREA also negotiated with the landfill in advance so the lease was contingent upon its application being approved. Even with the studies already completed, it took PVREA 6 months from starting the permit approval process to receiving final approval.

5. Building and Operating Lessons Learned

PVREA's project was unique for involving a specific low- to moderate-income (LMI) component. As part of this, the array was completed as a partnership between 3 different organizations. Each of the 3 project partners played a distinct role in the project:

- Colorado Energy Office (CEO): Partial funding organization and project oversight
- GRID Alternatives (GRID): LMI program design, EPC, workforce training program, and O&M
- PVREA: Financing, land acquisition and siting, interconnection, billing, subscription management, and outreach

GRID was initially brought in to lead the LMI program, but also won PVREA's competitive bid process to act as the EPC as well.

The landfill leasing PVREA land for the project did the initial site prep to level the land by removing as much dirt as possible. This meant that the piles needed to be drilled because all of the dirt down to the shale was gone. The hard shale also made it difficult to build trenches for wiring, so PVREA decided to hang them above the ground instead. This will make mowing more challenging and rules out sheep or goats for vegetation management, but was the fastest method to install the system.

Due to the multiple actors involved in the project there was occasionally confusion between PVREA and GRID as to which partner was responsible for what roles. For example, PVREA bought an ERMCO transformer that GRID ended up installing.

During construction, PVREA used a community development barn-raising model to encourage more than 300 volunteers and future-subscribers to help install the system. There are no official incentives provided for volunteers outside of feel-good community participation. In fact, there was often a challenge of finding work for the overabundance of volunteers who appeared at the worksite. In addition to rounding up volunteers, GRID runs a robust intern and AmeriCorps program that provides participants with NABCEM hours and real-world installation experience. PVREA is unsure of how much it saved from using volunteer labor, but was immensely pleased by the intangible benefits, such as the community and member engagement the project provided. According to Jeff Wadsworth, CEO of PVREA, the time spent working together on the solar array was one of the best team-building experiences PVREA has ever had.

The biggest building challenge PVREA faced was the procurement delay for the FlexRack equipment. Per their agreement with Tri-State, PVREA needed to energize the system by October 1, 2017, which it was able to do, thanks in no small measure to the army of volunteers that were mobilized through GRID and from PVREA staff..

The array uses a single-axis tracking system. PVREA found that for its area the additional energy generation from a tracking system made financial sense.

PVREA signed a 6-year contract with GRID for all of the array's O&M needs. There are many O&M providers in Northern Colorado, but one of GRID's strong components is workforce development, so GRID is willing to train PVREA to take care of some problems.

6. Other Technical Details

a. **System Impact Analysis**

PVREA was required to perform a system impact analysis per its agreement with Tri-State to not backfeed any of the connected substations. PVREA hired a third-party consulting firm to perform the work. Their analysis (using Milsoft/WindMil) found that the system will stay within the limits requested by Tri-State. PVREA can also trip the system offline in the event of backfeeding.

b. **System End-of-Life Plan if Applicable**

PVREA has no formal system end-of-life plan at this point. As of October 2017 it started a 20-year contract with Tri-State and expects that there will still be some value to the system and its components in years 20–25. At the end of its useful life, the equipment will be removed from the site and disposed of responsibly.

7. System Photos

https://www.flickr.com/photos/gridalternatives/36029150160/in/album-72157687304206185/
https://www.flickr.com/photos/gridalternatives/36380633986/in/album-72157687304206185/

Financial Details

1. Business Model/ Ownership

The system is owned by Farm Credit Leasing (CoBank) for the next 12 years. At that point, PVREA has the option to continue leasing the array or buy it outright from CoBank. CoBank is not involved in the management of the solar array as long as PVREA continues to pay. The assets are operated by PVREA's wholly owned subsidiary, Poudre Valley Associate Services (PVAS).

Per PVREA's 115 contract with Tri-State, there is a revenue grade meter at the site that meters all of the production from the array. This energy is purchased by Tri-State for a set rate. Then, at the nearby substation, PVREA buys back an equivalent amount of energy from Tri-State. PVREA benefits from this arrangement because the current buyback rate is lower than the selling rate; Tri-State receives the RECs.

PVREA kept the project cash positive by including non-profits and middle- to upper-income members as community solar participants. The project is structured such that PVREA does not need to sell to community solar shares to make the project economically viable.

