Final Technical Report (FTR)

Agency to which Report is Submitted:	DOE/EERE Solar Technologies office	
FOA Name:	SUNSHOT TECHNOLOGY TO MARKET (INCUBATOR ROUND 11, SOLARMAT ROUND 4)	
FOA Number:	DE-FOA-0001400	
Report:	Research Performance Progress Report (1)	
Award Type:	Cooperative Agreement	
Award Number:	DE-EE0007586	
Prime Recipient:	Amicus Solar Cooperative	
Prime Recipient Type:	For-Profit	
Project Title:	Amicus O&M Cooperative	
Principal Investigator (PI):	Amanda Bybee 720-663-0417 abybee@AmicusOM.com	
DOE Technology Manager (TM):	Emanuele Pecora	
DOE Technical Project Officer (TPO):	Daniel Stricker	
DOE Grants Management Specialist (GMS):	Clay Pfrangle	
DOE Contracting Officer (CO):	Diana Rebekah Bobo	
Prime Recipient DUNS Number:	078861380	
Award Period of Performance (POP):	Start: 09/07/2016	End: 04/28/2018
Award Budget Period (BP):	Start: 09/07/2016	End: 04/28/2018
Date of Report:	06/19/2018	
Reporting Period (covered by this report):	09/07/2016 – 04/28/2018	

Acknowledgement: This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office (SETO) under Award Number DE-EE0007586.

I. Executive Summary

Despite the maturation of the broader solar PV industry, the operations and maintenance (O&M) market segment is still relatively under developed. The lack of industry coherence jeopardizes the long-term performance of multiple gigawatts of installed capacity, and thus, the legitimacy of solar PV as a dependable source of electricity generation in the U.S. To address these challenges, the project team formed a new company, the Amicus Operations and Maintenance (O&M) Cooperative, whose mission is to ensure that solar PV fulfills its promise as a responsible and reliable energy source, for generations to come.

Amicus O&M Cooperative created solutions to the market gaps by establishing a consistent level of O&M service offerings; standardizing scopes of work and legal agreements; training and certifying technicians; minimizing transaction costs for asset owners; and mitigating risk by creating redundancy in the companies who are able to perform work to these standards. We attracted double the number of member-companies originally forecast (goal: 10, actual: 20), broadening the reach of the service area, minimizing travel costs, and reducing response times for O&M services. We built a professional website and a software platform for managing work orders. Lastly, we have established multiple channels for communication among members, including monthly calls for sales topics and for technical/operational topics, an intranet for announcements/ questions/articles, and regular in-person meetings in association with the meetings of our sister cooperative, Amicus Solar.

Throughout the project, participants sought feedback, input, and insights from stakeholders in the O&M market segment, including current and potential member-companies and potential clients. The problem statement above was confirmed many times over, with additional insight on the need for more workforce development, driving efficiency and lowering cost through better data analysis and remote diagnostics, and finding ways to reduce the cost of secondary and ancillary services as well (including items such as vegetation management and module cleaning).

For solar to maintain its status as a reliable energy source – and for it to continue attracting investment – it must perform to expectation. This is where solar PV O&M technicians come into play. The cooperative helps them perform their work more cost effectively by streamlining “soft costs” including legal costs and work management, as well as reducing travel time and expenses. The new cooperative has demonstrated significant price reductions for O&M services relative to reported industry averages, which benefits clients directly and the public indirectly through cleaner air, economic development, and job growth.

Contents

Prime Recipient: Amicus Solar Cooperative
Project Title: Amicus O&M Cooperative

II. Background

Founded in 2011, Amicus Solar Cooperative ("Amicus") is the first purchasing cooperative in the U.S. solar industry, made up of 48 member-owners, each operating under their own brand with office/service locations in 33 states, Puerto Rico, and Canada. Amicus is equally owned and democratically governed by its membership of independent solar photovoltaic (PV) installation companies. Through the cooperative, member-companies pool their purchasing power to obtain lower pricing on both the products they sell (solar PV modules, inverters, racking, etc.) and the services they utilize (marketing, payroll, office supplies, freight, fuel cards, credit card processing, software, website SEO, etc.). At bi-annual meetings, member-companies share best practices on a wide range of business topics; the expertise and information shared among our group cannot be found at any industry trade show, vendor conference, workshop, or training center. By working together, Amicus provides our member-companies with benefits that would not be available were they to act alone. In 2016, a subset of Amicus member-companies combined forces to launch a new, independent cooperative to help fill yet another solar industry need: streamlined, cost-effective operations and maintenance (O&M) services to ensure that solar PV systems fulfill their performance expectations over the short and long term.

This project is different than many others in our funding tranche, in that we are creating a service network and not a new technology. This approach is unique in the industry; while others have pursued the path of conventional general contractor/sub-contractor structures, no one has yet applied the cooperative model to this work. One advantage is that the cooperative structure creates a neat alignment in the interests of each party. Because the member-companies co-own the cooperative entity, and because the success of one member is tied to the success of the whole, they intrinsically approach business transactions in a different way. There is greater concern for equitable pay for services and less of a "me-first" attitude.

Though there is not much in the way of peer-reviewed journal publications relevant to this topic, another interesting business model that was introduced during this same timeframe is the company 365 Pronto. Founded by Rue Phillips, who also started True South (widely credited as the first O&M-focused business in the industry), its goal is to provide a single contact for corrective/reactive problems, for both residential and commercial scale solar PV systems. When a ticket comes in, the centralized platform will send it out to the registered technicians in the area and allow them to pick it up – similar to ride share models like Lyft or Uber. Their current business model does not include commercial O&M contracts or Preventive Maintenance agreements – it is solely intended as a Corrective Maintenance avenue. We have discussed possible partnerships to promote training and workforce development, and there may be opportunities for the cooperative to make use of 365 Pronto's services as well, in the event that we encounter time-sensitive needs that we can't respond to quickly enough.

