A Solar Revolution in Rural America

JULY 2018

NRECA
America's Electric Cooperatives

This Report on the Solar Revolution in Rural America ("Report") is owned by the National Rural Electric Cooperative Association (NRECA).

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The National Rural Electric Cooperative Association is the national trade association representing more than 900 local electric cooperatives. From growing suburbs to remote farming communities, electric co-ops serve as engines of economic development for 42 million Americans across 56 percent of the nation's landscape. As local businesses built by the consumers they serve, electric cooperatives have meaningful ties to rural America and invest $12 billion annually in their communities.

A Solar Revolution In Rural America

Introduction

Four years after the launch of the SUNDA project, the electric cooperative solar landscape is dramatically transformed.

America's electric cooperatives are expanding the nation's solar footprint and bringing the benefits of solar to hundreds of rural communities. In 2014, the National Rural Electric Cooperative Association (NRECA) launched the Solar Utility Network Deployment Acceleration (SUNDA) project in collaboration with several electric co-ops to demonstrate the potential for solar electricity generation in rural America. The cost-shared program leveraged funding from the U.S. Department of Energy to develop models and resources for electric cooperatives interested in developing solar energy.

When the SUNDA project began in 2013, less than 1 percent of electric cooperatives had deployed solar PV systems larger than 250 kilowatts. Four years later, the electric cooperative solar landscape is dramatically transformed.

- Today, the *average* co-op solar project is >1 megawatt, up from 25 kilowatts in 2014.
- Co-ops own or purchase more than nine times as much solar photovoltaic (PV) power as they did in 2013.
- Half of the nation's co-ops have solar offerings for their members through projects they own, electricity they purchase or joint projects with other co-ops.

By making projects more economical and less risky, SUNDA accelerated solar energy development across the cooperative sector. See Figure 1. The data and information collected over the course of this project provide insights that also can be applied to energy storage and other emerging technologies.

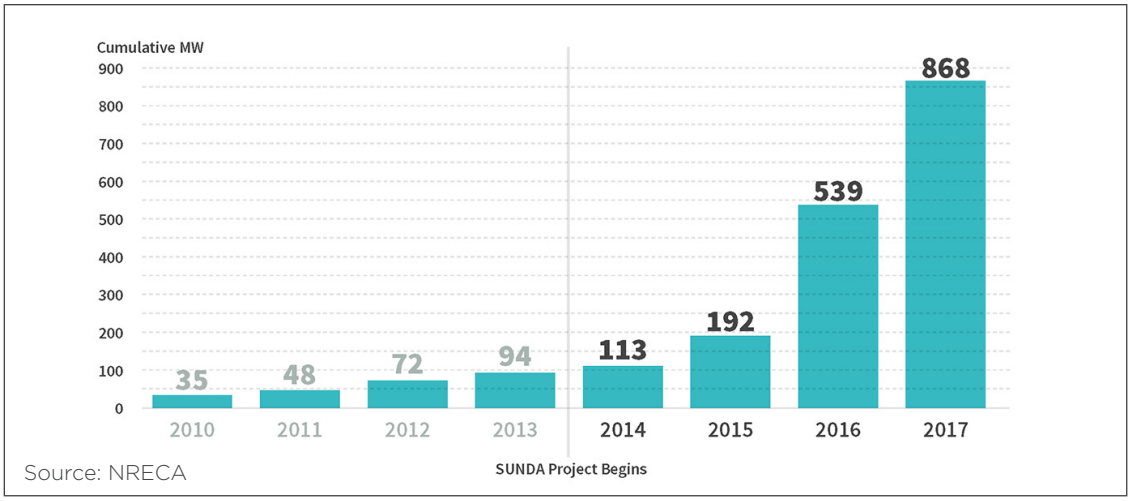


FIGURE 1: Cumulative increase in cooperative solar energy capacity nationwide.
Co-ops own or purchase more than nine times as much solar energy as they did in 2013.

Executive Summary

In 2013, with funding support from the DOE, NRECA's SUNDA team initiated a partnership with 17 cooperatives to build 30 megawatts of solar in 10 states.

The impact of these projects expanded far beyond the footprint of those early adopters. The experiences of the 17 SUNDA co-ops became a foundation of knowledge and solutions for the entire electric cooperative network. SUNDA applied lessons learned and created practical resources—from field manuals to sample business processes—for co-op leaders and staff. Access to these tools and business models reduced the risks and provided a roadmap for co-ops interested in pursuing solar.

By the end of 2019, the combined capacity of cooperative solar is expected to surpass one gigawatt — enough electricity to power more than 200,000 homes.

As the number and size of cooperatives' solar projects increased, total solar capacity surged. By the end of 2019, the combined capacity of cooperative solar is expected to surpass one gigawatt—enough electricity to power more than 200,000 homes.

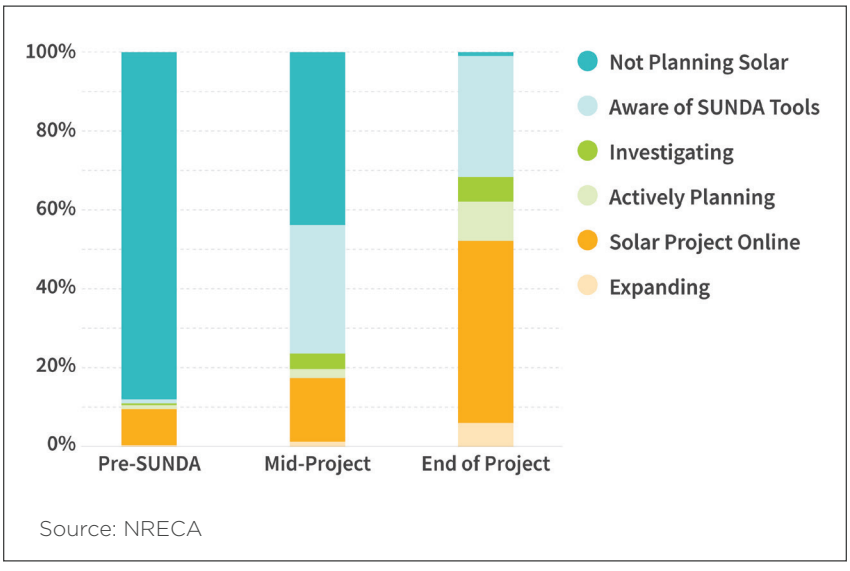


FIGURE 2: Co-ops get engaged. As of April 2018, 126 co-ops have at least one PV project online. Of those, 52 co-ops are expanding and adding more solar. Another 86 are actively planning projects and 72 are investigating options. Co-ops that have not responded to NRECA surveys are assumed to have no plans.

The SUNDA team surveyed cooperatives at the beginning of the project and at its conclusion. A third survey conducted midway through the project by NRECA provided additional data on solar activities and the perspectives of co-op leaders.

Electric co-ops are led by and belong to the communities they serve. Cooperatives innovate as they respond to the needs of their members.

Some innovations from the SUNDA project include:

- Community solar programs that benefit low- and moderate-income consumers
- Partnerships with military installations to help meet federal energy independence targets
- Combined solar and energy storage projects, including controllable water heaters

The early survey charted a path for the SUNDA project. Co-op respondents voiced concerns that would need to be addressed before they would embark on a solar project. And since they anticipated adding solar capacity but had not yet begun planning, the time was ripe for resources that could inform their decisions. The experiences of the 17 co-ops that collaborated with NRECA on the first phase of solar installations were converted into resources of knowledge and solutions for the entire electric cooperative network. See Figure 2.

The surge in cooperative solar energy, from local community solar programs to large-scale arrays, is helping reshape the energy future in rural America. This report outlines both the drivers of this transformation and the factors that made it possible.

Success Factors

At the outset of the SUNDA project, co-ops who responded to an initial survey on PV solar cited a variety of considerations for why they had not pursued a solar program. The two top concerns were the cost of solar and their lack of familiarity with PV technology. Electric co-ops also pointed to caps on "self-supply generation" in long-term wholesale power contracts with their power suppliers as a potential challenge. The following is a summary of factors that enabled cooperatives to address each of these challenges.

