



# A Guidebook

*to Increasing Low-to-Moderate Income  
Households' Access to the Benefits of Rural  
Public Power Community Solar Programs*



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## Executive Summary

This Guidebook summarizes how public power utilities can use community engagement as a tool for exploring and ultimately designing community solar programs for rural and small communities in ways that promote community support for the project and low-to-moderate income (LMI) household engagement. Community solar allows for the use of solar electric generation technology without requiring a single upfront source of investment, as community members can voluntarily participate and pay in to the system over time. However, community solar programs can be designed in many different ways and involve a complex set of technical, economic, legal, and social considerations. This Guidebook demonstrates how working with a team that has expertise spread across these factors and how intentional, proactive, and iterative engagement with community members can inform and ultimately improve community solar program design. Based on the experiences of the Upper Peninsula Solar Technical and Research Team (UPSTART), this Guidebook examines a case study of community solar program design that included community engagement and study of the social feasibility of the program. This work involved interviews with community leaders, a survey of community members, and community meetings that served as informational sessions and a source of data for the project team when thinking about community interests and ways to incorporate them into program design. Based on this case study, UPSTART recommends that public power utilities considering a community solar program should build flexibility into the entire study and design process; emphasize community involvement; offer affordable and flexible payment options; select the program design components based on community input and engagement; integrate energy efficiency into program study and design; and engage in community partnerships to build capacity.

## Introduction

The U.S. Department of Energy declares that a clean energy revolution is taking place across America. The renewable energy sector is expanding, with the solar industry growing at a record pace.<sup>1</sup> Dominant models for solar energy are either large utility-scale systems that feed into the grid or small residential systems that serve the owner's home. Interest is growing in a shift towards decentralized, renewable energy projects.<sup>2</sup> Yet, adoption of solar technology at the household level faces a number of barriers including high upfront hard costs,<sup>3</sup> poor sites for installation,<sup>4</sup> and operations/maintenance concerns.<sup>5</sup> Community solar is an emerging model that attempts to place control and ownership of energy generation in the hands of community members, while mitigating challenges experienced in residential adoption.

Community solar is a relatively new application in the solar PV industry,<sup>6</sup> and many states do not yet provide enabling policy.<sup>7</sup> However, states' existing regulatory structures may still allow public power utilities to facilitate access to community solar for their customers. Federal initiatives (such as the Department of Energy Sunshot Solar in Your Community Challenge) promote community solar as a tool to assist LMI household solar adoption.<sup>8</sup>

While community solar is promising, public power utilities face challenges implementing programs in LMI and rural and small town communities. Designing a community solar program requires a series of decisions related to whether, when, where, and how a project may be built, sold, and managed. Public power utilities in LMI and rural communities may lack the resources and expertise to spearhead, organize, and design a successful program. At the same time, turning to partnerships with organizations outside the community for guidance may lead to skepticism in the community. Many existing community solar programs struggle to achieve customer participation targets, particularly for LMI households, and may require more marketing and customer acquisition costs than anticipated.<sup>9</sup>

Structuring a successful program can be difficult without engaging local community members to better understand their unique interests, values, and potential constraints to participation. For example, community engagement can help inform how best to size a system, to construct attractive participation/payment options, and to market to local residents. This guidebook serves as a roadmap for public power utilities to navigate community solar program design, with a special focus on community engagement in LMI and rural communities.

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1. See <https://www.seia.org/solar-industry-research-data>
  2. Lerch, Daniel, ed. *The Community Resilience Reader: Essential Resources for an Era of Upheaval*. Island Press, 2017.
  3. Hirshberg, Alan and Richard Schoen (1974), 'Barriers to the widespread utilization of residential solar energy: the prospects for solar energy in the US Housing Industry', *Policy Sciences*, 5(4), 453-468.
  4. Mills, Bradford F. and Joachim Schleich (2009), 'Profits or preferences? Assessing the adoption of residential solar thermal technologies', *Energy Policy*, 37(10) 4145-4154.
  5. Rai, Varun, D. Cale Reeves and Robert Margolis (2016), 'Overcoming barriers and uncertainties in the adoption of residential solar PV', *Renewable Energy*, 89, 498-505.
  6. The first community solar program in the U.S. was piloted in 2006 in Ellensburg, Washington.
  7. With the exception of: California, Minnesota, Maryland, etc. Available in SEPA report, 2018.
  8. Paulos, Bentham (2017), 'Bringing the benefits of solar energy to low-income consumers: A guide for states and municipalities', Clean Energy States Alliance. <https://www.cesa.org/assets/2017-Files/Bringing-the-Benefits-of-Solar-to-Low-Income-Consumers.pdf>, accessed on 15 March 2018;
  9. Brummer, Vasco. "Community energy—benefits and barriers: A comparative literature review of Community Energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces." *Renewable and Sustainable Energy Reviews* 94 (2018): 187-196.



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## About this Guidebook

In this guidebook, community solar is described as a voluntary program where community subscribers pay for a portion of a locally-sited solar photovoltaic (PV) array and receive credit on their electricity bill proportional to the power produced.<sup>10</sup> Rural public power utilities and their partners can use this guidebook to develop community solar programs that are inclusive to LMI households. Its purpose is to describe and promote a community engaged social feasibility research model that public power utilities can use to design community solar programs that are tailored to specific community needs, emphasizing the needs of LMI households and rural and small town communities.<sup>11</sup> Many rural communities are characterized by a high proportion of LMI households in the population<sup>12</sup> as well as limited access to affordable and reliable electricity.<sup>13</sup> This guide offers a model and example case studies that communities might follow to help mitigate challenges experienced in the rural community context, including direction on income qualified programs and energy efficiency measures. The suggestions in this guidebook are based on the logic that every community is unique, that top-down or large utility-scale design models may not meet specific community needs or interests, and that residents deserve some say in how their energy systems are structured. The guidebook should first be used to assess whether to explore a community solar program, and then as a model for how teams might move forward with more detailed assessment and project development.