Throughout the funding period, the staff and member-companies of the cooperative have sought to learn about new technologies, including software that aggregates PV system performance information from

disparate sites into one; aerial survey and analytics technologies; and remote-control mowing devices. While many of these tools are new to the space and reflect a price point that is currently beyond our reach, they help us see the future of solar PV O&M work and what may become the standard practices of tomorrow.

III. Project Objectives

Over the years, many companies have sold solar PV systems with an expectation that they will be "maintenance-free," only to learn the hard way that that is not true. Commercial & Industrial (C&I) and utility-scale systems, in particular, must be maintained in order to ensure compliance with component warranties, safe operation, and performance consistent with expectations. Clearly, for us to achieve national goals of clean energy progression and economic benefit to the U.S., solar must generate the expected electricity. Timely, responsible, skilled O&M services play a critical role in attaining the overarching goals stated above.

The project goals included the establishment of the new cooperative – the first of its kind in the industry – as well as the tools and templates needed to perform these services cost effectively. Incorporating member-companies across the country requires a strong buy-in to central software, reporting and legal templates, and technician training. This provides clients (asset owners) with a consistent set of documentation and allows them to experience the benefits of localized expertise from independent regional providers with greater consistency. The geographically-dispersed network is a key way for us to reduce costs – while we can't eliminate travel altogether, through this network, we seek to minimize it. This also contributes to faster response times in the event of system outages, which ensures that systems continue producing electricity.

In the Statement of Project Objectives (SOPO), we included the following Objectives:

1. Reduce the cost for solar PV O&M services below the baseline outlined in a published Research Report chosen with the agreement of DOE;
    a. As you will see below, we reached these goals, as reflected in the signed contracts and proposals that comply with the stated price reduction targets.
2. Accelerate the maturation of the U.S. solar PV O&M services industry as a whole by training and certifying technicians to perform high-quality and technically advanced service;
    a. Through the award, we trained 40 technicians in the Solar Energy International curriculum on solar PV Operations & Maintenance.
3. Provide a more streamlined experience for asset owners through standardized service offerings, contract templates, client deliverable templates, an integrated information technology platform, and a single point of contact for managing a geographically-distributed portfolio; and
    a. These tools and templates are now in use by member-companies throughout the U.S.
4. Minimize the risk of underperforming assets and accelerate the deployment of solar generation resources in the U.S., leading to a lower levelized cost of electricity (LCOE).
    a. As we achieve #1, it leads to #4.

See below for the summary of the specific tasks and deliverables in the SOPO.

		Performance Metric Description: Specific, Measurable, Quantitative	Success Value	How Metric compares to Success Value	Goal Met (Y/N)	Verification Process & Additional Notes	Completed/Status as of 4/11/18
D1 Month 1 2.42%	B1	Create Articles of Incorporation, Bylaws, and Membership Agreements	The Articles of Incorporation, Bylaws, and Membership Agreement, completed by attorney and verbally approved by the founding members, create the framework for the cooperative.		Y	Submit final legal documents to EERE along with a letter from our attorney attesting that these legal documents adhere to Colorado law and are finalized.	100% complete: 11/11/2016
	B2	File Articles of Incorporation and Bylaws with Secretary of state	The Cooperative is formally established as an entity.		Y	Submit proof of filing from SoS website via screen shot	100% complete: 11/11/2016
	B3	Finalize cooperative membership agreements for founding member companies	Membership agreements from the first two founding member companies indicate approval of the terms of membership in the cooperative, the Bylaws, and the Articles of Incorporation.		Y	Submit executed membership agreements	100% complete: 11/15/2016
	B4	Create and post job description for O&M Project Manager position	The position posting serves two purposes: to recruit the right person to spearhead the initiative, and also to announce the creation of this new entity to the industry.		Y	Submit job description and screen shot(s) of job posting	100% complete: 11/11/2016
D2 Month 5 11.90%	B5	Recruit member-companies	Indication of agreement to the terms and conditions from a minimum of 3 additional companies, from a minimum of 3 different states, that will perform the sales and technical work.		Y	Submit 3 executed membership agreements	100% complete: 3/7/17
	B6	Establish O&M Price Baseline	Identify published research report chosen with the agreement of DoE to serve as national O&M price baseline		Y	Submit summary of data to EERE	100% complete 6/21/17
	B7	Hire O&M Project Manager	Employment contract signed.		Y	Submit signed contract to EERE	100% complete: 3/9/17
	B8	Sign contract with consultant to develop training program	Contract signed with explicit terms and timelines will ensure that the project is on a realistic timeframe for launch, in accordance with the project period.		Y	Submit executed contract	100% complete 6/21/17
	B9	Create standard scope of work (SOW) and cost structure	This critical path milestone indicates that member companies and asset owners agree with the standard SOW and cost structure, thus confirming viability of the model.		Y	Submit final written scope of work and cost structure, along with Project Team meeting minutes approving the standard templates. Provide 2 letters from Asset Owners verifying that their needs will be met by the SOW.	100% complete 6/21/17
	B10	Launch website	New members and asset owners should have access to education about the cooperative, how it works, and the geographic regions it covers. Solar companies should be able to submit a form indicating interest in joining.		Y	EERE should be able to view the website and submit a form indicating interest in membership.	100% complete: 2/28/17