As of December 2017, cooperatives had or were planning 196 community solar projects.

Consumer-member demand. Co-ops are committed to serving their members. In a 2016–'17 survey, co-ops with renewable energy programs were asked about factors driving their decision to offer or support renewable energy, including solar programs. Sixty-eight percent of respondents said they were motivated by a desire to increase consumer-member satisfaction; 59 percent cited consumer demand for solar offerings.

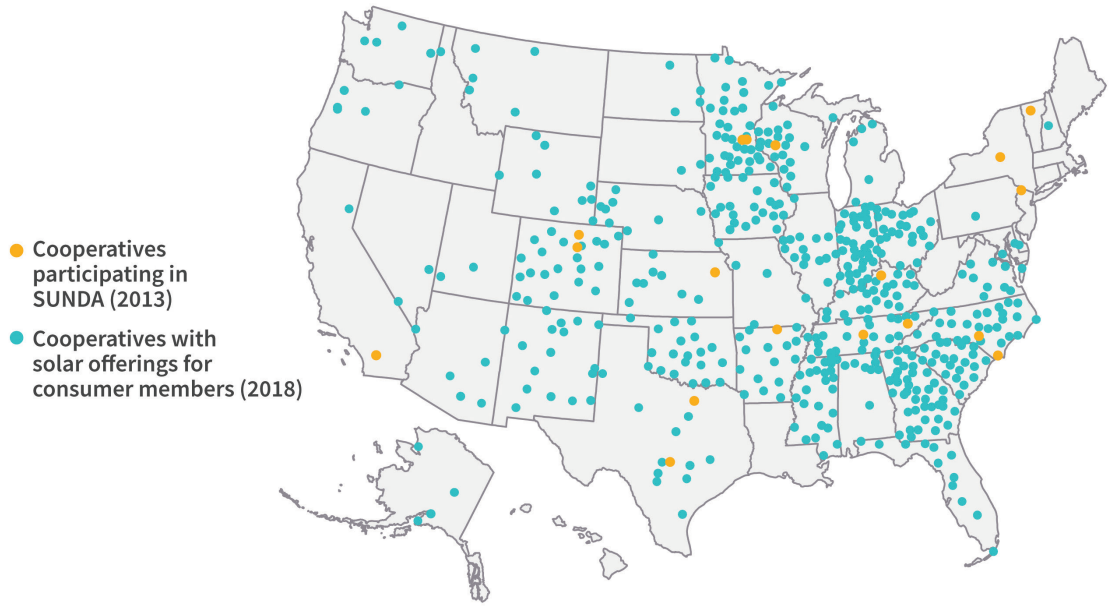
Decline in the cost of solar. Over the course of the SUNDA project, the cost of installed PV solar dropped by nearly half. In 2012, one co-op paid $2.40 per watt for a 1-MW deployment. By 2017, GreenPower EMC in Georgia paid $1.35 per watt for installations ranging between 1 and 3 MW. Forty-three percent of co-op survey respondents in 2017 said the declining cost of solar factored into their decision to pursue a solar project.

Economies of scale. In 2014, generation and transmission co-ops (G&Ts) had deployed a limited number of small solar projects, which were mostly demonstration projects. Tri-State Electric Cooperative, with a 30-MW solar array in New Mexico, was the only G&T with significant solar capacity. By the end of 2016, nine G&Ts had launched new solar projects in partnership with their distribution co-op members, totaling more than 370 MW. Today, G&Ts are developing 77 percent of planned co-op solar projects. Their entry into solar has been a game-changer, with G&T solar deployments significantly increasing electric co-op total solar capacity, lowering the cost through economies of scale, and reducing the business risk for their distribution co-ops.

Community solar. The community solar model aligns well with the co-op business model. A community solar program allows individual households to purchase or lease panels or to purchase a share of the output of a larger solar PV project. Community solar is a flexible model: Larger programs can benefit from economies of scale in construction and they can be sized and priced to fit member demand. As of December 2017, cooperatives had or were planning 196 community solar projects.

New financing models. Early in the SUNDA project, NRECA created a financial screening tool that allows co-ops to evaluate the feasibility of a solar program at their location. The tool enables a comparison of costs for small and large systems, which partly explains the increase in the average size of co-op deployments. During the same period, co-ops' traditional lenders standardized their solar financing options, making it faster and easier to finance solar projects.

Collaboration. The partnership between SUNDA participants, NRECA and the cooperative network has spread knowledge and workable business models. The SUNDA team conducted extensive outreach to cooperatives with training and resources, including materials, webinars and NRECA events. **See Figure 3**.



Source: NRECA

FIGURE 3: Seventeen early solar adopters paved the way for the more than 400 co-ops with solar offerings. In October 2013, DOE and NRECA signed a cooperative agreement for a multistate solar installation research project, focused on identifying and addressing barriers to PV deployment at cooperatives. DOE's Solar Energy Technologies Office provided $3.6 million, matched by a $1.2 million cost share from NRECA, the National Rural Utility Cooperative Finance Corporation (CFC), Federated Rural Electric Insurance Exchange, PowerSecure Solar LLC and 17 participating cooperatives.

Cooperative Solar in 2014: A Snapshot

The SUNDA team's initial survey of co-ops on activities and plans regarding solar PV revealed the following:

- Although 584 cooperatives said they anticipated some solar PV, including private rooftop solar installations, on their systems, the vast majority had no specific plans to install systems of >100 kW and fewer than 30 co-ops expressed interest in developing systems larger than 250 kW.
- Of the 83 respondents that reported having a PV solar project, most were small demonstration systems; 11 co-ops were planning installations of around 100 kW.

Respondents cited several factors why they were not planning solar projects at that time:

- Projects larger than 250 kW were not economically feasible (41 percent).
- Utility-scale solar could run afoul of caps on self-supplied generation in the all-requirements contracts with G&T cooperatives (37 percent).
- They believed consumer-members were not interested (19 percent) or co-op boards of directors were not interested (16 percent).

The survey results pointed to a perception among many respondents that solar projects carried financial and operational risks.

SUNDA RESOURCES

Prior to the SUNDA project, any cooperative planning a solar project larger than either a demonstration project or pilot program had to start from scratch. As the 17 SUNDA co-ops planned, installed and deployed a combined total of 30 MW of solar, the SUNDA team followed the process, collecting information about the technical, legal, financial and administrative issues that arose at each co-op. Based on this information, the team developed resources, including tools, technical designs and business templates that could serve as a roadmap for other co-ops across the country.

These resources guide co-ops as they investigate options, understand the costs and resource requirements, plan projects, deploy systems, operate and maintain the systems, and meet their members' needs and interests.

- The ***PV Cost & Finance Screening Tool*** is a spreadsheet-based tool that has been successful in helping co-ops in the solar planning stage. The tool is pre-loaded with information needed to size a PV project quickly and easily in the co-op's service territory; determine the total costs to finance, purchase and install the system; and produce a reliable 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.
- The ***Project Manager's PV Quick Start Guide*** is an overview for project managers with proven, annotated checklists outlining project tasks and schedules, what to watch out for, and references to other materials, such as field manuals.
- The ***Communicator's Toolkit*** provides 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 communications plan and sample materials from co-ops with solar projects online or well on the way to completion. It also includes NRECA's Community Solar Playbook, which provides specific guidance for executives and their boards of directors, finance staff, engineering staff, accounting staff and marketing and communications staff.
- **PV Field Manuals** were developed to be the culmination of all the in-depth information the co-ops needed to successfully deploy their solar PV systems during the SUNDA project, and as the ultimate 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 utility decision makers and engineers 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.

A suite of tools developed as part of the project is available at **www.NRECA.coop/SUNDA** or **www.NRECA.coop/solar**

Change drivers

Cooperatives are particularly sensitive to imposing additional costs on their consumer-members.