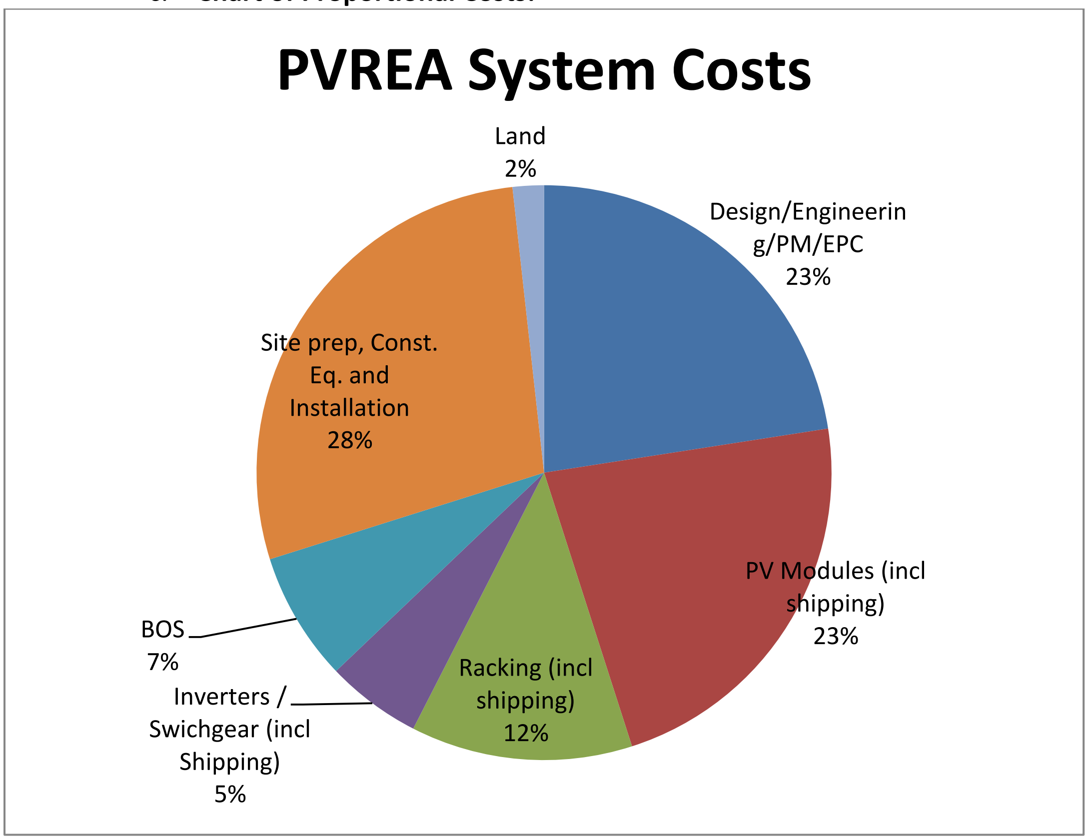
2. Financing

PVREA explored numerous financing options, including tax-equity flip, tax advantage lease, leaseback, direct loan, and Clean Renewable Energy Bonds (CREBs). It eventually chose to do a leaseback with CoBank for a 12-year term. CoBank acted as the tax-equity investor and utilized both the ITC and Modified Accelerated Cost Recovery System (MACRS) tax benefits. In addition to the tax benefits, PVREA received a $200K grant from the Colorado Energy Office to offset costs for the low-income portion of the project that was not eligible for the tax credits. Determining eligibility for various project expenses adds complexity, but PVREA decided the extra work was well worth the benefit.

3. **System Costs**
    a. **Total Cost:** $3,275,000

    b. **Cost per Watt-DC:** $1.68

    c. **Chart of Proportional Costs:**



Legal and Regulatory Challenges

In addition to the usual stress of signing contracts for a large project, PVREA had a few special areas of consideration. Tri-State recently changed its 115 payment policy regarding member generation and PVREA. Over the summer of 2016 Tri-State lowered the compensation for distributed generation and renewable energy credits to bring them in line with the falling DG costs.

As part of its 1041 permit under Colorado law, PVREA was required to contact all neighbors of the site about the impending construction and solar array. The neighbors were very supportive, and PVREA went beyond its legal mandate to inform all of the residents in the surrounding area.

PVREA was able to avoid wildlife impact studies and challenges to the project because the landfill had already done extensive surveys of the area. However, PVREA will spend a fair amount of money on land reclamation.

Outreach and Engagement

1. **Community Solar if Applicable**

The Coyote Ridge Community Solar Farm is PVREA's third community solar array. The first two were developed in partnership with the Clean Energy Collective (CEC) and are fully subscribed. For members wishing to participate in the Coyote Ridge array, there are 3 programs, depending on member status, with a maximum allocation for each:

1. Residential members—750 kW
2. Low-income members—700 kW
3. Non-profit organizations—500 kW

The allocations will ensure that each group has an opportunity to participate, and the participation structure varies for each group:

Residential Members, myLocal Solar:

- Members pay an initial fee of $48/panel and then an ongoing subscription fee of $3.55/panel; however, there is a minimum 3-panel subscription rule.
- Members' subscriptions can be sized up to 120% of their annual energy usage, or 25 kW per account, whichever is less.
- Members pay for their solar panel subscriptions directly on their electric bill each month throughout the life of the 20-year project.
- All members still pay the monthly facilities charge to cover the cost of having 24/7 electricity available at their home and/or business.
- Members may also purchase their solar panel subscription with a one-time payment of $852 (includes the initial panel fee).
- The panels will generate 450–475 kWh per panel per year, declining at approximately 0.5% per year. Members' subscription credits are credited to each month's bill at the retail rate and will fluctuate as the retail rate changes.
- The payback period is estimated to be 12 years, but will vary depending on the retail rate.