The guidebook covers aspects of program design and implementation along with key recommendations. It relies on specific examples from the Upper Peninsula Solar Technical and Assistance Resource Team's (UPSTART) case study sites to highlight key steps. It also leverages experience gained from two community solar pilot projects implemented by WPPI Energy in New Richmond, WI and River Falls, WI . The Guide begins by setting expectations for a timeline for community solar project development. It then continues into the different phases of developing and designing a community solar program. Figure 1 provides a general overview of the various activities and phases that community solar project teams should consider from initially forming a team through project implementation. It is an example, meant to give teams a sense of the full scope of the project and to demonstrate how the various phases of the project are connected.

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10. See <https://sepapower.org/resource/community-solar-program-designs-2018-version/>

11. Brummer, 2018

12. Flora, Cornelia Butler. Rural communities: Legacy+ change. Routledge, 2018.

13. Lerch, 2017

First, it is important to assemble a team that brings the necessary knowledge, skills, and resources for project success. Once the team is established, community engaged social feasibility research is a good way to engage the broader community in learning about and getting involved in decision making about community solar. The research process gathers data about whether the community is receptive to starting a community solar program, what kinds of pricing structures might work, who the relevant partner organizations are, and what kinds of values, beliefs, and practices might offer opportunities or pose challenges along the way. The next section summarizes various aspects of program design and structure that could be considered. A case study example illustrates how this process might look in real life along with suggestions for how to navigate challenges as they arise. The Guide concludes with general recommendations for public power utilities when considering a community solar program, specifically focused on using a community engaged approach to address community solar program design, LMI engagement, and incorporation of energy efficiency, especially in rural and small communities.

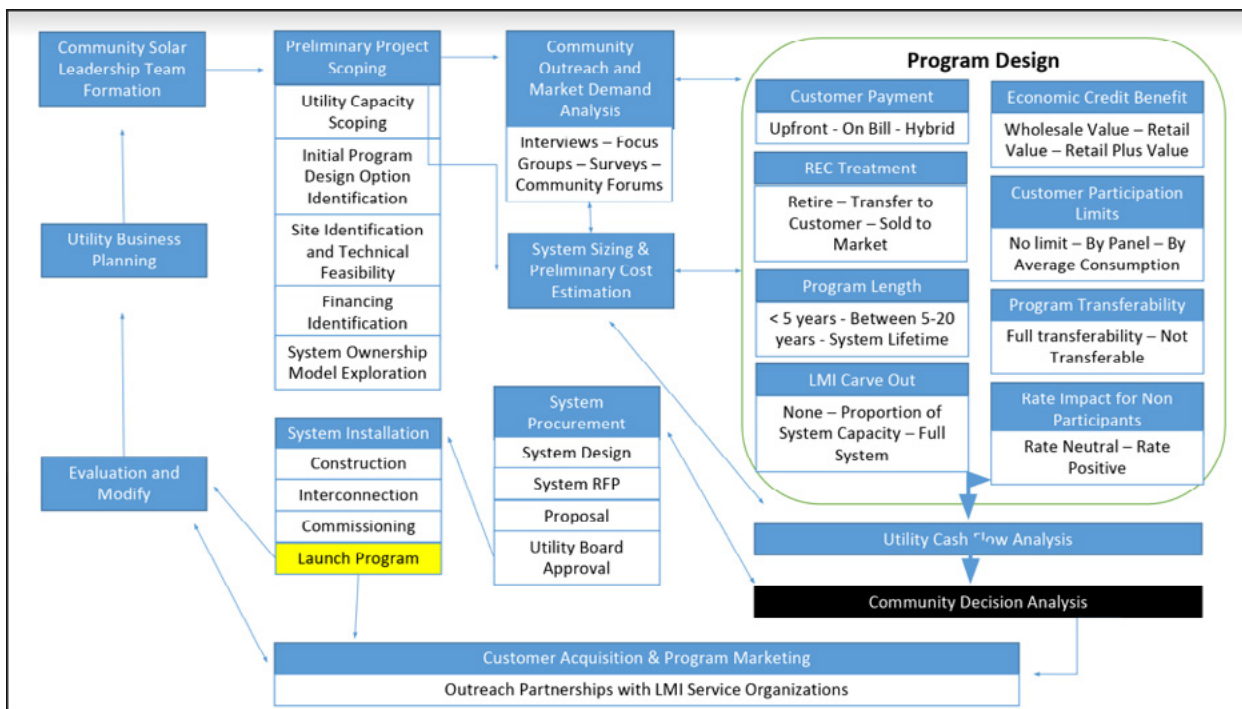


Figure 1. Community Solar Project Development Process

# Getting Started

## Timeline

The sequence of stages illustrated in Figure 2 is meant to emphasize the iterative nature of the community solar project development process. Public power utilities should plan for the process to take about two years; however every community is different and this timeframe can vary. While integrating robust research into the project development process does take time, it is an important means to understand the local context and to give communities a say in the ultimate project design.