		Performance Metric Description: Specific, Measurable, Quantitative	Success Value	How Metric compares to Success Value	Goal Met (Y/N)	Verification Process & Additional Notes	
D3 Month 7 19.88%	B11	Recruit additional member-companies	Indication of agreement to the terms and conditions from a minimum of 3 additional companies, from at least one state not present before, that will perform the sales and technical work.		Y	Submit 3 executed membership agreements	100% complete 6/21/17
	B12	Sign contract with consultant to develop software platform	Contract signed with explicit terms and timelines will ensure that the project is on a realistic timeframe for launch, in accordance with the project period.		Y	Submit executed contract	100% complete 6/13/17
	B13	Create training curriculum and materials	Curriculum & materials reflect a comprehensive training regimen for techs, including fundamental tasks they will perform in the course of the field work, training on the software system they will need to use, how to generate reports, and legal considerations to be aware of when onsite.		Y	Submit training curriculum and materials, along with board minutes approving the standard templates.	100% complete 6/21/17
D4 Month 10 42.80%	B14	Recruit additional member-companies	Indication of agreement to the terms and conditions from a minimum of 2 additional companies, from at least one state not present before, that will perform the sales and technical work.		N	Submit 2 executed membership agreements, for a total of 10 member companies by the end of the award period	100% complete 6/21/17
	B15	Create operational legal documents (Master Agreement, SLA, etc)	The Master Agreement is a baseline document that covers legal terms (indemnity, warranty, performance guarantees, penalties, etc), response times, and scope of work. The Service Level Agreement outlines pricing, response times, etc. Approval by member companies and asset owners indicate that these terms will be acceptable to meet their business needs, thus confirming viability of the model.		N	Submit standard document templates, along with Project Team meeting minutes approving the standard templates. Provide 2 letters from Asset Owners verifying that their needs will be met by the legal agreements.	100% complete 9/26/17
	B16	Conduct Technician Training	At least 25 technicians registered and trained with the approved materials.		N	Provide list of at least 25 trainee registrations, along with post-training exams (name, company, geographic location represented), with a minimum of 2 techs from each member company receiving passing certification.	100% complete 10/25/17
	B17	Issue initial certificates for training participants	Standardized certification ensures that work companies are providing a consistent work product, thus reinforcing the interchangeability of member companies to perform those functions.		N	Submit certification standards & certificates for attendees that passed the exam	100% complete 8/25/17
	B18	Early release of the software platform with limited functionalities for member-companies	Member companies should be able to - log in - enter data for a new sales contract - generate standard Preventative Maintenance reports that summarize the overall performance and health of the PV system.		N	EERE should be able to log in as a member, enter data for a new sales contract, generate work orders for the work companies, and initate Preventative Maintenance reports that summarize the overall performance and health of the PV system.	100% complete 9/1/17

		Performance Metric Description: Specific, Measurable, Quantitative	Success Value	How Metric compares to Success Value	Goal Met (Y/N)	Verification Process & Additional Notes	
D5 Month 18 22.99%	B19	Proof of Market Value	Asset owners accept the standard terms, pricing, scope of work, and deliverables presented by the cooperative.		N	Provide 2 signed contracts from asset owners with geographically dispersed portfolios (to be serviced by at least two "Work Companies")	100% complete 4/11/18
	B20	Proof of Cost Savings	Pricing in the first two (2) executed contracts shall be a minimum of 10% less than the cost baseline.		N	Provide 2 signed contracts from asset owners with geographically dispersed portfolios (to be serviced by at least two "Work Companies"), outlining the pricing, and how it compares with the cost baseline.	100% complete 4/11/18
	B21	Trajectory of Cost Savings	Pricing in at least three (3) issued proposals shall be a minimum of 20% less than the cost baseline.		N	Provide at least 3 proposals issued to asset owners, outlining the pricing, and how it compares with the cost baseline.	100% complete 4/11/18
	B22	Deliver final version of software platform for member-companies	Member companies should be able to - log in - enter data for a new sales contract - generate work orders for the work companies - generate standard Preventative Maintenance reports that summarize the overall performance and health of the PV system. Asset owners should be able to - log in - view projects (including visibility to next visits, billing schedule, links to their OM reports, Corrective Maintenance logs, SLA)		N	EERE should be able to log in as a member, enter data for a new sales contract, generate work orders for the work companies, and generate standard Preventative Maintenance reports that summarize the overall performance and health of the PV system-EERE should also be able to log in as an asset owner, view projects (including visibility to next visits, billing schedule, links to their OM reports, Corrective Maintenance logs, SLA). Provide 2 letters from Asset Owners verifying that their needs will be met by the website/platform.	software solution 100% complete 10/31/17 letter 1 from Asset Owner: in hand 1/18/18 letter 2 from Asset Owner: in hand 1/25/18

IV. Project Results and Discussion

Overall, we feel that the project unfolded more or less as expected, with a couple of notable pivots from the original concept. On the positive side, membership count was higher than the original goal – 20 member-companies signed up within the first year, double the 10 we originally forecast. As a result, we were able to train more technicians through the partnership with Solar Energy International, with excellent feedback from the participants. We built the central work order ticketing system in Salesforce, and integrated apps to facilitate onsite documentation by technicians and also streamline report generation. These tools will enable companies to generate client-facing materials in a more time-effective manner. Lastly, we have presented a polished face to the world of solar asset owners through the website, educational materials, and published articles such as the profile included in the March/April edition of Solar Pro Magazine.

We had to change course a bit from the original concept in our approach to pricing. We had hoped to create and internally publish a matrix of prices for Preventive Maintenance services on different sized systems to facilitate multi-regional proposals. In consultation with our attorney, we learned that this would, in fact, violate anti-trust law: sharing information in this way would amount to inadvertent price fixing, by allowing companies to see each other's pricing and potentially adjust their own upward. As a result, we have modified our approach to these sales, putting an emphasis not on centralized pricing but on average labor hours spent per site. The additional advantage of focusing on time rather than price is that it preserves an allowance for regional variation in labor rates while still encouraging member-companies to standardize their approach to the work.