Low-Income Members, PV for All:

- This program is designed to be revenue positive for participants, with no out-of-pocket costs and a guarantee that the bill will not increase due to participation.
- Eligibility is based on income guidelines by county and household size.

- The program is estimated to save participants 30% on the energy portion of their bill (does not include fixed costs).
- Participants pay 70% of the retail rate for energy provided from the solar array up to a cap, currently set at 5 kW-AC worth of panels.
- The program will first seek out eligible participants who have already done weatherization.

Non-Profits

- The program structure is similar to that of residential members, but the initial fee is $16/panel.
- The program will be invitation only.
- The goal is to reach community-oriented non-profits, such as to fire departments, children's homes, schools, and others.
- Participation is capped at 25 kW per organization, not by meter.

PVREA has marketed its community solar offerings only through its website and on one bill insert. So far, most of the sign-ups have come from actively engaged individuals looking for community solar and word of mouth. Moving forward, PVREA will discuss this project at more public events with the goal of full subscription.

Billing has been a large time drain. PVREA's solution so far has been to work with its billing provider, NISC, to change some language on bill. The co-op is still actively working on a solution to make the system production more tangible for members.

2. Member Engagement

The solar array has already provided numerous opportunities for community engagement. By far the most successful and well-attended has been the volunteer construction and installation described earlier. In addition, PVREA is operating tours as requested, and invited media, dignitaries, and industry experts for a ribbon-cutting celebration. In 2018 it plans to partner with the landfill to develop an energy module for the landfill's existing educational classroom.

3. Employee Training, Time Requirements, and Engagement

There was significant employee engagement in this project. Collectively, PVREA employees volunteered more than 140 hours to build the system, including two 4-hour shifts composed entirely of staff. The member service reps (MSRs) have enthusiastically embraced this project and are helping to steer members who meet the eligibility requirements to the PV for All program when they call in.

4. Board Engagement

PVREA's board was engaged throughout the project, from approving the initial 115 contract applications to supporting the idea and plan for an LMI and non-profit carve-out for the community solar array.

Lessons Learned

- Single-axis trackers have reached a cost point at which they make financial sense for most large-scale PV arrays.[19]
- Finding a suitable location that meets the necessary physical characteristics as well as being easy to interconnect is very difficult. The permitting process should be considered early in the land acquisition process as well.
- Offering solar programs to low-income members is still dependent on external grant funding.
- Equipment procurement can cause considerable delays.
- Be sure to consider multiple financing options. The modeled cost of the project varied dramatically across the different options.
- By combining different customer offerings into one array, PVREA was able to take advantage of economies of scale.
- Leave adequate time for siting. Taking an option on a site is cheap insurance to ensure the co-op has alternatives if the preferred land deal falls through.
- The co-op should be sure to address why it is building a solar array before any other work starts. Find the driving reason for the project and then build it to fit that need (community engagement, hedge against rising prices, low-income outreach, etc.)
- After the project is complete, schedule time for a post-op discussion on what went well, what the co-op would do differently in future projects—this is especially helpful for cross-departmental collaboration.
- Explore additional value-adds. Community solar could easily be paired with weatherization, water heaters, smart thermostats, or other consumer-centric programs.

Future Plans

PVREA is continuing to monitor for cost-effective renewables projects and additional methods of helping low-income members, such as encouraging energy efficiency along with solar program participation. It also has the necessary permitting for a Phase II deployment at Coyote Ridge if it wishes to add more capacity.

More Information

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[19] https://www.cooperative.com/interest-areas/crn/research-topics/documents/tech_advisory__tracking_and_pv.pdf

https://www.pvrea.com/mylocalsolar
https://www.pvrea.com/pvforall

Press Release/News Reports:

- https://pv-magazine-usa.com/2017/08/11/colorado-to-build-the-nations-largest-low-income-community-solar-project/
- https://cleantechnica.com/2017/08/14/colorado-co-op-develop-countrys-largest-low-income-community-solar-project/
- https://gridalternatives.org/regions/colorado/news/major-win-solar-access

Video:
https://www.youtube.com/watch?v=pi8ExD26TPs

Other participating co-ops

Central Electric Cooperative (South Carolina)

Central Electric decided to opt out of formal participation in SUNDA. Instead, it constructed the Colleton Solar Farm, a 3.0-MWp-DC/2.5-MW-AC test facility, with 60% of the modules mounted as fixed tilt and 40% mounted on a single axis tracker. The co-op continues to evaluate further opportunities with solar.

Maquoketa Valley Electric Cooperative (Iowa)

After a careful consideration, Maquoketa's board decided that it was not yet ready to participate in SUNDA.