As the solar industry matures, co-ops are extending the benefits of PV solar to their consumer-members in rural communities across the country. At the same time, because cooperatives are not-for-profit entities that provide at-cost service in regions of the country where incomes are mostly below the national average, cooperatives are particularly sensitive to imposing additional costs on their consumer-members. See Figure 4. As member expectations changed and costs came down, co-ops' assessment of benefits and risks of solar programs also changed.

CONSUMER-MEMBER DEMAND

Co-ops respond to their members' expectations and desires. Co-ops were investigating solar because their members expressed interest. In the initial survey, co-op leaders estimated 20 percent of their members were interested or very interested in solar. For some co-ops and their boards, the level of interest was not high enough to justify pursuing a higher-cost resource on behalf of the entire membership. However, as solar costs continued to decline, consumer interest continued to increase. Nationwide polling of consumer members conducted in 2016 for NRECA showed that more than 35 percent of co-op consumer-members were interested in solar and supported the co-op exploring options.

In late winter and early spring of 2017 when NRECA polled co-ops offering renewable energy options and asked them to identify factors driving their decision to offer such programs, 68 percent of co-op respondents said they were motivated by a desire to increase consumer-member satisfaction; 59 percent cited consumer demand for solar offerings. The major change over the past few years is that interest in solar shifted from being of interest to a minority of consumer members to the majority, and co-ops' solar deployment activity has increased in response.

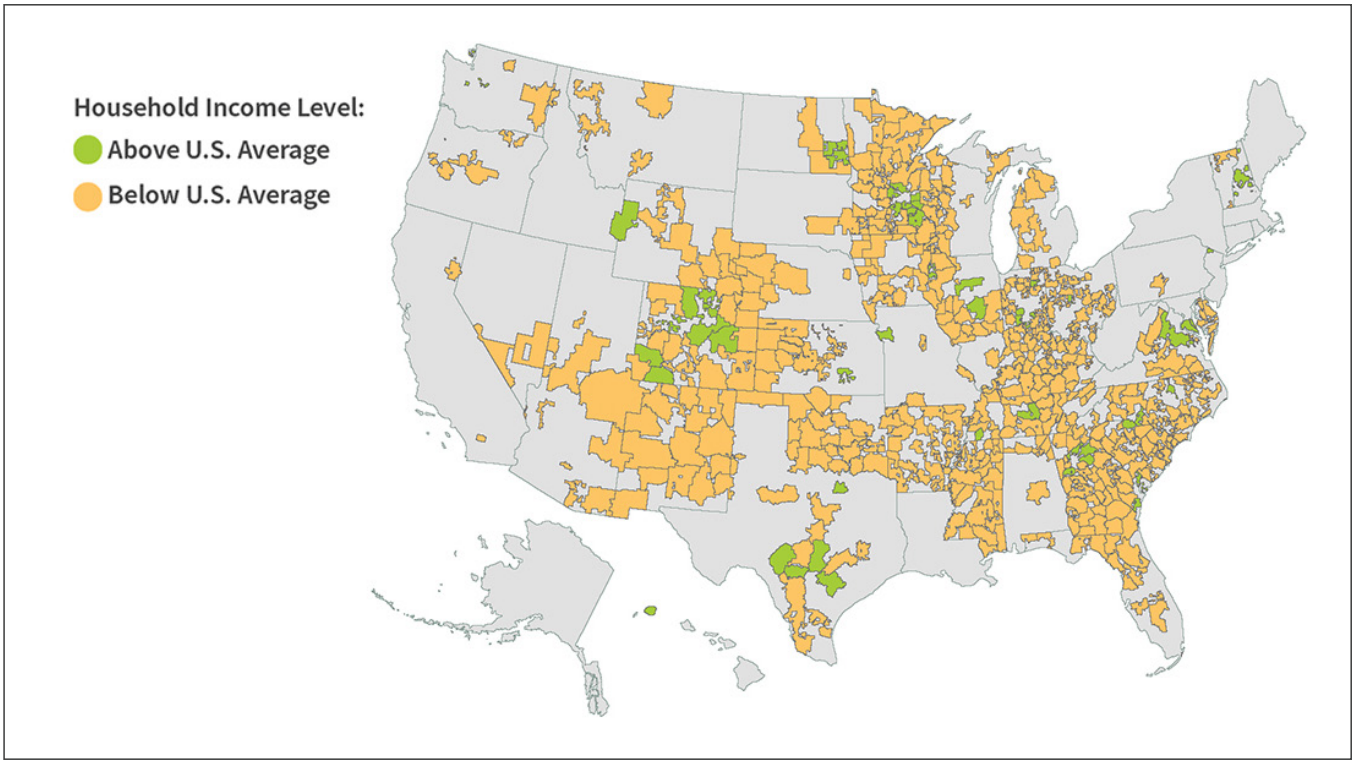
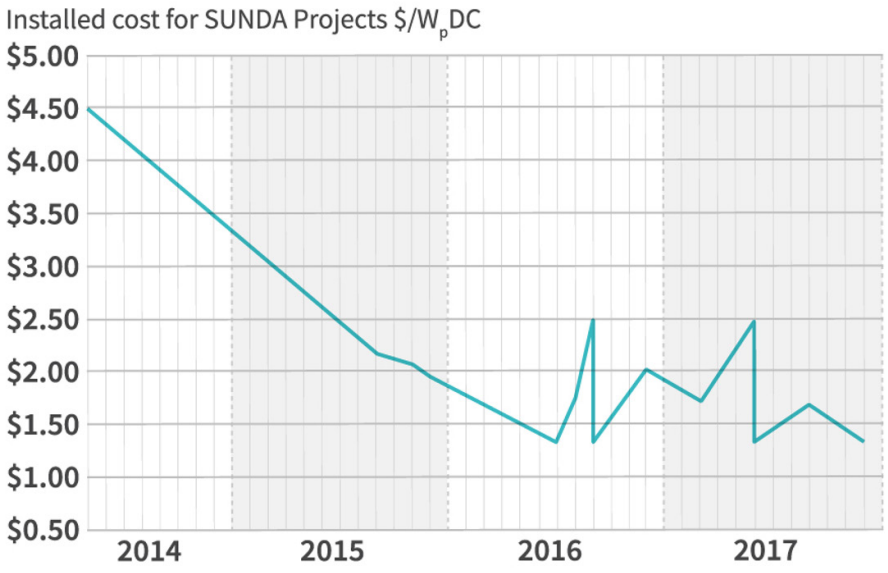


FIGURE 4: Expanding Access to Solar. Co-ops are bringing solar to communities where the household income is below the national average.

IMPROVED ECONOMICS

Prior to 2014, the relative high cost of solar was a significant barrier for electric cooperatives. According to the survey of members, 41 percent of co-op respondents cited cost as a challenge. Forty-three percent of co-op survey respondents in late 2016 and early 2017 pointed to the declining cost of solar as a motivating factor. The first system deployed by a SUNDA co-op tested equipment and designs at a cost of $4.50 per peak watt DC. The last SUNDA deployment benefiting from the lessons learned and declining costs came in at $1.30 per peak watt DC. See Figure 5.

Forty-three percent of co-op survey respondents in late 2016 and early 2017 pointed to the declining cost of solar as a motivating factor.



Source: NRECA

FIGURE 5: Co-ops' solar costs have plummeted. Economies of scale, falling panel prices and new business models reduced the cost of installed solar for cooperatives.

Enabling Factors

While changes in consumer expectation and declining costs altered the calculation of risks and benefits, other factors contributed to the widespread adoption of utility-scale solar in this very short period of time.

- The community solar model offered cooperatives a low-risk model for supplying a service that members wanted.
- G&Ts, the power providers for many co-ops, are working together with their distribution co-op members to implement projects that aggregate interest and leverage economies of scale.
- The co-ops' traditional lending partners have developed financing programs that take advantage of government tax benefits and leverage the low-cost capital available to cooperatives.
- Through the collaborative effort of the SUNDA project, NRECA staff and the SUNDA team offered more than 50 trainings, at least 70 outreach sessions in 39 states, and more than two dozen NRECA and industry journal articles to reach more than 10,000 professionals in the electric utility business and facilitate solar PV planning across the country.