The other aspect of the project that didn't go exactly according to plan was securing signed contracts with asset owners. This was the holdup that required us to file for a no-cost time extension for the award. Generally, member-companies are finding that it can be difficult to get clients to secure these agreements – while O&M services are understood to be important for the long-term performance of the system, if there are no immediate problems, clients are hesitant to sign and pay out funds for these services before they have to. It can thus be challenging to create the sense of urgency that will result in signed agreements. While we have received positive feedback about the concept of the cooperative, there is some reticence to be the first to test a new concept. This is a hurdle that all startups face, and we are no different.

Task 1.0: Launch and Grow the Amicus O&M Cooperative; Time Period: Months 1-18
Subtask 1.1: Create Corporate Legal Documents (Months 1-18)
Engage an attorney to create articles of incorporation, bylaws, and membership agreements for the Cooperative. The project team will work closely with the attorney to review, revise, and finalize the documents.

We were able to leverage the corporate documents of the Primary Recipient, Amicus Solar Cooperative, to accomplish this step quickly and with lower-than anticipated costs.

Subtask 1.2: Incorporate the Cooperative (Months 1-18)

File the Cooperative's articles of incorporation with the local Secretary of State.

This was a straightforward task, accomplished online.

Subtask 1.3: Establish Corporate Treasury Functions (Months 1-18)
The project team will open a bank account and establish an accounting system for the Cooperative.

We reviewed the corporate offerings from several banks before choosing to open an account with New Resource Bank.

Subtask 1.4: Sign up the Cooperative's Initial Members (Months 1-18)
The Cooperative will execute membership agreements with the first two (or more) member-companies of the Cooperative.

The initial members, Namasté Solar and Radiance Solar, were also sub-recipients of the award and have been instrumental in applying for the award and carrying out the work.

Subtask 1.5: Recruit Additional Cooperative Members (Months 1-18)
The entire project team will participate in membership recruitment. Recruitment efforts will be conducted with several criteria in mind, including but not limited to: effective geographic coverage of key regions in the U.S., which correspond to PV system location and density; quality of the workmanship of each company; willingness and ability to meet the membership requirements of the Cooperative. This will culminate in signed membership agreements with additional companies throughout the U.S.

As mentioned above, recruitment was a notable success of the award. The initial 20 member-companies are all also members of the Primary Recipient, Amicus Solar Cooperative.

Subtask 1.6: Establish O&M Cost Baseline (Months 1-18)
The project team shall utilize the data in a Research Report chosen with the agreement of DOE to establish a baseline of national O&M costs. The data shall establish an "O&M cost baseline" utilized in Subtask 5.5.

This was a challenging task, given the dearth of recently published information on costs of O&M services. This is in part a function of the lack of maturity in this market segment, which results from some companies not knowing how to price the work, some companies undercutting the market through artificially low pricing, and in some cases not allocating adequate staff to perform services. We worked with the project team to find an acceptable methodology, essentially averaging the credible sources of information for different system sizes.

Task 2.0: Develop Operational Infrastructure; Time Period: Months 1-18

Summary: Establish the operational infrastructure for the Cooperative, including the IT platform and operational legal documents. This includes, but is not limited to, selecting and hiring a contractor to fully

build out the IT platform, designing/launching/testing that platform, and drafting operational legal agreements such as the service level agreements (SLA's) that will govern inter-company work.

Subtask 2.1: Sign contract for development of Software Platform (Months 1-18)
Execute agreement with IT consultant to design, build, and test the software platform that will manage all of the Cooperative's work.

To arrive at the selection of Salesforce as the platform for managing work, we first viewed demonstrations from a number of asset management software options, including 3Megawatt, Power Hub, Power Factors, eMaint, and two different configuration companies that work with Salesforce. We also explored building software from the ground up with a local partner. In the end, we felt that it would be the best use of funds to utilize a well-established vendor that integrates (relatively) easily with other software providers.

Subtask 2.2: Establish standard scope of work and costs for preventive maintenance visits and corrective maintenance service level agreements (SLAs). (Months 1-18)
Engage current and potential member companies in establishing a standard scope of work for preventive maintenance visits, identify tasks that will populate the standard Service Level Agreements (SLA), and agree on a cost structure. This will provide the basis for the operational legal documents in subtask 2.3.

We started with the best practices promoted by the SunSpec Alliance and then surveyed the new member-companies of the cooperative on their standard scopes of work, ultimately producing a hybrid document that uses the best of both.

Subtask 2.3: Create Operational Legal Documents (Months 1-18)
Engage with an attorney who has experience in solar PV commercial law to create O&M contract, corrective services contract, professional services contract, and the contracts for member-to-member SLA's.

We interviewed three attorneys experienced in solar and construction contracts, and settled on Donald Simon with Wendel, Rosen, Black, and Dean. He helped us craft the legal framework that governs the internal cooperative structure as well as the client-facing agreements. Together, we supervised two legal interns last summer who conducted state-by-state research on licensing requirements, and this informed the ultimate approach.

Subtask 2.4: Develop and Launch Software Platform (Months 1-18)
Work closely with IT consultant to architect the software, including data capture fields, workflows, and reporting. Platform will be refined based on the outcomes of Subtask 2.4. The software platform will be launched with a single roll out and improved through iterative feedback from team members and potential clients, as indicated in Subtask 2.4.

This step was one of the more consuming aspects of our process. It was clear from the beginning that the software was a critical piece of the infrastructure that we would need to get right in order to make the

cooperative function smoothly. Member-companies weighed in throughout the process to ensure that the design was in line with the way that work flows.

Subtask 2.5: Perform Software Platform Testing and Improvements (Months 1-18)
Test, refine, and finalize the software to ensure smooth operation as the Cooperative begins to make sales. Feedback will be sought from Amicus member companies as well as asset owners (potential clients), and that feedback will be incorporated on an iterative basis.

As outlined, we sought feedback from both member-companies and asset owners on the software design. One result of this iterative improvement process was that we originally designed the software around our standard scope of work. However, we soon realized that there would be many clients who prefer to use their own scope of work, and that our software needed to be flexible enough to accommodate that as well. So we reconfigured the scope of work assignment to allow for different "service sets."