Oneida-Madison Electric Cooperative (New York)

Oneida Madison continues to work with its members, including a local university, to find a site and an appropriate business case for a small (0.25 MW) PV system, but has not yet found the right opportunity. Oneida Madison receives most of its generation through the wholesale purchase of extremely low-cost hydro power, which creates feasibility challenges when low-cost renewable resources are evaluated within the context of scenarios involving other such resources. Oneida Madison has been an active participant in SUNDA, continues to evaluate options for local PV and energy storage systems, and has helped define and resolve some of the challenges facing smaller (2,000 members and less) co-ops in planning solar projects.

Owen Electric Cooperative (Kentucky)

Owen originally intended to build a community solar project and looked at several locations, settling on a 3-acre site at its headquarters property. It had RFP prices on projects of different sizes, ranging from 30 kW to 500 kW. However, eventually the 10-MW EKPC project was a much lower-cost option (due to economies of scale) for its members and was its selection moving forward. Owen was an active participant and its partnership with East Kentucky helped show a way for distribution co-ops and G&Ts to work together on larger-scale solar projects.

Pedernales Electric Cooperative (Texas)

Pedernales evaluated many different options before eventually deciding to implement PPAs on a number of modest-sized arrays (0.98 kWp-DC) rather than a single larger system. These systems were not installed in time to fit into the SUNDA project, but it participated actively in early stages of the project.

Plumas-Sierra Rural Electric Cooperative (California)

Plumas-Sierra was very involved in planning a 2-MW solar project at Sierra Army Depot and was interested in being part of the SUNDA project. Unfortunately, the Army's schedule was not conducive to completing during the project, though it is due to come online in 2018 and will be a 250-kW community solar array.

Sandhills Utility Services (North Carolina)

Sandhills has a power contract to support the utility grid at Fort Bragg in North Carolina and has been an active participant in SUNDA. It plans to build a multi-megawatt PV system on the base, but the project has been held up due to various issues. The base is also now looking at expanded PV and energy storage for a microgrid.

Tri-State Generation & Transmission Assn. (Colorado)

Tri-State did not formally participate in the SUNDA project but has continued to support large-scale arrays (25- and 30-MW projects), and its distribution co-ops continue to invest heavily in solar, including PVREA, which actively participated in the SUNDA project.

Vermont Electric Cooperative (Vermont)

VEC was an active participant in the project, but after rigorous evaluation eventually decided to go with PPAs for its 5 MW of solar projects, which means its installations could not be formally counted toward the SUNDA project.

Appendix 2: Training and Outreach Activities

Training

Event Type	Training Session	Location	Date	Audience & Attendance
SUNDA Kickoff Meeting	*Orientation to SUNDA project, technical training, and site visit*	NRECA	11/19–11/20/13	SUNDA Team
TechAdvantage	*Standardized Engineering Designs*	Nashville, TN	3/3/14	Co-op technical staff
TechAdvantage	*Volume Purchasing*	Nashville, TN	3/3/14	Co-op technical staff
TechAdvantage	*Business Models and Financing Options*	Nashville, TN	3/3/14	Co-op technical staff
Webinar	*State of the Solar Market: Knowing the Facts and Understanding the Trends*	Online	6/3/14	Co-op CEOs, CFOs, engineers 170
Webinar	*Technical Workshop on Residential & Utility-Scale Solar Trends*	Online	7/16/14	Co-op staff 197
Webinar	*The Business of Solar: Owning Utility-Scale PV*	Online	7/23/14	Co-op CEOs, CFOs, project managers 78
NRECA's Accounting, Finance, and Tax	*SUNDA Session on Business Models and Financial Structures*	Miami, FL	7/24/14	Co-op finance staff
NRECA's Innovative Power Summit	*Solar PV Business Models—How to Become Engaged from a Business Perspective (presentation plus a five-hour pre-conference workshop)*	Indianapolis, IN	10/28–10/29/14	Co-op leaders
Webinar	*How Co-ops Are Implementing Community Solar Projects*	Online	12/15/14	Co-op staff 46
SUNDA Team Meeting	*Technical training and collaborative session*	Tech Advantage	2/23/15	SUNDA Team
TechAdvantage	*PV Any Way it Comes at You!*	Orlando, FL	2/24–2/26/15	Co-op staff
TechAdvantage	*Solar PV Engineering and Business Models*	Orlando, FL	2/24–2/26/15	Co-op staff