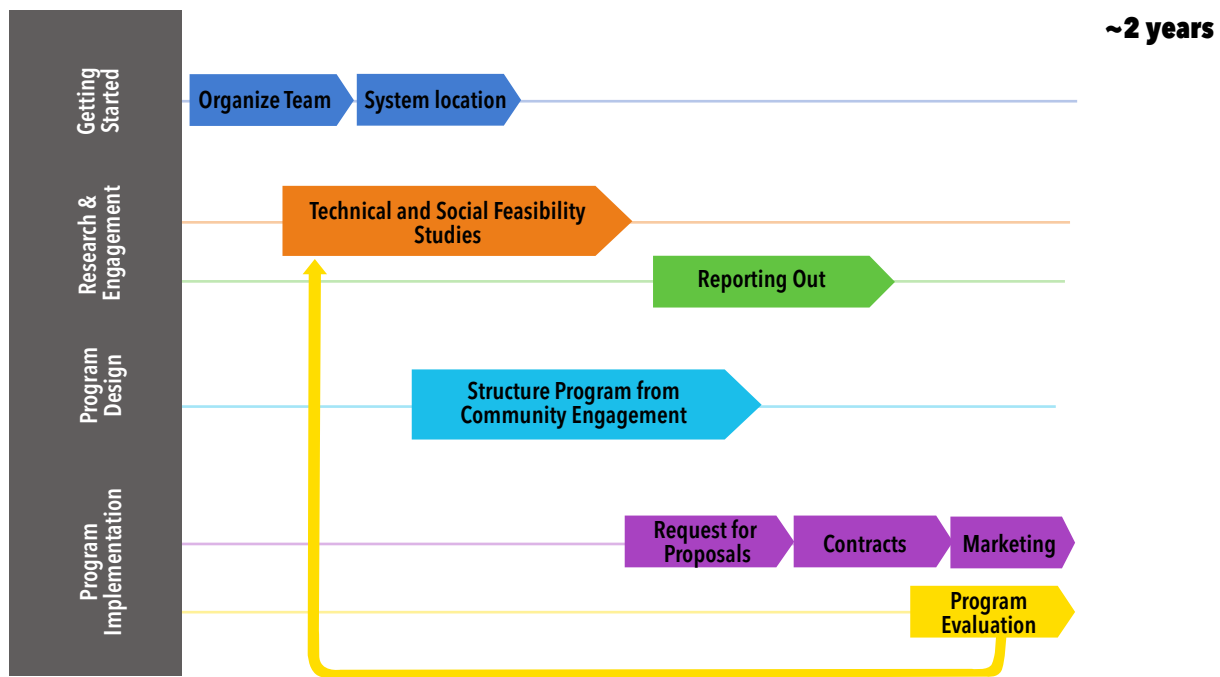


Figure 2. Sequence of Stages

## Community Engagement & Building a Team

Unlike many utility energy programs, a successful community solar project requires the support of a wide array of community stakeholders and decision makers. In addition, a community solar program requires a combination of technical, economic, social, legal and policy considerations in order to work. The public power utility should develop a team and determine a shared understanding of the project goals, which can help shape the community solar program type as well as team needs. Once goals are established, the team can seek out and extend partnerships to others (i.e. local government, nonprofits, research institutions, etc.) who possess the knowledge, networks, resources, or skills to help achieve program goals.

Assembling a team with the right mix of skills and expertise is an important step in the project development process. Including stakeholders early in the development process can also help to achieve support for the project and identify key challenges and considerations when considering the program's design. Leadership teams can take different shapes and sizes. A helpful strategy to identify key team members is to consider the following:

- ◉ **What community members and/or organizations have relevant skill sets?:**
  - Energy, electrical engineering, and solar technology
  - Financing
  - Tax law
  - Public outreach
  - Public zoning and permitting
  - Public housing and other social programs serving LMI households
  - Marketing and communications
  - Environmental sustainability
  - Utility operations and programs
  - Other relevant skill sets
- ◉ **What community members and/or organizations represent different segments or key stakeholders in our community? Examples include:**
  - Local government
  - Service and philanthropic groups
  - Local businesses
  - Educational and research institutions
  - Religious and faith-based organizations
  - Environmental and conservation groups
  - Economic development organizations
  - Tribal organizations
  - Other relevant groups
- ◉ **What community members and/or organizations serve in a decision making capacity that facilitates or impedes the development of the community solar program?**
  - The utility administrator
  - Local elected officials
  - Community administrators
  - Appointed individuals to boards such as planning commissions, zoning boards; permitting officials, etc.
  - Other relevant departments or organizations

Once the team is in place, it is important to define partner roles. A program manager or equivalent will be helpful in keeping the team on track to meet incremental goals, satisfy deadlines, and orchestrate external meetings to help the team meet their needs. Other team member roles can include liaison between the team and broader community leaders, media outlets, or the entire community. Conducting social and technical feasibility studies will require adding experienced researcher(s) to the team. Researcher roles and goals must align with the team's needs and interests, so that the project remains community driven. Researchers who follow a community-based participatory research model<sup>14</sup> will be most appropriate.