Building and administering software is a lot like owning a house – the work is never done. There are always new projects that you want to do, things that break, and a need for maintenance. We have continued to refine the software's functionality throughout the award period, ensuring that the associated apps work as intended, establishing appropriate sharing rules for all parties that will access the system, demonstrating its capacities to member-companies and asset owners, etc.

Task 3.0: Staff development; Time Period: Months 1-18

Summary: Recruit, hire, and train the O&M Project Manager and (potentially) subsequent staff of the Amicus O&M Cooperative. During this task, the project team will draft the job description for this unique role and publicize it through targeted channels. We will conduct several rounds of interviews before making an offer, and then anticipate spending substantial time educating the ultimate hire on the areas where s/he lacks experience.

Subtask 3.1: Create O&M Project Manager Job Description (Months 1-18)
Draft the job description.

Subtask 3.2: Publicize the O&M Project Manager Job Posting and Collect Job Applications (Months 1-18)
Post the job description on websites that target the solar industry as well as cooperative industry professionals. Screen for applicable experience and commitment to the mission of the Cooperative.

Subtask 3.3: Filter Job Applicants and Conduct Interviews (Months 1-18)
Form a hiring subcommittee of participating team members. Initial interview to be a phone screening with two hiring committee members. For candidates that proceed to the next interview, set up in-person or video interview with hiring committee. If needed, additional rounds of interviews must be conducted in-person with final decision makers.

The first two steps of this task were straightforward, and don't bear their own responses. The most challenging aspect of this task was in finding the right mix of technical skills and understanding of cooperatives at the price point we were able to offer. We interviewed a number of individuals that had one or the other, but not both. That said, in round one of the hiring process, we arrived at a final candidate and made him an offer, only to find that we could not agree on the salary. So, we launched a second round. At that point, the Principal Investigator, Amanda Bybee, chose to formally apply for the role (as did two others in the development group). Along with the others, she was formally interviewed and ultimately offered the role in March 2017.

Subtask 3.4: Hire O&M Project Manager (Months 1-18)
Once a finalist is chosen, we will check his/her references and work with an attorney to draft the employment agreement. As soon as s/he is available, the O&M Project Manager will join the project team.

This ended up being an easy integration since Amanda had already been serving as the Principle Investigator for the award and was intimately familiar with the project.

Subtask 3.5: Onboard and Train O&M Project Manager (Months 1-18)

Members of the project team will spend time with the O&M Project Manager to train and support this individual as s/he comes up to speed on all aspects of the role.

Members of the project team, most notably Stephen Irvin from Amicus Solar and David Henry from Namasté Solar, spent time with the O&M Project Manager to onboard and train on certain aspects of the work.

Subtask 3.6: Additional staff
If needed, the Cooperative will add additional staff to further support the member companies, manage administrative duties, etc.

The Cooperative did not hire any additional staff during the award period.

Task 4.0: Develop and Launch Technician Training Program; Time Period: Months 1-18

Summary: Design a robust training program that addresses technical, IT, and legal aspects of the various O&M services that the Cooperative's member-companies will regularly perform. We will create thorough technical content as well as ensure that all participating attendees are familiar with the IT platform and how to effectively log and manage work orders.

Subtask 4.1: Sign Contract(s) to Develop Training Program (Months 1-18)
Sign contract with a consultant experienced in developing curriculum and training programs for solar and/or O&M to oversee the development and execution of the training program. While many project team members will participate in the process, having a dedicated party manage that process will be essential to its

timely completion, as participating project team members will still have daily responsibilities at their respective employers.

The original thought was to develop our own curriculum for training and an internal certification standard, but after further reflection, we concluded that this was beyond a realistic scope for such a lean organization to maintain. As a result, we turned to Solar Energy International (SEI) as our training partner – a well-respected and longstanding institution in the solar industry. They offered a customized curriculum that used both online and in-person classes and included a group discount for our technicians.

Subtask 4.2: Create Training Program, Curriculum, and Materials (Months 1-18)
Team members will work closely with the consultant to develop the curriculum, library of technical resource material, trainee exams, certification criteria, and agenda for the trainings.

SEI provided the curriculum, library of technical resource material, trainee exams, certification criteria, and agenda for the trainings.

Subtask 4.3: Plan and Prepare to Conduct Training Program (Months 1-18)
In parallel with the recruitment effort for the Cooperative member companies, we will establish a date for the inaugural training (to be held at a single on-site location), engage hotel for block discount and make room reservations, assist with travel reservations, engage training instructors/presenters, determine site visit logistics, aggregate tools, book facilities, etc.

The O&M Project Manager coordinated all of the trainings, with some help from the Director of Member Engagement from Amicus Solar. Due to timing and limitations of class size, we ended up hosting two offerings of the online class and three in-person classes. This required coordination for 45 trainees (of which, the award paid for 40 and the companies paid out of pocket for the additional trainees).

Subtask 4.4: Conduct Training Program (Months 1-18)
Hold the training, including virtual, classroom, and/or field instruction. Conduct exams with the trainees as a requirement for internal certification as O&M technicians who are qualified to perform work on behalf of the Cooperative.

Technicians completed the self-paced online classes themselves, and these were followed by in-person classes in Paonia, Colorado, at SEI's campus. SEI issued certificates of completion for trainees who completed the courses with a grade of at least 70 on the exams.

Subtask 4.5: Establish Certification Requirements (Months 1-18)
Create internal certification standards and requirements for O&M technicians who are qualified to perform work on behalf of the Cooperative. The certification standards and requirements will be agreed to by the members of the cooperative as a whole.

As mentioned, in the end we decided not to undertake an internal certification. Instead, we relied on the criteria established by SEI. We are also strongly encouraging technicians to pursue the new specialized certification through the North American Board of Certified Energy Practitioners (NABCEP) which will be offered in 2018.