TechAdvantage	*Solar Procurement at Your Co-op*	Orlando, FL	2/24–2/26/15	Co-op staff
TechAdvantage	*Ongoing live demos of the Cost and Finance Screening Tool*	Orlando, FL	2/24–2/26/15	Co-op staff
Webinar	*Tools for Utility-Scale PV at Your Co-op*	Online	3/31/15	Co-op leaders 429
NRECA's Directors Conference	*SUNDA Tools*	Reno, NV	3/31/15	Co-op board members 100
SEPA's Utility Solar Conference	*PV Ramping, Best Practices for Financing Co-op Projects and Planning Projects*	San Diego, CA	4/27–4/29/15	Industry
New Course for Co-op Board Members	*Communicating the New Energy Landscape (to be repeated regularly)*	Multiple locations across the country	6/1/15 to present	Co-op board members 30 (Jun15) + 259 (Sep15) + 390 (Dec15) + 257 (Mar16) + 700 (Aug)
Webinar	*Structure Your Solar Strategy with Help from Co-op Nation*	Online	6/25/15	Co-op staff 319
New Course for Co-op Board Members Certificate	*Strategic Technologies and their Impact on the Cooperative*	Multiple locations across the country	9/15 to present	Co-op board members 117 (Sep15) + 439 (Dec15) + 377 (Mar16) + 700 (Aug)
Co-op Finance Professional Certificate Program Training	*SUNDA Overview, Cost and Finance Screening Tool*	NRECA	7/9/15	Co-op finance staff
NRECA's Renewable and Distributed Energy Member Advisory Group	*SUNDA Overview and Community Solar Playbook work session*		7/20/15	Co-op technical staff 20
NRECA's Tax, Accounting, and Finance Conference	*SUNDA Overview, Cost and Finance Screening Tool*	Denver, CO	8/3–8/4/15	Co-op finance staff
Webinar	*Cooperative Experiences with Community Solar Webinar*	Online	8/13/15	Co-op staff 562
Webinar	*Best Practices for Communicating Your Community Solar Projects with Members*	Online	8/10/15	Co-op communicators 276
Solar Power International	*Electric Co-ops and Solar: Survey Results, Modeling Tools, and the*	Anaheim, CA	9/17/15	Industry

	SUNDA Project			
Solar Power International	*Half-day, post-conference workshop on SUNDA Tools*	Anaheim, CA	9/18/15	Industry
NRECA Co-op University	*Utility-Owned PV: How to Efficiently Plan, Implement, and Maintain 250kW–5MW Systems*	San Antonio, TX	10/20/15	Engineers, project managers 24
Webinar	*Utility-Owned PV: How to Efficiently Plan, Implement, and Maintain 250kW–5MW Systems*	Online	12/3/15	Engineers, project managers 25
SUNDA Mid-Project Review	*Review of recently completed deployments and planning for remainder of project*	Corinth, TX	1/20–1/21/16	SUNDA Team + invited co-ops 30
TechAdvantage Conference	*DER Resources: Planning, Implementing, & Maintaining Utility-Scale PV*	New Orleans, LA	2/15/16	Engineers, project managers 25
Annual Meeting	*Co-op Solar Strategies Why Now What's Next*	New Orleans, LA	2/15/16	CEOs, board members, engineers 1,000+
Annual Meeting	*Co-op Solar Strategies Why Now What's Next*	New Orleans, LA	2/16/16	CEOs, board members, Engineers 1,000+
CEO Close-Up	*Planning and Implementing Community Solar by NRECA and Clean Energy Collective*	Tucson, AZ	01/10–12/16	Co-op CEOs 50
SUNDA Team Meeting	*Mid-Project Review*	Corinth, TX	1/20 to 1/21/16	SUNDA Team
NRECA's Directors Conference	*Solar: How Do We Decide What's Right for Our Co-op? (Two sessions)*	Austin, TX	04/3–4/16	Co-op board members 50/session
NRECA's CONNECT Conference for co-op communicators	*Building a Communications Plan for Solar*	Portland, OR	5/11/16	Co-op communicators 100
Webinar	*Converting PV into Community Solar*	Online	11/7/16	Co-op staff 128
SUNDA Team Meeting	*Lessons Learned from recent deployments and remaining plans*	Murfreesboro, TN	11/10/16	SUNDA participants 24
CEO Close-Up Solar Interest Group	*SUNDA co-op CEOs share deployment experiences*	Fort Lauderdale, FL	1/10/17	Co-op CEOs
Solar Interest Group	*SUNDA co-ops led discussion with representatives from co-ops that had not yet started deployments*	Conference call	1/23/17	Co-op leaders 10
NRECA's 2017 TechAdvantage	*SUNDA co-ops led roundtable discussion on utility-scale, utility-*	San Diego, CA	2/26/17	Co-op CEOs and engineers

Utility Solar Interest Group	*owned solar deployments*			22
SUNDA Interest Group	*SUNDA co-ops led discussion with representatives from co-ops that had not yet started deployments*	Conference call	3/29/17	Co-op CEOs, CFOs, and engineers 15
NRECA's Directors Conference	*SUNDA Interest Group: SUNDA Co-ops led discussion with co-op board members from around the country*	Tampa, FL	4/4/17	Co-op board members 150
SEPA Utility Conference	*Community Solar 2.0–How Do You Make a Good Thing Better*	Tucson, AZ	4/25/17	Industry
IEEE Rural Electric Power Conference	*Does a PV Tracking System Make Sense for Co-ops?*	Columbus, OH	4/25/17	Co-ops and industry
Solar Interest Group	*Community solar lessons, opportunities, and challenges*	Tampa, FL	5/3/17	Co-op communicators
Solar Interest Group	*SUNDA co-op representatives led a discussion with co-ops that are looking at solar options*	Conference call	5/24/17	Co-op CEOs and engineers 9
Course	*DER Resources: Planning, Implementing, and Operating Utility-Scale PV*	Arkansas statewide association	6/26–6/27/17	Arkansas co-op engineers
Webinar	*Ag-Friendly Solar & Benefits of PV Tracking*	Online	11/30/17	Co-op staff
NRECA's 2018 TechAdvantage	*Energy storage lunch, building on the success of SUNDA*	Nashville, TN	2/26/18	Select group of co-ops interested in energy storage and SUNDA 24
NRECA's 2018 TechAdvantage	*Does a PV Tracking System Make Sense for Co-ops?*	Nashville, TN	2/28/18	Co-op technical staff