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14. Burns et al, 2011. A short guide to community based participatory action research. Available at: <https://hc-v6-static.s3.amazonaws.com/media/resources/tmp/cbpar.pdf>

## ***Decision-making Process***

Discussing and defining the decision-making process and decision-making power early can improve clarity and understanding throughout the project. There will be multiple levels of decision-making within the core team, among the utility management, and extending out to the community on issues ranging from whether and when to move forward, to system design components, research design, project timeline, pricing structures, and more. Teams should start a dialogue about this process when they first form. They may choose to follow any number of decision-making models<sup>15</sup>. There may be one team member or a small portion of the team who ultimately decides if the project should and can move forward, or it may be a unanimous decision. Some decisions may require one type of process, while others require a different process. The key is to discuss how this will be handled and to remain transparent about how decisions are made both within the team and with the broader community. In many energy projects, the community is left out of decision-making, which can defeat one of the goals of a community solar project- to have local ownership over the energy system.

Engaging the community in decision-making where possible and remaining transparent throughout the process for how decisions will be made can increase trust and buy-in.

## ***Where Will the System Go?***

Determining potential sites for the community solar array can be tricky. The utility has to find a viable site for energy production that is acceptable to both participating and non-participating community members. The site needs to be large enough to install the system, be free of obstacles creating shade, and have access to the utility distribution system. It can be helpful to work with the community to determine potential locations. Some community members may not appreciate the aesthetics of a solar PV system in their neighborhood while others may want to see the panels in which they have subscribed. Some locations may be more susceptible to vandalism or theft. While having some site locations in mind prior to engaging with the broader public is a good idea for generating conversation, teams should keep these potential sites preliminary, and draw upon the social feasibility study to determine final system size and location.

### **THE UPPER PENINSULA SOLAR TECHNICAL ASSISTANCE AND RESEARCH TEAM:**

UPSTART formed in March 2017 to respond to a Department of Energy Solar in Your Community Challenge. The idea was to bring together knowledge, resources, and skills to help design and develop a community solar program in two rural Upper Peninsula Communities. The team began as a partnership between the Villages of L'Anse and Baraga Administrators, WPPI Energy, the Western Upper Peninsula Planning and Development Region (WUPPDR), and researchers at Michigan Technological University. As the project evolved, UPSTART membership and resources expanded to include marketing and contract development with Michigan Energy Options, energy efficiency studies with LOTUS Sustainability & Engineering, development of a cost-benefit analysis tool with the University of Michigan Dow Sustainability Fellows Program, and media development with a team of Michigan Tech students learning documentary production (CinOptics).

15. DEFG. 2019. Low Income Consumer Solar Working Group Final Report. Available at:<http://defgllc.com/publication/low-income-consumer-solar-working-group/>

Like any land use decision, local zoning ordinances can play a pivotal role in shaping a project's physical characteristics and even the overall performance and economics of a community solar program. Often times, large solar projects are classified as industrial projects in local zoning codes which may require screening around the project site. This requirement can add additional costs and cause shading which may decrease the systems overall efficiency. Zoning practices that allow solar projects to remain visible can help avoid this concern and help the utility more effectively market the project to attract participants. Many communities believe their zoning codes help to facilitate solar development because the codes don't specifically restrict solar projects. Unfortunately, staying "silent" on solar may actually do the opposite by leaving the community open to legal challenges from individuals who oppose solar development. Adopting zoning practices that allow for solar through conditional or special use permits proactively confirms opportunities for solar land use<sup>16</sup>.

### *Who Will the Program Serve?*

One of the project team's first tasks should be to define who the target participants will be. This will help to shape which community solar model is chosen and determine availability of supporting resources and opportunities for engaging additional stakeholders. Projects might choose to target LMI households and/or other groups who are often left out of energy projects.

Community solar attempts to increase access and affordability of our energy systems. Yet, a majority of community solar programs exist and operate within affluent communities<sup>17</sup>. Making community solar more accessible is possible and is often an important goal. While there are special considerations and challenges in designing programs for less advantaged participants, there are also opportunities for engaging different groups, expanding the stakeholder base, and accessing resources. Some possible targeted participants include:

- **Low-to-moderate income (LMI):** there are many existing federal and state definitions for LMI households. A first step is to select a definition that fits program goals. UPSTART utilized the U.S. Department of Housing and Urban Development definition<sup>18</sup>. One challenge is that some LMI households may not have large enough tax liability to take advantage of current tax incentives for renewable energy development (e.g. 30% Renewable Tax Credit).

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16. For additional guidance on best practices for solar zoning visit <http://www.solsmart.org>.

17. National Renewable Energy Lab. Feldman, David, Anna M. Brockway, Elaine Ulrich, and Robert Margolis. 2015. Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation. National Renewable Energy Laboratory and U.S. Department of Energy. Available at: [www.nrel.gov/docs/fy15osti/63892.pdf](http://www.nrel.gov/docs/fy15osti/63892.pdf); also Lotus Engineering and Sustainability. 2015. "Analysis of the Fulfillment of the Low Income Carve-Out for Community Solar Subscriber Organizations". Available at: <https://www.colorado.gov/pacific/sites/default/files/atoms/files/Low-Income%20Community%20Solar%20Report-CEO.pdf>; see also Smart Electric Power Alliance. 2015. Community Solar Program Design: Working Within the Utility". Available at: <https://sepapower.org/resource/community-solar-program-design-working-within-the-utility/>.

18. See [https://www.huduser.gov/portal/glossary/glossary\\_1.html](https://www.huduser.gov/portal/glossary/glossary_1.html) for a full understanding of the definition.