COMMUNITY SOLAR GOES VIRAL

Like co-ops themselves, community solar programs have open membership, they are local, and they are consumer-owned.

In 2009, United Power, a cooperative based in Brighton, Colorado, was among a 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 bill for the power produced by their panels. By 2015, 34 co-ops had adopted variations of the community solar model—and three years later, nearly a quarter of NRECA's members either have community solar online or a plan in the works.

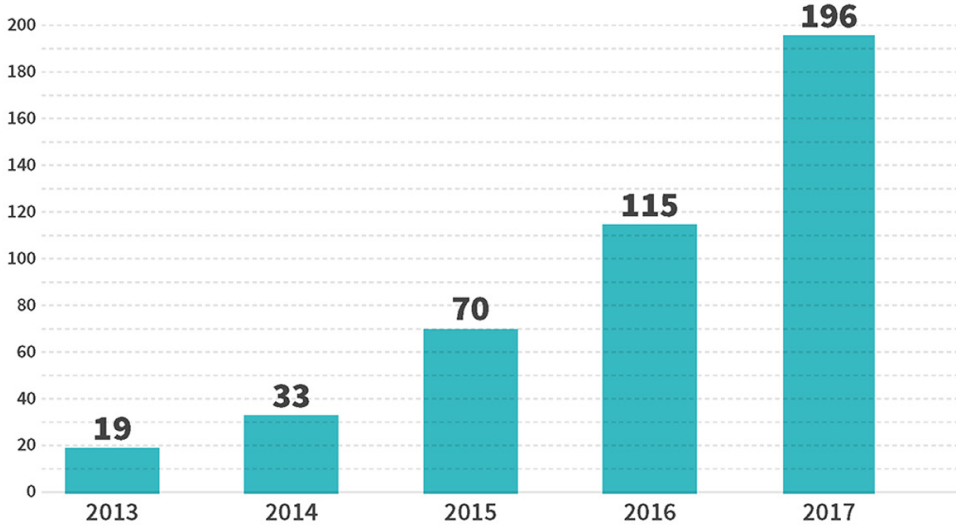
Figure 6 shows how the community solar model has gone viral among cooperatives. The popularity of this model stems in part from an alignment of the two business models: Like co-ops themselves, community solar programs have open membership, they are local, and they are consumer-owned.

The SUNDA project also enabled this spread by converting the experiences and lessons of SUNDA participants developing community solar into tools and making those resources available to the rest of the membership. A community solar webinar with CEOs of three SUNDA co-ops attracted 562 participants in 2015; a webinar on how to market community solar to members had 267 participants.

Program models typically fall into two categories: 1) the participant purchases or leases panels and receives a bill credit for the power produced; or 2) the member buys green energy from the array, also known as 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 is a fixed rate for purchasing solar power.

Over the four years of the SUNDA project, attitudes about solar shifted from it being a special product for a few (typically wealthy) members to it being something in which all members can participate. For a fuller discussion of community solar and costs, see **Appendix C: Summary of Community Solar Market Research**.

Today, cooperatives lead the utility sector in the penetration of community solar.



Source: NRECA

FIGURE 6: Co-ops lead the electric utility sector in the number of community solar programs nationwide.

LEARNINGS FROM SUNDA COMMUNITY SOLAR PROJECTS

- **Program design: Community solar should offer members flexibility**

  Early community solar projects coming online in 2014 and 2015 typically had large upfront payments associated to recoup the capital expenditure and avoid cost-shifting to non-participating members. Co-ops that followed this model had trouble signing up participants. Midway through the SUNDA project, one co-op adopted a pay-as-you-go plan with no upfront charges, long-term contracts, or switching fees. Flexibility proved attractive to consumer-members, and the success of this program enabled the co-op to offer solar energy at a cost near parity with conventional sources. By following suit, co-ops have greatly improved their ability to reach their targeted subscription levels. Flexibility in subscription offerings and responding to member demand can net the co-op higher participation levels.

- **Programs should meet consumer expectations**

  The advent of the online economy and on-demand services has altered expectations, and consumer-members bring those expectations to their interactions with the co-op. They expect an easy sign-up process, and they expect to see the solar credits show up on their bill within the first month. The dividend of a community solar program is increased member loyalty; to get the full benefit, however, co-ops need to focus on making the process as easy and hassle-free as possible.

- **Co-ops should retire the Renewable Energy Credits (RECs)**

  Federal securities law defines Renewable Energy Credits as legal instruments that convey the "environmental attributes" of renewable electricity to the owner of the credit. Only the owner of the REC has the right to claim — either explicitly or implicitly — about "using" or "being powered with" the green energy associated with the credit. If the co-op sells the RECs, neither the co-op nor the consumer-members can promote the project or their participation as supporting renewable energy. Cooperatives should consult a legal expert to make sure they are not at risk.

- **Co-ops need to think about the effect of future projects on community solar program design**

  The cost associated with PV continues to decline, which creates a risk that locking members into a pricing model based on current costs will prevent them from realizing the benefits of future price declines. Community solar programs should be designed in such a way that members who subscribe today do not regret it in the future.

*For more information, check out **NRECA's Community Solar Playbook**.*

Case Study
Eau Claire Energy Cooperative (Wisconsin)

Eau Claire Energy Cooperative is a distribution co-op located in west-central Wisconsin with 10,640 members. Eau Claire joined the SUNDA project in response to the community's desire for clean, renewable and local energy solutions. The co-op's principal goal in deploying a 750 kW-AC community solar array was to increase consumer-member engagement.

LEARNINGS

- Leveraging the benefits of community solar requires a proactive, aggressive marketing effort.
- The pricing model may have to be adjusted to ensure robust participation.
- For Eau Claire Energy Cooperative, creating a monthly subscription option enabled the co-op to sell out the project.

Eau Claire decided to develop a community solar program after consumer-member surveys and in-person outreach showed significant interest within the membership. The launch of Eau Claire's MemberSolar program garnered positive press coverage and provided opportunities for member engagement. To cite the best example, the co-op partnered with the 4-H to use sheep for keeping the vegetation under control at the site and asked consumer-members to name the sheep.

Eau Claire's initial community solar offering required a significant upfront payment with a long-term contract for the output of a panel. An aggressive marketing effort brought the subscription level to 60 percent, where it plateaued until the co-op created a monthly subscription option with no long-term commitment for members. With this change, the subscriptions quickly sold out.

System Size (kW-AC):	750 kW-AC
Array Size (kWp-DC):	872 kWp-DC (Canadian Solar 305 & 315 Wp)
Inverter Configuration:	32 x SMA 23.5kW string inverters
Structure:	Fixed tilt, driven pier, south facing
Location:	Adjacent to ECEC headquarters, Fall Creek, WI
Completion Date:	Dec. 15, 2015
Purpose:	Community Solar

GENERATION AND TRANSMISSION COOPERATIVES SUPERSIZE COOPERATIVE SOLAR

Many contracts between distribution co-ops and and the G&Ts that are their power suppliers cap the amount of generation that can be self-supplied by the distribution member. In 2014, more than two-thirds of distribution cooperative survey respondents characterized existing contracts with power providers as a challenge for co-ops interested in developing solar.