Outreach Activities

Session	Event	Date	Audience # of Attendees
SUNDA and NRECA Solar Updates	CEATI's working group on Strategic Options for Sustainable Generation	5/5/14	Utility leaders 25
SUNDA and NRECA Solar Updates	NRECA's CONNECT Conference	5/14/14	Co-op communicators 110
SUNDA and NRECA Solar Updates	NRECA's Haiti Project Meeting with UN Environmental Program and IADB reps	6/25/14	Team members 10
SUNDA and NRECA Solar	Georgia Statewide Mtg	8/14/14	Co-op leadership

Updates			400
SUNDA and NRECA Solar Updates	Minnesota Statewide Mtg	9/4/14	Co-op CEOs 35
SUNDA and NRECA Solar Updates	Oklahoma Statewide Mtg	9/22/14	Co-op leaders and key account reps 400
SUNDA and NRECA Solar Updates	Pennsylvania Statewide Mtg	10/6/14	Co-op CEOs 20
SUNDA and NRECA Solar Updates	Energy and Economic Growth Initiative – Executive Planning Meeting	10/9–10/10/14	Industry 20
SUNDA and NRECA Solar Updates	Cooperative Resource Planners Association Mtg	10/16–10/17/14	Co-op resource planners 100
SUNDA and NRECA Solar Updates	Women's Council on Energy and the Environment	11/6/14	Industry 20
SUNDA and NRECA Solar Updates	Arkansas Statewide Engineering & Ops Workshop	12/4/14	Engineers and operators 100
SUNDA and NRECA Solar Updates	PowerGen International	12/10/14	Industry 60
Trends and economics of the solar industry	South Dakota REA	1/15 & 1/16/15	Co-op directors and employees 300
SUNDA project and lessons learned to date	Call with Council of Independent Colleges in VA	2/12/15	CICV 4
Integrating Renewables and SUNDA Overview	Oklahoma Association of Electric Co-ops Statewide meeting	4/23/15	Co-op communicators 25
PV Ramping, Financing Options, New Markets for Solar	SEPA's 2015 Utility Solar Conference	4/27–4/29/15	Industry
Current and Emerging Technologies	Alaska Center for Energy and Power Solar Energy Workshop	4/30/15	Industry 75
Statewide Goals and Policies for PV	South Carolina Statewide Strategic Planning Session	5/4/15	Co-op leaders
Strategic planning session on developing solar strategies	Habersham MEC Board Meeting	5/13/15	Board members
Roundtable discussion on community solar—input for Communicators' Toolkit	NRECA's CONNECT	5/14/15	Co-op communicators 20
SUNDA project and lessons learned to date	CEATI's Strategic Options for Integrating Emerging Technologies	5/14–5/15/15	Industry

Solar 101	NRECA's Summer Intern Education Program	5/21/15	NRECA interns 20
Strategic Planning Session on PV	Iowa Statewide Meeting	6/8/15	Iowa co-op leaders
SUNDA Tools	Dairyland Power Cooperative Solar Workshop	6/18/15	Co-op leaders 40
SUNDA Poster Session	Solar 2015 Conference, American Solar Energy Society at Penn State	7/28–7/30/15	Industry
SUNDA Poster Session	Solar Power International	9/14–9/17/15	Industry
Solar and Energy Storage	Nebraska Wind and Solar Conference	11/4–11/5/15	Co-ops
Solar in the cooperative world and its future role	PowerSouth Fall Focus, Florida	11/11–11/13/15	PowerSouth (G&T) members
Utility-Scale Integration of Solar and SUNDA Lessons Learned	POWER-GEN International	12/8–12/10/15	Industry
Communicator's Toolkit and NRECA tools to support co-op solar Information Table	NRECA Showcase at orientation for new co-op communicators	4/6/16	Co-op communicators
Managing the Age Gap (tied in SUNDA)	Michigan Cooperative Engineering & Operations Workshop	4/20/16	Michigan co-ops
NRECA Industry Update (tied in SUNDA)	CEATI SOIG	4/28–4/29/16	Utilities in N. America
Solar Tools and Community Solar Information Table	CFC Forum	6/6–6/8/16	Co-ops
Exposure of SUNDA & cooperative progress on energy efficiency and renewables	EESI Expo 2016	7/12/16	Capitol Hill staff and attendees
Engineering and Operations Conference	Tennessee Electric Cooperative Association (TECA)	7/28–7/29/16	Co-ops in Tennessee
Poster Session Cooperative Solar: Home-Grown, Consumer-Owned	2016 Solar Power International in Las Vegas, NV	9/13/16	Industry
Cooperative Solar: Home-Grown, Consumer-Owned	2016 Solar Power International in Las Vegas, NV	9/13/16	Industry
A Solar Perspective, Cooperatively Speaking	Women's International Network of Utility Professionals (WinUP)	10/10/16	Industry 500
Co-op Solar	Oklahoma Statewide Meeting	11/3/16	Co-op communicators and member services