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- **Non-profits:** 501c3 organizations cannot access existing tax incentives (e.g. 30% Renewable Energy Tax Credit and/or 100% Bonus Modified Accelerated Cost Recovery System depreciation) for solar because of their tax benefits.
  - **Renters:** Renting households are generally more transitory than homeowners. It doesn't make sense for them to invest in solar panels in a rental unit, so community solar may be appealing. Still, renters may require extra considerations in thinking about transferability of panel shares should they move.
  - **Tribal communities:** Tribal communities are often leaders in renewable energy generation, and may be particularly interested in participation that meets the needs of tribal members. Tribal involvement could open access to federal funding initiatives that emphasize clean energy goals in tribal communities.

Additionally, team members need to consider other factors that can shape program participation. Some projects can be predetermined by geographic boundaries. For example, in some states regulated utilities operate within mandated service territories, and recruiting program participants from this service territory into a community solar program may violate the state regulated utility service agreement.



## Research Process

Before making too many decisions about whether to start a program or how to design the specifics of one, it is important to engage with the local community in a meaningful research process to evaluate both technical and social considerations. A project can struggle with program participation, support, or acceptance if it does not consider the needs or values of the community. Social considerations can include project location, program costs, and awareness and perceptions surrounding community solar systems, to name a few. The most important piece is to determine if the community even wants a project like this. Engaging the community can help teams understand local perspectives on these issues and potentially lead to improved program design.

### *Technical Feasibility and Specifications*

The Solar Market is changing quickly and it is important for the utility to have a good feel for the energy output, size, and cost of a system before starting a social feasibility study. In the past few years, energy density on solar panels has increased from <250 watts per panel to >400 watts per panel at similar costs. This is likely to continue much the same as in the 1970's when handheld calculators increased in speed, size, and functionality with no change in price. Likewise, inverters and monitoring systems have similarly improved in sophistication. Taking all these improvements into consideration can be a difficult task for a smaller public power utility that may not have staff experienced with solar PV installations. Novice utility staff should partner with a reputable and experienced installer or site assessor to help develop the initial system specifications.

This said, there are web tools readily and publicly available to facilitate this process. Two such tools are available from the National Renewable Energy Labs (NREL) in Golden, Colorado-PVWatts and SAM<sup>19</sup>. PVWatts is a simplified tool that allows homeowners and small businesses to make good estimates of the size and cost of solar installations with minimal data.

SAM (System Advisory Module) is a more sophisticated program. To use this tool, minimal information is needed, including:

1. Site Location (address or GPS coordinates)
2. Target Nameplate Power Generation (usually in Kilowatts)
3. Estimated Budget (note items 2 and 3 will require some iteration)

To use the SAM program, you simply enter the required information. The software will use weather data and the location's irradiance (energy from the sun) for the site to estimate the potential energy production. The software will also select a default solar panel from its database as well as required electronics to come up with an estimate of total system cost and annual energy production. The user can change the solar panels used and the electronics to match available equipment from local suppliers. This tool thus can be used to compare different vendor quotes when RFP's are submitted. Fine tuning of the model can be done as well to explore parameters like the altitude angle of the solar panels and the use of microinverters versus full system inverters. With this tool the team can play "What if?" games to explore larger or smaller systems.

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19. <https://www.nrel.gov/>; PVWATTS tool <https://pvwatts.nrel.gov/>; System Advisory Model <https://sam.nrel.gov/>



In addition to experienced installers and site assessors, educators from local Universities might also be a good resource for assisting with making these estimates. Solar panels are an attractive area of study and make for a great student project. UPSTART worked with Michigan Technological University undergraduate students to do an initial technical feasibility analysis and cost estimate. The resulting student report is available in Appendix A.

### ***Social Feasibility Study***

Many projects address technical and broader economic feasibility, but fail to research social feasibility. A social feasibility study (also known as a social impact analysis) is a methodology, framework, or process that elicits and incorporates social information and feedback to design and implement a project. Public power utilities can utilize social feasibility studies to prioritize, gather, and analyze information obtained from and with their communities to best design a project for the community. Overlooking social conditions (interests and concerns) puts the success of the project at risk and limits its potential for positive impact<sup>20</sup>.

Utilizing a social feasibility study in community solar program design can help public power utilities to better understand how to design programs that satisfy project goals and fit community needs. Existing community solar programs that included a social feasibility study felt they influenced the project's success by identifying concerns early on that could later be addressed in the project design phase<sup>21</sup>. Social feasibility studies can also help identify key stakeholders, determine key community considerations, and translate project information to the community. While there are many benefits, not all public power utilities possess the skills or resources to successfully conduct social science research. Partnering with a research institution can provide access to these skills, and also ensure appropriate human subjects research ethics are followed.

Teams should first conceptualize goals of the social feasibility study. What exactly does the team want to learn? How do they plan to use that information? How will the team know if the results indicate the project is feasible or not? Is one of the goals simply sharing information with the community and increasing broad participation? And, if so, how much participation (and from who) should be expected? These are all important questions that teams should collaborate with researchers to define at the start of the project, and which will ultimately inform the research design and analysis process. Once the team decides what the aims will be, they can begin to craft the study design.

There are various tools and research approaches that teams might choose to employ, depending on the project goals. These might include: qualitative interviews with key informants, community meetings, focus groups, surveys, charettes, bus or walking tours, and/or a critical review of existing community solar projects. Each are described below. Teams might choose to combine several of these into their research design.