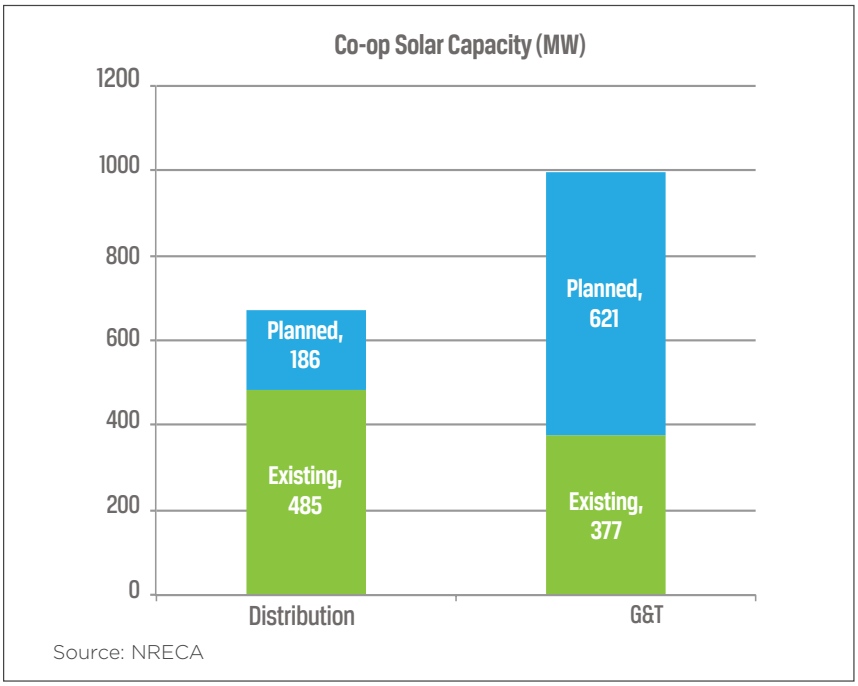


FIGURE 7: G&Ts take the lead. Responding to distribution co-op needs, G&T's are leading cooperative solar development, aggregating interest and leveraging economies of scale.

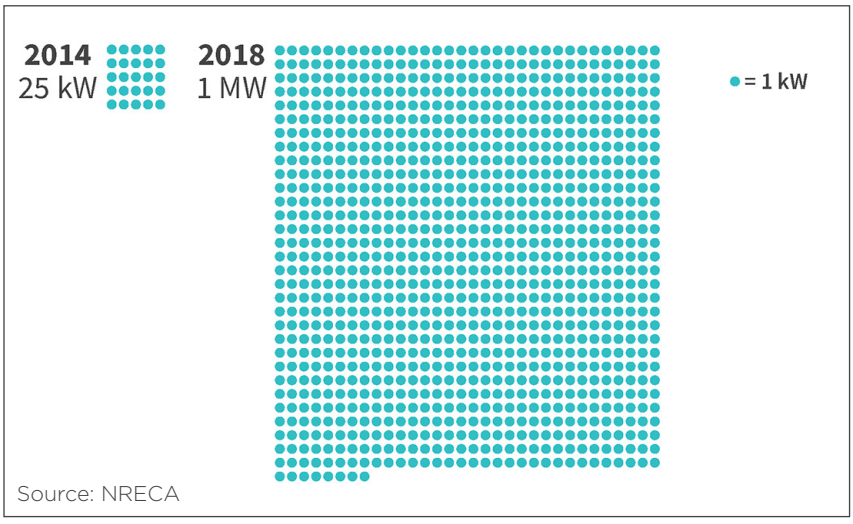
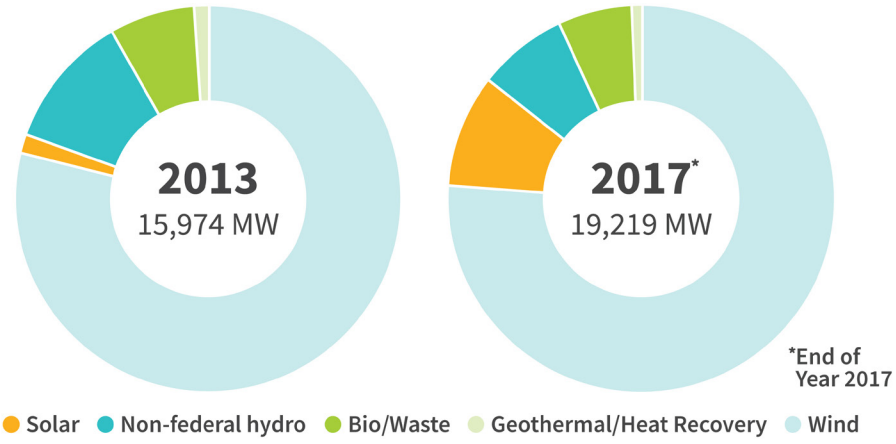


FIGURE 8: From trial size to supersize. The average size of a co-op solar installation has grown from 25 kW to 1 MW.

In the last four years, as consumer-member interest in solar bubbled up to cooperative leaders, the distribution cooperatives relayed that interest to the boards of their G&Ts. True to the cooperative principle of "cooperation among cooperatives," the G&Ts and their members embarked on a process of collaborative problem-solving. Together, the G&Ts and their distribution co-ops were able to develop solutions that served both their interests.

The entrance of G&Ts into the cooperative solar arena has been a game changer (see **Appendix A** for the full list of G&T projects). While the community solar model expanded the footprint of cooperative solar, G&Ts are responsible for substantially driving up the combined total capacity. And by going big, G&Ts have been able to drive down costs. In 2016, nine G&Ts launched or brought online solar initiatives on behalf of their distribution members. In 2016 and 2017, G&Ts were responsible for additional >370MW. See Figure 7.

Not surprisingly, G&T-led solar has catalyzed a shift from small, demonstration solar in 2013 to utility-scale solar projects integrated into resource and capacity planning. See Figure 8. While consumer-member engagement and satisfaction continue to drive co-op solar initiatives, competitive costs, power diversification, peak load management and asset upgrade deferral play a bigger role in the decision-making. **See Figure 9**.



Source: NRECA

FIGURE 9: A more diverse mix of renewable resources. Over the course of the SUNDA project, solar's share of the co-ops' renewable fuel mix, excluding federal hydro-power, went from nearly nonexistent to 5 percent.

Each G&T is unique and, accordingly, they have taken various approaches to meeting the needs and expectations of their members. These approaches fall into the following categories:

The co-op model... has led to solar programs that are consumer-focused, cost-conscious and financially viable.

1. A distribution co-op owns or purchases solar power without exceeding the cap (the standard is between 1 and 5 percent of the total capacity, usage or peak) defined in the contract.
2. A distribution co-op owns and operates one or more solar arrays, sells all of the output to the G&T, essentially becoming a "qualified facility." The G&T then sells the power back to the distribution co-op. Sometimes a fee is 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 does combinations of 3 & 4 to provide local systems for community solar and large systems (20-plus MW) as part of its own generation resources.

The co-op model, which encourages both distribution co-ops and G&Ts to focus on solutions that meet member needs, has led to solar programs that are consumer-focused, cost-conscious and financially viable. The result of increased collaboration between G&Ts and their distribution co-op members can be seen in the final survey of co-ops: In 2017, only 7 percent of co-op respondents thought of the all-requirements contract as a barrier to solar development. More than half (56 percent) of co-op respondents reported participating in a G&T-led solar project.

Today, the majority of G&Ts and their distribution member co-ops are deploying solar programs within the confines of existing contracts.

Case Study
Great River Energy (Minnesota)

Great River Energy (GRE) is a G&T cooperative that provides wholesale electric service to 28 member cooperatives with approximately 1.7 million consumer-members. As an early adopter, GRE joined the SUNDA project to explore models for collaboration with their co-op members that would leverage the G&T's size and engineering expertise to drive down the costs and risks.

As part of Phase I, Great River Energy's 250-kilowatt (kW) research and demonstration array at its Maple Grove headquarters tested the performance of three types of panels:

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

In Phase II, the G&T partnered with Wright-Hennepin Electric Cooperative on a 2.25-MW community solar array. The G&T assisted in the contracting, design, and construction; 100 percent of the output is dedicated to the distribution co-op.

LEARNINGS

- When possible, aggregate. Small, scattered projects are more costly than one large array.
- By partnering, the G&T and the distribution cooperative can find flexibility in the all-requirements contract.

In addition, GRE built 19 arrays at distribution sites across Minnesota with a generating capacity of 20 kW each that together provide statewide distributed generation information. All of the projects are helping Great River Energy and its member cooperatives evaluate the impact of solar energy.

The projects provided real-time valuable data about the challenge of solar in a region where the weather is more often cloudy than not. An understanding of the sudden shifts in power output caused by cloud interference is an important lesson learned for utilities to find ways to properly manage the grid as more solar and other renewable energy resources are interconnected to the electric system.