Task 5.0: Customer and Stakeholder Outreach; Time Period: Months 1-18

Summary: During this task, the project team shall prepare informative documents, hire a website developer to design and build the site, create client proposal templates, and begin selling O&M services through the cooperative framework.

Subtask 5.1: Sign Contract to Develop Website (Months 1-18)
Hire a website developer to design the new Cooperative website according to functionality goals required by all stakeholders.

We worked with the same website designer that Amicus Solar uses. This decision stemmed from a desire to have a similar look and feel to the other cooperative, to preserve branding consistency. As part of this work, we also developed a logo and some basic graphics to make a professional presentation to the world.

Subtask 5.2: Create Content for Website and Informative Documents (Months 1-18)
Write copy, create graphics, and populate the website pages. Create brand-consistent information about the Cooperative for distribution to prospective clients. Website content creation will occur on an iterative basis, following the results of Subtask 5.4.

Development of other informative documents was performed by cooperative staff.

Subtask 5.3: Launch Website (Months 1-18)
Publish the website and begin beta testing functionality and completeness of data with potential customers and other existing and potential member-companies. Beta testing results will lead to iterative improvements in subtasks 5.2 and 5.4.

Subtask 5.4: Perform Website Testing, Audit, and Improvements (Months 1-18)
Maintain a list of website improvements throughout the beta period. Execute updates in the subsequent months. Results will be utilized to complete subtasks 5.2 and 5.3.

The website's functionality was straightforward and did not require much modification after its go-live date in February 2017.

Subtask 5.5: Engage Potential Clients and Demonstrate Market Value (Months 1-18)
Member shall engage customers through existing contacts, attending industry conferences and events, etc. Members shall execute contracts with new clients, highlighting cost reductions from baseline. Generate proposals to potential clients, in addition to executed contracts, which highlight a cost reduction trajectory.

Staff of the cooperative as well as member-companies began introducing the concept in conversations with potential clients early in its development. This education continued throughout 2017 and 2018 in phone calls, at conferences, and in other meetings.

Task 6.0: Manage and Coordinate Project Activities; Months 1-18

Summary: The project team will perform coordination, administrative, and operational work necessary to fulfill project requirements and achieve its objectives.

Subtask 6.1: Launch Online Communication Platform (Months 1-18)
Design and launch the online communication platform, with appropriate sections for each task outlined.

The cooperative managed most of its work through Podio, an online communication platform. It allowed us to track timesheets for each task.

Subtask 6.2: Coordinate Among Project Team Members (Months 1-18)
Conduct regular conference calls with the project team to review progress reports for each team member, a review of next steps and outstanding tasks for each team member, a review of project milestones and schedule, and votes on decisions that need to be made.

Project team members coordinated work through Podio and also through regular bi-weekly calls. The calls allowed us to review progress, take feedback on issues, and vote on items as needed.

Subtask 6.3: Accounting and Grant Management (Months 1-18)
Staff of prime recipient will maintain timesheets and all accounting records for the project and provide reports when requested. Reports and other deliverables will be provided in accordance with the Federal Assistance Reporting Checklist following the instructions included therein.

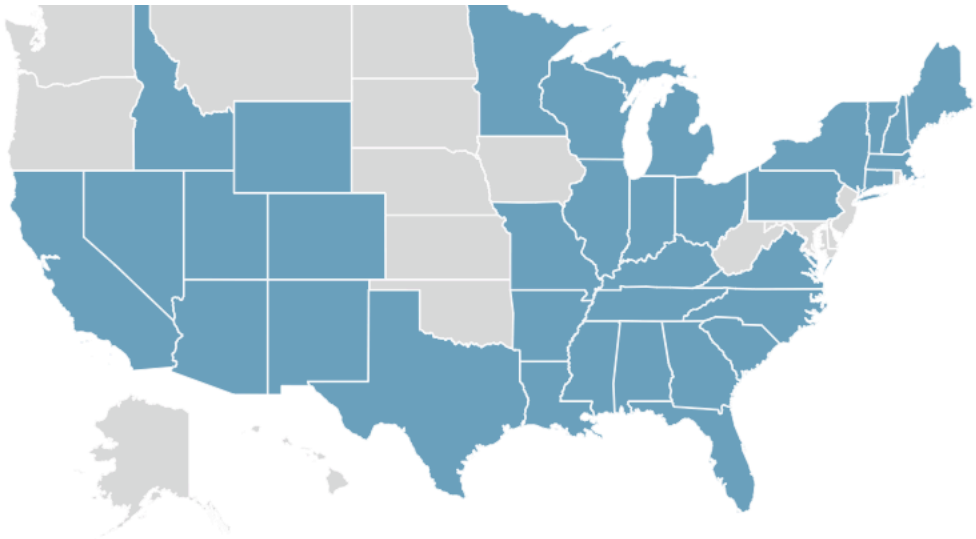
Staff of the cooperative performed most of the administrative work for the award, including reporting. Members from the prime and sub-recipients kept timesheets and other accounting records, as required.

V. Significant Accomplishments and Conclusions

As previously mentioned, we generally feel that the project unfolded as expected, with a couple of notable pivots from the original concept. On the positive side:

- Membership count was higher than the original goal – 20 member-companies signed up within the first year, double the 10 we originally forecast.
- As a result, we were able to train 40 technicians through the partnership with Solar Energy International (up from the 30 included in the original grant application), with excellent feedback from the participants.