- **Interviews:** Qualitative interviews with key informants are a good first step to explore the local context and possible opportunities and challenges that may arise. Interviews examine how residents and business owners feel about a community solar project in their community, what hurdles might come up in if the utility pursues a community solar project, and what cultural, economic, social, or institutional factors could impact the success of a project. Researchers should collaborate with non-academic and local team members to develop interview

20. Wüstenhagen, Rolf, Maarten Wolsink and Mary Jean Bürer (2007), 'Social acceptance of renewable energy innovation: An introduction to the concept', *Energy Policy*, 35(5), 2683-2691.

21. see <https://www.nppd.com/innovation/solar/sunwise-community-solar/>

questions and to select appropriate interviewees to ensure that the views of important community stakeholder representatives are heard. Key informants are often community leaders who know the community well, and they should come from a variety of backgrounds and be affiliated with various institutions (e.g. schools, local businesses, social service organizations, religious organizations, political organizations, sports teams, or servers/bartenders in popular gathering places). Additional contacts for interviewing can be found through snowball sampling, where interviewers ask interviewees who else they should talk to in order to hear important or different perspectives. The interviews themselves are often audio-recorded and later transcribed so that team members can review them to identify key themes. UPSTART's interview protocol and summary of interview results can be found in Appendix B.

- **Community meetings:** Community meetings allow for larger community discussions and broad information sharing. They can be structured so that the community solar team can share preliminary information about the proposed community solar project, and offer discussion time to gain insight into how community members feel about the possibility of beginning a community solar project and about potential opportunities and obstacles for designing a project that meets community interests. They might target a specific group or be open to the public and broadly advertised, in order to garner the most participation and diversity of views possible. A World Cafe<sup>22</sup> format is a meeting design that is particularly well suited for both sharing and receiving information with a broad set of community members in an informal, relaxed atmosphere where participants sit and discuss specifically-posed questions in small groups, combining aspects of a community meeting with those of a focus group. Community meetings offer community members an opportunity to learn about the potential project and to expand the decision-making process widely. Opening a dialogue with the community can help to reduce local skepticism and increase community empowerment by allowing participation. UPSTART's community meeting protocol can be found in Appendix C.
- **Focus Groups:** Focus groups gather input from a small group of stakeholders on pertinent program features or topics. Focus groups are usually comprised of five to eight pre-selected stakeholders who can represent key target audiences. Generally, the group is led through a series of predetermined questions by a facilitator allowing for discussion between the participants. An important element of a focus group session is the ability to explore potentially unanticipated topics brought to light by the group's discussion. These can be challenges to participating in the program or creative program design options not yet identified by the project team. This may help identify important concerns or benefits of a project. Depending on a community's resources, multiple focus group sessions could be held with different sets of stakeholders.

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22. Jorgenson, Jane, and Frederick Steier. 2013. Frames, framing, and designed conversational processes: Lessons from the World Cafe. *The Journal of Applied Behavioral Science* 49: 388–405; see also Brown, Juanita. 2010. *The World Café: Shaping Our Futures through Conversations That Matter*. Surry Hills: ReadHowYouWant.

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**Surveys:** A survey of public power utility customers is a good way to gather basic information from a large number of households. Surveys help to determine if the perspectives of people who participate in interviews, focus groups, or community meetings are more broadly shared and generalizable across the broader community. Survey aims might be to determine broad interest levels in participating in a community solar program, what price points are most attractive, to generate a rough estimate of how many panels a project might sell, to determine how widespread potential perceived barriers to participating in the program may be, or to provide another channel through which people can voice concerns and generally stay involved in the decision-making process with minimal time and effort committed. Survey sampling strategies and questionnaire design are critical and will require expert input in order to ensure reliable results. Getting representative response rates is another concern, and may require door-to-door canvassing or other follow-up measures. Altogether, the information gathered should help the team develop a preliminary business model that could later be presented to the community for further feedback. UPSTART's survey protocol can be found in Appendix D.

- **Charrettes:** Charrette sessions are often intense, multi-day workshops where participants help craft a vision and design for a major development project. For community solar planning, this approach can be leveraged to help design a more socially acceptable project site or location or for overall community solar program design. This process is often led by a trained facilitator and can help build consensus for the project and help community members better understand the dynamics influencing a successful project.
- **Bus or walking tours:** Walking and bus tours allow communities to collect feedback from stakeholders on key land use decisions that influence community solar projects. Tours can be used to allow stakeholders to visit existing solar projects in order to become more familiar with project development outcomes or to visit potential project sites to better understand the challenges and opportunities to site development. The process allows community members to share feedback with utility officials and project team members on proposed projects or offer new alternatives to the project's design.
- **Evaluate existing projects:** While community solar is still relatively new, several projects exist across the country. It is important to learn from the range of different projects and the challenges, successes, and failures they have experienced. Several resources exist<sup>23</sup> to serve as a starting point, but teams can also conduct their own evaluation of community solar; especially in regions with similar demographic characteristics and climate conditions.

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23. See <https://sepapower.org/resource/community-solar-program-designs-2018-version/>; See also <https://www.mtu.edu/social-sciences/research/reports/lanse-cs-report2.pdf>; see also <https://www.nrel.gov/docs/fy11osti/49930.pdf>

- **Financial analysis:** Ultimately, at the end of a social feasibility study, both utilities and community members are going to want to know: (1) how much subscribing to a panel or share in a community solar project will cost; and (2) what will be potential returns on investment. This all comes down to the size of the system, installation costs, “soft” costs of administration, operation, and maintenance, how many people are willing to participate (estimated from the social feasibility), and how costs will be distributed. In order to determine program design options, teams will ultimately need to balance costs of implementing a program that the utility will incur with meeting the needs and designing a program that is affordable, attractive, and accessible to community investors. This is discussed in more detail in the section on Determining Customer Costs and Payment Structures below.