			staff 50
Overview of NRECA's BTS portfolio, including SUNDA	PowerGen International	11/13/16	Industry
SUNDA overview, progress, and updates	NRECA Board of Directors Meeting	12/6/16	NRECA board members
SUNDA overview and tools for communicators	G&T Communicators' Conference in Florida	1/18/17	G&T communicators
Discussions with Walmart staff to discuss C&I co-op collaboration	NRECA's Net Conference in San Diego, CA	1/30/17–2/1/17	Meeting
Update on SUNDA project	NRECA's Transmission and Distribution Member Advisory Group (MAG) in Spokane, WA	2/8/17	MAG members 15
SUNDA project overview	NRECA Conference Call to Co-op Statewide Associations	2/15/17	Statewide staff 15
SUNDA overview, Q&A session	NRECA's New Co-op Communicators' Showcase	3/15/17	New co-op communicators 50
Solar business models and the SUNDA toolset	Iowa Statewide Conference	4/11/17	Iowa co-op managers and board members
SUNDA and pathways to energy storage	Energy Storage Association Annual Meeting in Denver, CO	4/19/17	Industry
SUNDA project and tools	VA, MD, DE Association's E&O Conference	5/4/17	VA, MD, DE co-ops
SUNDA project and tools	Network for Energy, Water and Affordable Buildings and Energy Efficiency for All Conference in New Orleans	5/24/17	Industry
SUNDA project and tools	Community Solar Value Project Workshop in Golden, CO	6/17–/18/17	Industry 50
America's Electric Co-ops and Solar	National Conference of State Legislators and the National Association of State Energy Officers in San Antonio, TX	6/9–6/10/17	Legislators, legislative staff members, state energy officials 46
Solar PV Implementation: Plans & Lessons Learned in the Co-op World	NRECA's AREGC Conference in La Crosse, WI	6/21/17	G&T staff
SUNDA project and tools	NRECA's Generation, Environment and CO2 MAG in La Crosse, WI	6/21/17	MAG members 20
SUNDA project and tools	EUCI's Community Solar for Utilities	6/26 to	Industry

	in Charleston, SC	6/27/17	
SUNDA update	NRECA's Business and Technology Strategies Board Committee	6/27/17	NRECA board members
SUNDA project and related updates	Distributed Energy Resources MAG	7/18/17	MAG members 24
Panel discussion on community solar	First Annual Community Solar Access for All (CCSA) Summit	7/26–7/28/17	Industry 75
SUNDA project and tools	Central Electric Cooperative's R2E2 (Renewable Resources and Energy Efficiency) Summit	8/8/17	Co-ops
Solar Focus Group	VA, MD, DE Association for Electric Cooperatives	8/22/17	Staff from 7 co-ops
SUNDA project and tools	OK Statewide Manager's Meeting	8/30/17	CEOs, OK co-ops
SUNDA project and tools	MN Energy Fair in St. Paul, MN	9/9–9/10/17	Industry
Poster Session: 1. Cooperative Solar, Home Grown, Consumer-Owned Update and 2. Does Tracking Make Sense for Co-op PV Systems	Solar Power International in Las Vegas, NV	9/11/17	Industry
SUNDA project and tools	NRECA's New Co-op Communicators' Orientation in Arlington, VA	9/27/17	New co-op communicators 60
SUNDA video highlighting the project, team, and DOE support	NRECA Regional meetings in PA, MN, TN, CO, and AZ	Sept and Oct 2017	Co-op board members
SUNDA included in overview of NRECA's Business and Technology Strategies' activities	Nebraska Statewide Meeting	Jan 2018	Co-ops in Nebraska
SUNDA	NRECA Town Hall	3/17/18	NRECA Arlington, VA and Lincoln, NB staff

Coverage in NRECA Publications

Article	Publication	Date
"State of Change, A Dozen Key Developments that Are Transforming the Way Co-ops Operate"	RE Magazine	Dec 2014