- We built the central work order ticketing system in Salesforce, and integrated apps to facilitate onsite documentation by technicians and also streamline report generation. These tools will enable companies to generate client-facing materials in a more time-effective manner.
- Lastly, we have presented a polished face to the world of solar asset owners through the website, educational materials, and published articles



We had to change course a bit from the original concept in two regards:

- Our approach to pricing. We had hoped to create and internally publish a matrix of prices for Preventive Maintenance services on different sized systems to facilitate multi-regional proposals. In consultation with our attorney, we learned that this would, in fact, violate anti-trust law: sharing information in this way would amount to inadvertent price fixing, by allowing companies to see each other's pricing and potentially adjust their own upward. As a result, we have modified our approach to these sales, putting an emphasis not on centralized pricing but on average labor hours spent per site. The additional advantage of focusing on time rather than price is that it provides helpful benchmark data for companies and will encourage greater efficiency onsite as we strive to lower the number of hours in the future.
- Securing signed contracts with asset owners. This was the holdup that required us to file for a no-cost time extension for the award. Generally, member-companies are finding that it can be difficult to get clients to sign these agreements – while O&M services are widely understood to be important for the long-term performance of the system, if there are no immediate problems, clients can be hesitant to sign and pay out funds for these services before they have to. It can thus be challenging to create the sense of urgency that will result in signed agreements. While we have received positive feedback about the concept of the cooperative, there is some reticence to be the first to test a new concept.

Additional lessons learned:

- This is a rapidly changing marketplace. While we certainly knew that walking in, it has been reinforced many times throughout the award period. We have seen a number of new vendors in the space, offering services such as aerial surveillance and thermal imagery, software, and data analytics.
- Potential clients can be difficult to find. The large players are easier to identify, as they are more likely to attend conferences, publish press releases, etc. In many cases, particularly if their assets are geographically dense, they perform O&M services in-house. The clients that we are best suited to serve are small- to mid-sized asset owners and asset managers with geographically distributed portfolios, and they don't always attend conferences. Like the members of the O&M Cooperative, they tend to be regional players with a lower profile. So, accumulating a list of these clients and getting in front of them has been more difficult than anticipated.
- While O&M is still a relatively young market, there are a handful of companies that established a strong foothold early on. These include O&M service providers such as MaxGen, SOLV (Swinerton), Borrego, Miller Brothers, Cypress Creek, EDF, and Sun System Technology, and manufacturers such as First Solar and SMA. They were better capitalized than the O&M Cooperative and have made significant investments in the infrastructure needed to offer sophisticated services and scale quickly. As a result, they hold the majority of the market share for O&M services. That said, many of them still need to sub-contract work in areas where they don't currently have technicians, and we regard them as potential clients as well. But in those scenarios, the price pressure is that much greater on our member-companies, which undermines the profitability of this work.
- For the cooperative to be successful long-term, it must maintain a healthy balance of "Sales Companies" and "Work Companies." Sales Companies are the ones that sell regional or national contracts and are positioned to perform system performance monitoring, dispatching other member-companies to perform work as needed, aggregate reports from the various partners, and handle the invoicing. Work Companies perform the Preventive and Corrective Maintenance visits at each site. Currently, the cooperative has great geographic coverage for Work Companies, but needs more Sales Companies to ensure that everyone is getting adequate work orders for O&M services.
    - In the future, we may explore a modification to the business model whereby the cooperative itself will be in position to make sales directly.

VI. Inventions, Patents, Publications, and Other Results

We have no inventions or patents to report. The cooperative has been featured in a few publications during the award period:

- Website published in February 2017: www.AmicusOM.com
- PV Insider, November 10, 2016
    a. http://analysis.pv-insider.com/national-solar-cooperative-shares-staff-cut-om-costs-35?utm_campaign=PVI+10NOV16+Newsletter+A&utm_medium=email&utm_source=Eloqua&elqTrackId=545bef7dd0a748f8aef2db7ff99d964a&elq=5e60e695818044de95e0b94d098d0c1a&elqaid=23477&elqat=1&elqCampaignId=10558
- Solar Pro Magazine, Jan/Feb 2017
    a. http://solarprofessional.com/articles/business-finance/the-state-of-the-solar-industry/page/0/2
- Solar Power World Magazine, May 2017, Article: 2017 Solar Trends"
    a. http://www.solarpowerworldonline.com/2017/06/trending-solar-om-industry-players-call-standardization/?spMailingID=11300894&spUserID=MjAyMjMzMjg0MTMzS0&spJobID=1181722979&spReportId=MTE4MTcyMjk3OQS2
- Solar Pro Magazine, March/April 2018, Article: "Amanda Bybee, CEO Amicus O&M Cooperative"
    a. http://solarprofessional.com/articles/industry-interviews/amanda-bybee-ceo-amicus-om-cooperative#.WuNShNPwZ0w

VII. Path Forward/Commercialization Plan

Target market: The target market for the Amicus O&M Cooperative is the Commercial and Industrial (C&I, 250kW - 5MW) and small Utility (5-20 MW) Solar PV Market, where asset owners concentrate on developing portfolios of projects with system sizes of 250kW or greater and where the portfolios are too dispersed for the asset owners to perform these services themselves. These entities rely on requisite amounts of electricity generation from the systems to yield the financial returns on which they based their initial investment decisions. As such, it is critical that these systems are properly serviced and maintained in order to optimize the production of electricity, and subsequently, optimize the investors' rate of return on those investments. These portfolios will consist of commercial and industrial scale systems of all varieties: roof mount, ground mount, carport, fixed tilt, and tracking systems, and will be located within the U.S.

Residential solar PV systems will not be an initial market focus for the Amicus O&M Cooperative. Due to their small system sizes, unwillingness of the system owners to pay for O&M services, and high transaction costs, the residential O&M model is not a good fit (at least initially) for the Amicus O&M Cooperative. That said, there is some potential for asset managers that oversee large fleets of residential systems, especially those that span multiple states, to become clients.