### ***Reporting Out***

For broader communities to be engaged in the community solar process, they need to know the results of the feasibility research described above. A summary of study results can be shared via press releases, presentations to key stakeholder groups (e.g. school boards, city/village/town councils, chamber of commerce) or other community organizations (religious gatherings, community economic development offices, community action meetings, etc), radio conversations, social media, hosting a community meeting, or through online or print publications. It is helpful to utilize media outlets to advertise these events. Teams might use study results to design a preliminary program structure (or a set of buy-in options or scenarios). They can then share these publicly, along with the more general study results, and request additional feedback. This allows community members to generally see where the community lies in terms of community solar program support, as well as to provide additional feedback on the program design.

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## Program Design

### *Policy Context*

The state and local policy context can heavily influence the success of community solar programs. Some states<sup>24</sup> have formal laws to support and promote community solar program implementation while others leave program development to the utility's discretion. Some other states prevent non-utility owned community solar by prohibiting some kinds of program designs (e.g. virtual net metering or power purchase agreements). The policy context can influence who owns the project, how and who reaps the benefits and costs, system siting, and other program design elements. Reviewing state and local policies ensures the project is in compliance with existing laws, regulations, and rules.

### *Tax Incentives*

Solar projects may be eligible for a 30% Federal Investment Tax Credit (ITC). The ITC allows the system owner to deduct 30% of the solar project cost from federal taxes. The 30% amount is available through 2019, after which the tax credit steps down to 26% in 2020, 22% in 2021, and 10% for commercial and industrial systems thereafter.

Additionally, systems owned by commercial businesses are eligible for the Modified Accelerated Cost Recovery System (MACRS) Depreciation. The 2017 Tax Laws allow for 5 years of 100% bonus depreciation for systems installed after September 27, 2017. This means that eligible systems can essentially expense a portion of the project cost within the first year of commissioning.

Other incentives, such as solar energy property tax exemptions, vary by state and locality. The Property Assessed Clean Energy (PACE) mechanism allows commercial and residential property owners to use government financing for up-front costs of eligible projects. In exchange property owners repay the up-front cost through special assessments on property taxes over a period of time. PACE programs exist at the state, regional, and local government levels and can vary in financing structures and eligibility measures<sup>25</sup>. Some municipalities are located in Opportunity Zones which allows investors to take additional tax deferrals when investing in LMI and rural communities. Again, these vary state to state and by location<sup>26</sup>.

While all of these incentives can function to lower total community solar program cost, they are available only to residential, commercial, or industrial consumers that have a tax appetite. LMI communities, non profit organizations, governmental agencies, and municipalities cannot monetize these tax benefits. Seeking alternative funding options or partnership opportunities (discussed below) can reduce community solar project costs.

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24. California, Minnesota, Maryland are a few examples

25. To find out if your project is eligible for PACE financing, please visit <https://www.energy.gov/eere/slsc/state-and-local-solution-center>

26. To find out if your intended solar PV site is located in an Opportunity Zone, please visit <https://esrimedia.maps.arcgis.com/apps/View/index.html?appid=77f3cad12b6c4bffb816332544f04542>

## ***Program Costs***

There are many factors that will influence the overall cost of a community solar program, with installed capacity being the largest contributor. PV system and construction costs increase as the capacity of the array increases, but the installed cost/capacity ratio will also gradually decrease with economies of scale as system capacity increases. Other “soft” costs that affect the overall cost of the program include operation and maintenance, marketing and administration, insurance, permitting, interconnection, financing and site development. The effects of system size and soft costs on program finances are discussed in more detail in the remainder of this section and Program Implementation section.

### **WPPI THIRD PARTY OWNERSHIP MODEL**

In 2016 WPPI Energy implemented 250 kW community solar pilot programs with each of their member public power utilities located in River Falls, WI and New Richmond, WI. In the design phase, the goal of the project was to implement community solar in each of these communities to meet customer demand with no adverse rate impacts to non-participating utility customers. As WPPI Energy was developing the financial model for the program, it became obvious that under the utility ownership model, subscription rates would have to be set too high and would discourage customer participation. To lower costs, they successfully worked with a third party owner that could bring in the benefits of ITC and accelerated depreciation into the financial model.

## ***Ownership Models***

When implementing a community solar project, a public power utility doesn’t necessarily have to own and operate the PV system. Although the most common model is for the utility to own the array, a developer, community organization, or other entity can build, own, and maintain the system for the utility. In this model, the utility purchases the energy output from the third party owner via a power purchase agreement (PPA), customers purchase subscriptions from the utility, and the utility credits the customer. For public power utilities, utilizing a third party ownership model can lower implementation costs by making the federal ITC accessible. Although financially attractive, managing additional contracts and agreements from a third party ownership model becomes complex for public power utilities. The utility must find a party willing to accept the financial liability and be dependable over the life of the project or until the assets can be transferred to the utility. It should be noted that third party financing and ownership may not be an option for public power utilities that have all-requirements wholesale power supply agreements.