For more information on how G&T co-ops are working with their members and their power providers to implement solar PV, please see ***SUNDA final report.***

NEW FINANCING MODELS REDUCE FINANCIAL RISKS

Not-for-profit electric cooperatives have access to low-cost capital that frequently originates from the U.S. Department of Agriculture's Rural Utilities Service. In addition, the U.S. government incentivizes renewable energy programs through tax reductions. As not-for-profit organizations, however, electric cooperatives cannot directly benefit from federal and state tax incentives.

When SUNDA started in 2013, there were few options for financing a solar project.

When SUNDA started in 2013, there were few options for co-ops financing a solar project. For several years, the Treasury Department offered one solution for tax-exempt entities in their Clean Renewable Energy Bonds, which were available to help finance solar programs at an advantageous rate. Tax-equity-flip financing, in which a for-profit entity partners with the not-for-profit entity in order to collectively take advantage of incentives, was well-known from large wind-power installations. However, it was often too expensive for projects of an appropriate size for a local distribution cooperative (typically under 2 MW). These limited options added to the complexity and cost for co-ops interested in solar.

In 2018 the traditional co-op financing partners now have options available for co-ops interested in financing a solar project at favorable rates. Financing choices available to cooperatives include:

- Direct financing, available from cooperative lenders such as National Rural Utilities Cooperative Finance Corporation (CFC) or CoBank
- Federal financing, through the Rural Utilities Service
- Leasing arranged by entities such as CFC or through CoBank Farm Credit Leasing
- Tax-equity financing (organized by third-party vendors or cooperative network organizations)
- Additional options that work for co-ops are available through the National Renewables Cooperative Organization and the National Rural Telecommunications Cooperative

For more information on each of these options, see the **SUNDA PV Manual, Volume I**.

Case Study
Anza Electric Cooperative (California)

Anza Electric Co-op 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 owned by Southern California Edison (SCE), with a capacity of 14 MW. Anza purchases its power from Arizona Electric Power Cooperative (AEPCO). Anza Electric Cooperative joined the SUNDA project to explore how solar might help with capacity shortages.

LEARNINGS

- Solar resources can help distribution co-ops with asset upgrade deferral.
- Site permitting can be a lengthy, cumbersome process.

Anza originally planned to install 1 MW near the headquarters and main substation in Anza, California, approximately 100 miles outside of Los Angeles. In the design phase, Anza determined the labor required to permit the site for the maximum 4-MW capacity was identical to what was required for 1 MW, and the economics of the power produced favored a larger installation. Because 4 MW was more than the board was willing to authorize in their first venture into solar, the board compromised on a plan to install an initial 2 MW to be followed by an additional 2 MW within a few years. The completed array is expected to provide 14 percent of the total annual energy needed by the co-op.

Anza started the project late in 2013, but siting and permitting issues prevented the co-op from breaking ground until October 2016; commissioning was completed July 2017. While some of the permitting issues are unique to California, others are more universal. The co-op had to work through issues related to property taxes, water rights and the discovery of an endangered species, the pocket mouse. Local regulations required the construction of a special fire road. Each of these hurdles added time and cost and might 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 may ultimately outweigh the difficulties faced.

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

System Size (kW-AC):	2,010 kW-AC
Array Size (kWp-DC):	2,890 kWp-DC (Canadian Solar 330Wp)
Inverter Configuration:	67 x 30 kW SMA string inverters
Structure:	Fixed tilt, driven pier, south facing
Location:	Adjacent to AEC headquarters and Tony Lappos substation, Anza, CA
Completion Date:	July 31, 2017
Purpose:	Generation mix, possible community solar; planned for future energy storage

ENGAGEMENT AND OUTREACH

The impact of the SUNDA team's engagement with cooperatives should not be underestimated. Engagement with the staff and board members who will be responsible for the project is key to accelerating technology adoption. The SUNDA team reached more than 95 percent of NRECA's cooperative membership. Surveys were an important component of the outreach effort, enabling the team to target materials to the needs of the cooperatives. Training included the following:

- Direct support to participating co-ops
- Facilitation of peer-to-peer learning
- 50+ trainings at NRECA and industry events
- 70+ outreach sessions at NRECA and industry events
- 25+ articles in NRECA and industry publications

YEAR 1: Support of SUNDA early adopters

- Conducted a series of data collection activities including the 2014 survey
- Facilitated conversations and quarterly calls among SUNDA participants, collecting information on the planned deployments

YEAR 2: Developing resources and sharing early lessons from SUNDA participants

- Developed resources, bringing together both co-op participants and outside experts, including PowerSecure Solar LLC, CFC and Federated Rural Electric Insurance Exchange
- Shared the early lessons and experiences of SUNDA co-ops with the cooperative network via NRECA webinars, events and industry conference sessions
- Used quarterly calls to identify specific challenges such as soliciting board approval, member-consumer education, financing, land acquisition and siting and finding contractors

YEAR 3: Dissemination of resources

- Disseminated manuals, tools and guides as quickly as they became available
- Served as information clearinghouse. Inquiries from non-participating co-ops increased significantly

YEAR 4: Peer-to-peer learning

- Facilitated peer-to-peer learning between the SUNDA co-op participants and other co-op staff across the country
- Conducted phone interviews with more than 40 G&T cooperatives
- Revised the SUNDA products to incorporate new learnings
- Conducted consumer research to enhance communications with consumer-members

SUNDA activities helped co-ops learn, share experiences and accelerate the adoption of new technology across the country. Through surveys and direct outreach, NRECA has a detailed picture of co-ops' level of engagement with solar technology.

As of April 2018, 126 co-ops have deployed at least one PV project online (Solar Project Online). Of those, 52 co-ops are adding more solar (Expanding). Another 86 are planning their first projects (Actively Planning) and 72 are actively exploring options (Investigating). Co-ops that have not responded to NRECA surveys are assumed to have no plans for solar development.

Staff at all co-ops know, however, that the SUNDA tools are available to support future planning.

For more information about the SUNDA project, please visit ***www.NRECA.coop/SUNDA.***

Conclusion

In 2013, less than 1 percent of electric cooperatives had deployed solar PV systems larger than 250 kW. By the end of 2019, the combined capacity of cooperative solar is expected to surpass 1,000 MW. The SUNDA project played an instrumental role in accelerating cooperative solar development through aggressive outreach to co-ops with training and resources.

The SUNDA project used five 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
5. Data-driven assessment of project efficacy

This approach, coupled with NRECA's broad geographic reach and its outreach, training and communications channels, resulted in a model for accelerating the adoption of solar PV across the country. It created a virtuous cycle of improvement and sets the stage for future projects.

APPENDIX A

SUNDA Summary

(List of cooperatives and their deployments)

This four-year project grew from a core team of 17 cooperatives to more than 40 associated cooperatives participating at varying levels. Deployments completed by participating cooperatives are shown in Table 1.

TABLE 1: Completed Solar PV Deployments

Goal: 20MW Planned: 23MW Actual: 〉30MW + 〉60MW at SUNDA "Associates"		
Phase I (Y1 & Y2: 10/13 – 9/15)	**State**	**MW**
CoServ Electric 1	TX	2
Great River Energy – 1	MN	0.25
Sussex REC	NJ	0.624
Total		**2.874**
Phase II (Y3: 10/15 – 9/16)	**State**	**MW**
Anza Electric Co-op	CA	2
Brunswick EMC	NC	1.2
Eau Claire Energy Cooperative	WI	0.75
Great River Energy – 2 (Wright Hennepin)	NM	2.25
Green Power EMC – 1 (4 projects)	GA	6.7
Total		**12.9**
Phase III (Y3: 10/16 – 9/17)	**State**	**MW**
Appalachian REC	TN	1.373
Green Power EMC – 2 (7 projects)	GA	10.038
Kansas Electric Power Co-op	KS	1
Middle Tennesse EMC	TN	0.8
Poudre Valley/TriState G&T	CO	1.5
Total		**14.711**
Grand Total		**30.485**

APPENDIX B

Surveys and Data Collection

Over the four years of the SUNDA project, NRECA conducted member co-op surveys to assess baseline, midpoint and end-of-award progress.