“Overcoming Solar Barriers”	RE Magazine	Feb 2015
“How-to Guides for Co-ops Pursuing Solar”	ECT	2/27/15
“SUNDA Drive: Co-op Participants in DOE Solar Project Draw Power from Nationwide Collaboration”	RE Magazine	Apr 2015
“Going Solar: Options for Co-ops Committed to Harnessing the Sun”	RE Magazine	Jun 2015
“How Much Will Solar Power Cost You?”	ECT	7/20/15
“SUNDA Project Resources Paved the Way for CoServ’s Utility-Scale PV Array”	RE Magazine	Aug 2015
“Co-ops Warned of Potential Solar Panel Delays”	ECT	Oct 2015
"TechAdvantage at 2016 NRECA Annual Meeting"	ECT	Feb 2016
"Great River Energy Developing Utility-Grade Solar"	ECT	Feb 2016
"Community Solar to Meet Member Demand	ECT	Feb 2016
"TechAdvisory: Extension of Solar and Wind ITC"	ECT	Apr 2016
"Report Sees Falling Solar, Wind Prices"	ECT	Jun 2016
“Community Solar Playbook, Modules 1-5”	Cooperative.com	Jul 2016
“Solar Fact Sheet Update”	Cooperative.com	Sep 2016
“Cooperative Solar Skyrockets”	Press Release	3/9/17
“Technology Advisory: Does Tracking Make Sense for Co-op PV Systems?”	Cooperative.com	Jul 2017
“Co-ops Have a Solar Success Story, Energy Department Says”	RE Magazine	Jul 2017
“Going Big on Solar: G&Ts Put Their Weight Behind the Demand for Renewables”	RE Magazine	Aug 2017

Coverage in External Publications

Article	Publication	Date	Summary
How Pepco and Rural Electric Co-ops Are Preparing for Grid Solutions for Solar	Utility Dive http://www.utilitydive.com/news/how-pepco-and-rural-electric-co-ops-are-preparing-grid-solutions-for-solar/276261/	7/20/14	Highlights SUNRISE funding and NRECA’s leadership of the SUNDA project.
Cheap Comes to Wisconsin	GreenTechMedia http://www.greentechmedia.com/articles/read/cheap-solar-comes-to-wisconsin	10/13/15	Article highlights the SUNDA project at Eau Claire Energy Cooperative.
Public Power and Rural Electric Leadership on Community Solar	Consumer Federation of America http://consumerfed.org/wp-content/uploads/2016/04/Community-Solar-Energy-White-Paper-4-15-16.pdf	4/15/16	Report that recognizes electric co-ops as leaders in developing community solar for consumers for

Initiatives			whom rooftop solar is not feasible.
The SunShot Story: Challenging the Solar Industry to Say 'What If' Since 2011	DOE http://energy.gov/eere/articles/sunshot-story-challenging-solar-industry-say-what-if-2011	5/8/16	SUNDA highlighted as one of SunShot's successful projects in an article discussing how SunShot has advanced the solar industry.
Unlocking the Value of Community Solar: Utilities Find Opportunity in the Inevitable Growth of Distributed Energy	Deloitte http://www2.deloitte.com/us/en/pages/energy-and-resources/articles/community-solar-market-renewable-energy-trends.html?id=us:2em:3na:comsolar:awa:er:032216	March 2016	The SUNDA Team contributed significantly to this article, which highlights the leadership role co-ops are playing in community solar.
Utilities See Growing Opportunity in the Community Solar Market	GreenTech Media http://www.greentechmedia.com/articles/read/utilities-see-growing-opportunity-in-the-community-solar-market	3/21/16	Article about the Deloitte report.
Why this New Solar Market Could Be Set to Explode	Washington Post https://www.washingtonpost.com/news/energy-environment/wp/2016/03/24/why-this-new-solar-market-could-be-set-to-explode/	3/24/16	References the Deloitte report and highlights a co-op in MN.
Green Power EMC Named 2016 Solar Power Player Co-op Utility of the Year	Utility Dive https://www.utilitydive.com/press-release/20160915-green-power-emc-named-2016-solar-power-player-co-op-utility-of-the-year/	9/15/16	Honors Green Power EMC for its comprehensive solar strategy, which included multiple SUNDA deployments at its members' distribution co-ops.
Soaking Up Some Solar: Kansas Power Cooperative Takes Dive into Solar Energy	The Topeka Capital Journal http://www.cjonline.com/news/business/2017-03-10/soaking-some-solar-kansas-power-cooperative-takes-dive-solar-energy	3/10/17	Highlights the SUNDA deployment at Kansas Electric Power Cooperative, Inc.
EERE Success Story—Electric Cooperatives Channel Solar Resources to Rural American	Department of Energy, Office of Energy Efficiency & Renewable Energy https://www.energy.gov/eere/success-stories/articles/eere-success-story-electric-cooperatives-channel-solar-resources-rural	3/14/17	Highlights the success of the SUNDA project.

Communities			
A Small Cooperative Moves to Solar Energy	Northwest Public Power Association's Bulletin https://www.nwppa.org/wp-content/uploads/Bulletin_August_2017_WEB.pdf	August 2017	Highlights the SUNDA deployment at Anza Electric Cooperative in CA.
Hit Me with Your SunShot Photo Contest Winners Announced	Department of Energy, Office of Energy Efficiency & Renewable Energy https://energy.gov/eere/sunshot/articles/hit-me-your-sunshot-photo-contest-winners-announced	9/11/17	CoServ's drone view shot of its SUNDA deployments was one of the winning photos.