Product development: We are able to sell our services as-is, with the current "product version." That said, we can continue evolving the service offering through new additions, including:

- Aerial thermal and visual imaging: this is a growing sector of the O&M marketplace. For systems of sufficient size or with sufficient density, aerial imaging can be a cost-effective way to quickly survey large solar fields and identify problem areas. It is also far safer to fly planes or drones over a field and identify hot spots than it is to have technicians opening live electrical panels to do IV curve traces. To offer these services, member-companies would either need to hire a contractor to perform these services or outfit themselves. The latter path requires purchasing a plane/drone, training and certifying a person to fly it, and learning how to interpret the results (or hiring a sub-contractor for that scope of work).
- More sophisticated Operations capabilities: to date, few of the member-companies are fully resourced to perform remote monitoring services. Those that are can offer it to the other members as needed, and that is how we are filling the gap when clients request it.
- Additional skills and certifications for a larger scope of work: companies could choose to do additional workforce development to seek medium-voltage certification, erosion mitigation, or vegetation management.

First customers: Our first customers were clients that own assets in multiple parts of the country, where the sales company could not comfortably service the sites itself. We were able to leverage previous relationships to offer this improved service level, and their past knowledge of our companies gave them confidence that the model would work well for them.

Growing the customer base: Member-companies that choose to perform sales work are largely self-driven in how they approach potential customers. Their distribution channels and strategies are supported and complemented by activities of the Amicus O&M Cooperative. These include:

- Reaching out to known clients whose portfolio has historically been too large to service;
- Attending industry conferences where customers congregate such as Solar Power International, Solar Asset Management North America, and regional Solar Power conferences;
- Cultivating relationships with clients that we originally reach through conferences with ongoing communications, calls, etc.;
- Conducting PR and marketing campaigns ;
- Building a digital presence including a high-profile website with compelling data and testimonies;
- Creating co-branded marketing collateral to distribute to potential clients; and
- Advertising in key publications such as Solar Pro magazine.

Financial breakdown of product today and at commercial scale:
In our original award application, we included an estimate of how the cooperative would be able to reduce costs. This was primarily due to tighter services, lower administrative burdens thanks to the tools the cooperative has developed, standardized legal templates, lower sales acquisition costs, and lower travel needs. Travel is one of the areas where the cooperative stands to have the greatest impact, but we can't remove those

costs altogether: it's simply impossible to station technicians within an hour of every site in the country, and when drive time exceeds approximately two hours in either direction, in most cases, there simply aren't enough hours left to conduct services in one day.

	Baseline Sub-Contractor/Multi-Contractor Model	Baseline Travel Model	Baseline National Provider Model	O&M Cooperative Model
System Size (kW):				
1,000	1,000	1,000	1,000	1,000
Initial Project Capital Cost:				
$3,700,000	$3,700,000	$3,700,000	$3,700,000	$3,700,000
Core O&M Services	$5.80	$5.90	$7.10	$5.55
Administrative	$4.81	$4.40	$4.81	$2.65
Legal	$5.83	$3.90	$3.89	$2.25
Overtime Pay	$0.81	$3.20	$0.70	$0.00
Sales Acquisition Cost	$1.25	$1.10	$2.00	$0.75
Travel	$1.35	$3.70	$1.02	$0.90
Toltal Annual O&M Cost ($/kW):	**$19.85**	**$22.20**	**$19.52**	**$12.10**
Toltal Annual O&M Cost ($):	**$19,850.00**	**$22,200.00**	**$19,520.00**	**$12,100.00**

During the course of the award, we undertook an effort to establish pricing baselines for O&M services using publicly-available data:

Price Baseline, established June 2017			
Prices in USD/MW-dc/Year (basic plan*)			
	Price Baseline	Target -10%	Target -20%
51-250 kW	$18,338	$16,504	$14,670
251-1,000 kW	$16,225	$14,603	$12,980
1,000-5,000 kW	$11,713	$10,541	$9,370
5,000-10,000 kW	$8,050	$7,245	$6,440
10,001 kW +	$7,325	$6,593	$5,860
*The basic plan is defined by the standard scope of work for preventive maintenance visits.			
It excludes corrective maintenance, vegetation management, and module washing.			
This pricing does not take into account systems that are geographically isolated and far from providers' service centers.			

In the two and a half years since, we have seen pricing in the industry reduce quite a bit, due to increased efficiency, new technology, and stiffer competition. The signed agreements and proposals we ultimately

submitted with our final deliverable came in at significantly lower pricing than we had envisioned at the time of the award application – more than 10% below the established baseline.

Specific work to be done on technical and business aspects over the next 24 months:
Over the coming two years, the cooperative will need to scale in order to achieve financial sustainability. In general, for O&M work to be profitable, it is largely a function of volume (ideally coupled with density) to allow for best utilization of labor resources. The cooperative's financial projections are no different. Fundamentally, the revenue model for the cooperative relies on two sources:

- New member initiation fees and annual member dues
- Revenue-based fee

Recruiting goals over the next two years would see the cooperative expand from 20 member-companies to 30+ by the end of 2019. Adding new companies is one of the most important functions the cooperative staff provides, as we must maintain high standards of workmanship, fill in geographic holes in service area, and ensure good values alignment. There are many companies in the industry that would not be good candidates for membership, and we must sort through them to identify those that are.

With regards to the revenue-based fee, it is currently set at 3% of revenue and shared proportionately by the Sales and Work Companies according to how much each of their services costs. This rate is determined from time to time by the board of directors. It is intended to provide a fair structure whereby those companies that see work through the cooperative pay for a higher percentage of the operating expenses, allowing us to reduce the flat member dues (which all companies pay) over time. For the revenue-based fee to provide a significant portion of the cooperative's revenues, we must see upwards of 400 MW under management. It is very difficult to predict how quickly it will reach that point; current projections indicate that we may reach that threshold in year three, though these projections could be off by a significant margin in either direction.

We will continue to explore offering additional services through the cooperative during the next 24 months, including a more specific function for business development/sales, centralizing system performance monitoring and other operations functions, and other services as desired by the member-companies.