Baseline: To evaluate the PV market and co-op involvement in PV projects at the beginning of the SUNDA project, NRECA conducted a baseline "PV Maturity Survey" in 2014.

Methodology: In May 2014, NRECA's in-house database contained records of PV status for ~400 member co-ops. NRECA staff called the remaining 520 co-ops to conduct a Solar PV Pre-Screen Survey to discover whether these co-ops had or planned to build PV projects within their service territories. A total of 484 calls reached the designated contact, with 429 co-ops participating and 55 declining to participate. From this effort, NRECA derived a total list of 584 cooperatives that expected to have solar PV on their systems — at least in the form of behind-the-meter residential systems — in the next three to five years (over the duration of the SUNDA project).

In June 2014, NRECA emailed a longer PV Maturity Survey (baseline) to the 584 co-ops identified in the pre-screen effort. 176 co-ops completed this baseline survey, for a response rate of 33 percent. The ***2014 PV Maturity Report*** based its analysis on these 176 co-ops.

Midpoint: NRECA Market Research conducted a survey of its full membership in late 2016 and early 2017 to identify key co-op drivers for energy programs, including distributed generation, renewables, energy efficiency and demand response programming.[1] **See Figure 10**.

Methodology: On Dec. 15, 2016, emails were sent to the CEO/general manager of 818 distribution co-ops inviting them to participate in the survey. As of Jan. 17, 248 had responded to the online survey and are included in these results for a 30 percent response rate.

[1] *2016/2017 Renewables, Energy Efficiency and Demand Response Drivers Study*

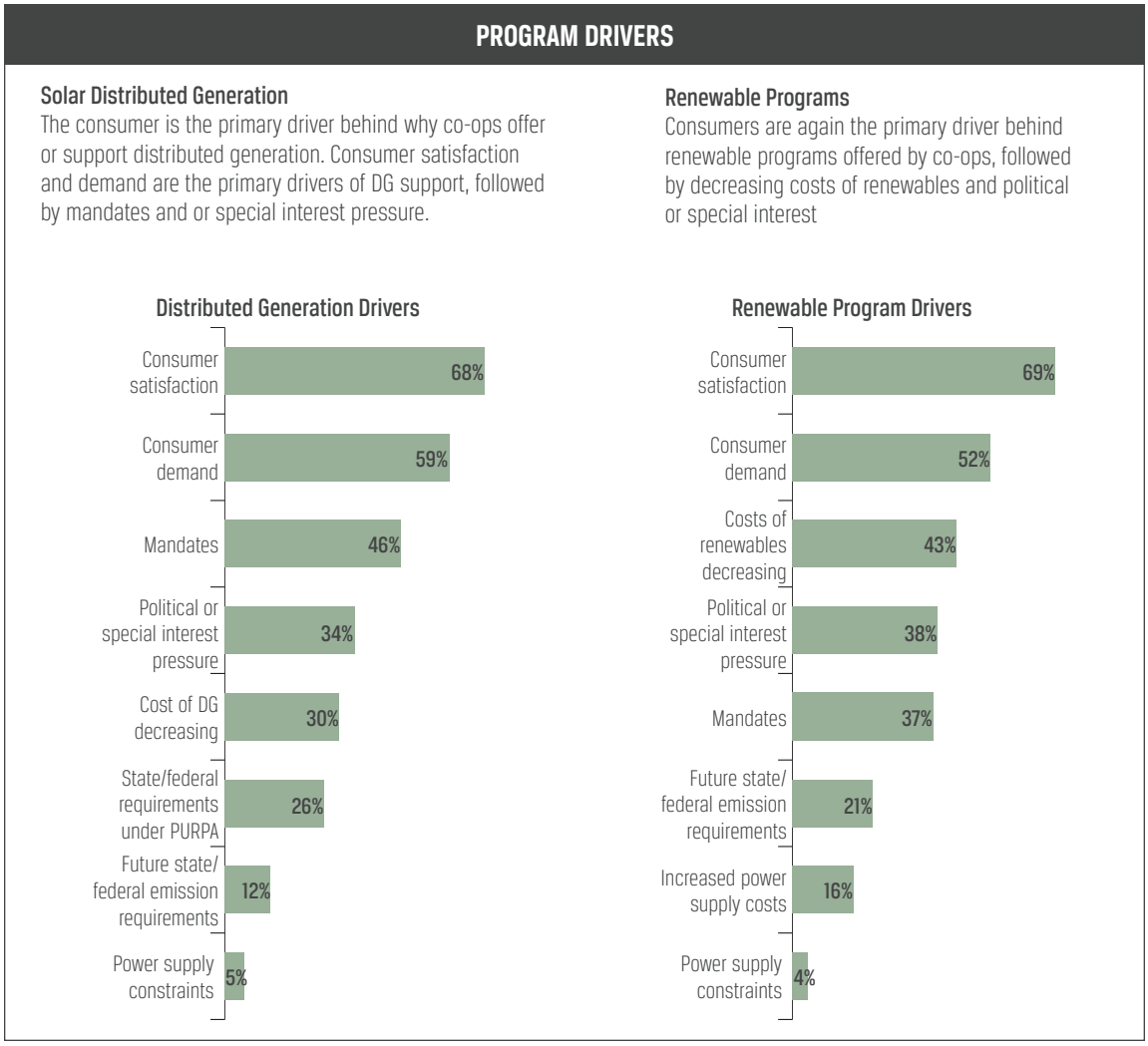


Figure 10: Program Drivers: Solar Distributed Generation and Renewable Programs. From 2016/2017 Renewables, Energy Efficiency and Demand Response Drivers Study, p. 11

Endpoint: NRECA repeated the PV Maturity Survey in summer 2017. Only distribution co-ops received the long-form (39-question) email survey. NRECA staff also conducted 41 telephone interviews with G&T co-op managers regarding solar deployment.

Email survey methodology: The survey was emailed to distribution co-ops only from the 2014 list of 584 co-ops. Two challenges hindered early results: Insufficient numbers of distribution co-op contacts completed the first emailed survey to consider results meaningful, and responses from 2014 and 2017 did not overlap significantly. NRECA staff repeated the survey, targeting co-op staff who had responded in 2014 but had not yet responded in 2017. This second effort yielded 112 co-op completions from staff who took both the 2014 and 2017 surveys. Unless indicated otherwise, results from these 112 respondents are used in this 2017 Survey Summary Report.

The 2014 and 2017 surveys conducted with distribution co-ops asked questions to explore:

- Co-op generation resources and approaches to resource planning
- Consumer-member engagement
- PV of various size and ownership
  - Utility-scale PV
  - Community solar PV — expanded in the 2017 survey
  - Member-owned solar PV
- Technical/engineering issues related to solar PV
  - Behavioral and financial issues related to solar PV

Throughout the survey, questions distinguished between utility-scale (>250kW) solar PV generation, as well as residential (<10kW). Other noted market segments included:

- Commercial and agricultural (10-250kW)
- Institutional (schools, hospitals, etc.) — (10-250kW)
- Independent power producers (IPPs) (>250kW)
- Other (>250kW)

Telephone interview survey methodology: There are 65 G&T cooperatives. Beginning in May 2017 and continuing through November, 2017, a panel of NRECA SUNDA staff conducted 42 telephone or in-person interviews with G&T staff leads for solar deployment using a 14-question script. Questions covered:

- Description, size and structure of solar programming offered by the G&T to its member co-op
- Motivation for deploying solar projects
- Challenges for G&Ts in executing solar PV projects (financing, siting, engineering, member engagement, etc.)
- Community solar—description of these programs, size, structure, benefits
- Engineering/technical concerns with solar projects
- Distributed energy—knowledge of/support for member co-ops solar offerings to their members

APPENDIX C

Summary of Community Solar Market Research

While 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 program. Several SUNDA participants saw their community solar subscriptions plateau somewhere between 30 and 60 percent. 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, developing recommendations and strategies to achieve subscribership goals. With better program design and improved consumer communications, the programs are more likely to meet the co-op's needs and deliver on the expectations of their own consumer-member. 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 the course of three days
- Analysis of community solar participants using co-op data from 12 co-op community solar programs in 10 states

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.

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

...the willingness to participate was dependent on price.... "signing up can't result in a net loss to my wallet."

EDUCATING CONSUMERS ON COMMUNITY SOLAR

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

In order to better understand the task of educating consumers about community solar, the researchers conducted an online focus group with 33 participants over the course of three days. Seventeen of the 33 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 three factors affecting the decision to participate are 1) the upfront investment, 2) any premium over the short term, and 3) net monthly impact over the long term.

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 nine of the 28 focus group participants. "We can come together to create more sustainable energy options and help each other save money doing so."

Over the course of the SUNDA project, concerns that the programs would not be fully subscribed waned for many of the co-ops.

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 the participant can use the same system used to pay the bill, and the benefits should be reflected on the bill within a month.

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

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 in order to gain a better understanding of a target market for these programs.

The typical pricing for early community solar programs makes this a premium product. Community solar participants have higher home values, live in higher density areas and have higher household incomes. They are also older and have a higher 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 have seen increased subscriptions.

Evolving Models

Over the course of the SUNDA project, concerns that the programs would not be fully subscribed waned 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 six to 10 low-income families. Six Colorado co-ops, including SUNDA participant Poudre Valley REA, 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 upfront costs, long-term contracts and penalties for canceling the contract

make the program less attractive for many consumers. A co-op that takes this approach should plan on investing in a robust marketing campaign. On the other side, easy-in/easy-out contracts and low upfront 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 bill.

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.

APPENDIX D

G&Ts' Solar Deployments in 2016 and 2017

TABLE 2: G&Ts' Solar Deployments in 2016 and 2017

State	Ownership	Cooperative	Project	Year Commissioned	Capacity	Type
AZ	own	Arizona Electric Power Co-op, Inc.	Apache Solar Project	2017	20.000	PV
IA	own	Central Iowa Power Cooperative	Urbana Array (East Central Electric)	2016	1.100	PV
IA	own	Central Iowa Power Cooperative	Marshalltown Gateway Centre Solar Array (Consumers Energy)	2016	1.100	PV
IA	own	Central Iowa Power Cooperative	Clarke Solar Farm (Clarke Electric)	2016	1.100	PV
IA	own	Central Iowa Power Cooperative	Zon Veld Solar (Pella Electric Cooperative)	2016	1.100	PV
IA	own	Central Iowa Power Cooperative	Wilton Array (Estern Iowa REC?)	2016	1.100	PV
MS	own	Cooperative Energy	SMEPA Coast EPA Array	2016	0.100	PV
MS	own	Cooperative Energy	SMEPA Singing River EPA Array	2016	0.100	PV
MS	own	Cooperative Energy	SMEPA Coahoma EPA Array	2016	0.100	PV
MS	own	Cooperative Energy	SMEPA Delta EPA Array	2016	0.100	PV
MS	own	Cooperative Energy	SMEPA Southern Pine EPA Array	2016	0.100	PV
WI	own	Dairyland Power Cooperative	Solar for Schools-Alma Area School	2016	0.012	PV
WI	own	Dairyland Power Cooperative	Solar For Schools-Cochrane-Fountain City School	2016	0.012	PV
WI	own	Dairyland Power Cooperative	Solar For Schools-De Soto Area Middle & High School High School	2016	0.012	PV
WI	own	Dairyland Power Cooperative	Solar For Schools-Western Technical College	2016	0.012	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier New Haven Solar Array	2016	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Henryville Solar Array	2016	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Ellettsville Solar Array	2016	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Trafalgar Solar Array	2016	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Center Solar Array	2017	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Ogilville Solar Array	2017	1.000	PV
IN	own	Hoosier Energy REC, Inc.	Hoosier Spring Mill Solar Array	2017	1.000	PV

Continued

TABLE 2: G&Ts' Solar Deployments in 2016 and 2017 (cont.)

State	Ownership	Cooperative	Project	Year Commissioned	Capacity	Type
KS	own	Kansas Electric Power Co-op	Prairie Sky Solar Farm (SUNDA Utility Scale PV Project)	2017	1.000	PV
OK	own	Western Farmers Electric Co-op	Cyril Array	2017	5.000	PV
OK	own	Western Farmers Electric Co-op	Tuttle Array	2017	4.000	PV
OK	own	Western Farmers Electric Co-op	Hinton Array	2017	3.000	PV
OK	own	Western Farmers Electric Co-op	Marietta Array	2017	3.000	PV
OK	own	Western Farmers Electric Co-op	Pine Ridge Array	2017	3.000	PV
AR	purchase	Arkansas Electric Co-op Corp.	Aerojet Rocketdyne Highland Industrial Park Solar Array	2016	12.000	PV
AR	purchase	Arkansas Electric Co-op Corp.	PPAs for solar projects throughout Arkansas	2016	2.000	PV
MS	purchase	Cooperative Energy	Sumrall II Solar Array	2017	52.000	PV
WI	purchase	Dairyland Power Cooperative	St. Croix Electric Cooperative Array (aka Sunflower 2)	2017	2.000	PV
WI	purchase	Dairyland Power Cooperative	Price Electric Cooperative Array	2017	2.500	PV
WI	purchase	Dairyland Power Cooperative	Richland Electric Cooperatives Array	2017	0.500	PV
WI	purchase	Dairyland Power Cooperative	Jump River Electric Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Oakdale Electric Cooperative Array	2017	1.500	PV
WI	purchase	Dairyland Power Cooperative	Dunn Energy Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Taylor Electric Cooperative Array	2017	2.000	PV
WI	purchase	Dairyland Power Cooperative	Vernon EC Liberty Pole Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Vernon EC Hillsboro Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Eau Claire Energy Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Scenic Rivers Energy Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Riverland Energy Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Polk-Bennett Cooperative Array	2017	1.000	PV
WI	purchase	Dairyland Power Cooperative	Chippewa Valley Cooperative Array	2017	2.500	PV
WI	purchase	Dairyland Power Cooperative	Allamakee-Clayton Cooperative Array	2017	1.300	PV
GA	purchase	Green Power EMC	Hazlehurst Solar Project 2	2016	46.960	PV
VA	purchase	Old Dominion Electric Co-op	Hecate Clarke County Array	2017	10.000	PV
VA	purchase	Old Dominion Electric Co-op	Hecate Energy Cherrydale	2017	20.000	PV
CO	purchase	Tri-State G&T Assn., Inc.	Alta Luna Solar Project	2017	25.000	PV
CO	purchase	Tri-State G&T Assn., Inc.	San Isabel Solar Project	2016	30.000	PV
OK	purchase	Western Farmers Electric Co-op	Caprock Solar Power Project	2017	25.000	PV
KY	own	East Kentucky Power Cooperative	Cooperative Solar One	2017	8.500	CS
FL	own	Seminole Electric Co-op, Inc.	Seminole Electric Cooperative Solar Project	2017	2.200	CS PV

Continued

TABLE 2: G&Ts' Solar Deployments in 2016 and 2017 (cont.)

State	Ownership	Cooperative	Project	Year Commissioned	Capacity	Type
IN	own	Wabash Valley Power Association	Citizens EC (MO) Community Solar Project	2017	0.580	CS PV
IN	own	Wabash Valley Power Association	Miami-Cass (IN) Community Solar Project	2017	0.540	CS PV
IN	own	Wabash Valley Power Association	EnerStar (IL) Community Solar Project	2017	0.580	CS PV
MI	purchase	Wolverine Power Supply Co-op, Inc.	SpartanSolar-Wolverine Array	2017	1.200	CS PV
SC	own	Central Electric Power Co-op, Inc.	My SC Solar (minus projects with identified capacity)	2017	2.040	CS PV