## ***Identify Program Funding***

Identifying appropriate and sustainable sources of funding is key to financing up-front solar and other soft program costs. Public power utilities may be unable to take advantage of existing solar tax benefits, but they may be able to cooperate with other entities that can through creative ownership models, as described above. Many community energy projects begin with some portion of grant-funding that they ultimately turn into a revolving clean energy fund<sup>27</sup>. Some options to consider can include:

27. See Dubuque, Iowa and Pennsylvania as examples: <https://dced.pa.gov/programs/solar-energy-program-sep/>.

- **Partnerships:** These can be important sources of financing as third parties may allocate funds strictly for investment in LMI communities. Examples include: corporations, banks, and project developers. Businesses may have internal initiatives for corporate responsibility, such as engaging low-to-moderate income communities or environmental sustainability. The Community Reinvestment Act encourages commercial banks and savings to meet the needs of borrowers in all segments of their communities, including LMI households. New Markets Tax Credits help project developers lower the cost of participation for LMI customers.
- **Tax equity:** Similar to third party partnerships, a tax equity partner finances the community solar program up-front, owns the system, and monetizes and passes along existing tax benefits. Depending upon the agreement, system subscribers can realize a portion of the tax benefits through decreased subscription costs. The investor also realizes a favorable return on investment and may be more likely to invest in future projects.
- **Grants:** Existing federal and state initiatives and grant programs are available to help fund and forward clean energy and energy efficiency goals. Some of these can be accessed by local governments in rural communities. The US Department of Agriculture's Rural Development Program periodically solicits applications for loan and grant funding through the Rural Energy for America Program (REAP). The Department of Energy (DOE) SunShot initiative offers many solar grant funding opportunities and competitions to lower solar project costs for LMI communities. Additionally, the DOE offers a Tribal Energy Program Grant to promote tribal energy sufficiency, economic growth, and employment through clean energy projects in tribal communities. Some State Departments of Agriculture and Rural Development may offer funding opportunities for renewable energy and energy efficiency projects as well.

#### **COST-BENEFIT ANALYSIS:**

An accurate depiction of the costs and benefits of a community solar project is an important piece of information in the decision making process. A cost-benefit analysis (CBA) attempts to monetize costs and benefits of a project or program to determine if it results in a positive net benefit for a customer, utility, or community. CBAs are a common decision making tool for policy makers and utilities since it allows for current and future project costs and benefits to be measured using today's dollars. The analysis can include direct project expenses and benefits (e.g. the cost of equipment and value of energy produced) as well as other important values that often are included in project budgets (e.g. the value of carbon emission reductions). The utility can use CBAs to determine if community solar projects financially makes sense for the utility to build the array and whether or not community members would benefit from subscribing.

UPSTART developed an Excel spreadsheet based cost-benefit analysis tool for this project. By simply manipulating variable cost and revenue inputs, a utility can use this tool to develop a program and evaluate how different financial models will affect both the utility and its customers with respect to cash flow and net present value of money. An example of the cost-benefit tool can be accessed under the listing for this project on the DEED project database at <https://www.publicpower.org/deed-project-database>.

- **Low interest loans:** Community solar programs are increasingly targeting low-to-moderate income populations. To make financing more feasible to these populations, some external funding entities can provide low or no-interest loans. Additionally, some banking institutions maintain a local funding pool to help promote sustainable development initiatives in municipalities<sup>28</sup>.

### ***Determining Customer Costs and Payment Structures***

In order to increase participation and accessibility, especially among LMI households, it is critical to keep customer buy-in costs as low as possible. At the same time, public power providers must ensure community solar projects are fiscally responsible and balance the interests of non-sub-

scribing customers. This means that several factors and tradeoffs need to be considered when determining customer costs, payment structures, and buy-in options.

#### **SOLAR DESTINATION YPSILANTI:**

Solar Destination Ypsilanti formed in early 2017 with the SunShot Solar In Your Community Challenge. This is a partnership between a private firm, Chart House Energy, a nonprofit grassroots company, Solar Ypsi, and the City of Ypsilanti to bring community solar and job training to LMI communities and nonprofit organizations. In this ownership model, Chart House Energy helps to bring the solar array cost down for non-profit organizations by owning the solar assets to monetize the tax benefits. The system owner rents the host facility roof, while the host facility receives discounted power through an equipment lease. Solar Destination Ypsilanti then uses their portion of energy savings to re-invest in additional solar projects. The team also recruits and trains individuals from LMI communities on solar installation, general construction, and safety practices in hopes these community members find employment in general construction or solar installation careers.

Enhancing LMI participation in the program increases the difficulty of the balancing act. Public power utilities should consider reserving a portion of system capacity for LMI customers along with payment options (such as lower upfront costs, grant-funded down payments, and on-bill financing) to increase access for these customers. These decisions may require increasing costs for non-LMI customers. Cash flow for the utility can be an issue if on-bill financing is offered and minimal upfront payments are collected. Program costs can also increase as the utility attempts to fill reserved LMI capacity with additional marketing and customer verification efforts. Offering different subscription costs to different customer types can help to prevent or alleviate these issues.

Determining the size of the system can also affect program pricing for subscriptions. While economies of scale can reduce construction costs as system capacity is increased, the utility's liability increases if the program is oversized for customer demand and is not fully subscribed. Enlisting or pre-subscribing an "anchor tenant" to the program can help reduce the risk to the utility while helping to increase customer demand and maximize the

capacity of the system. Ultimately, a successful program ensures a good investment to both the customers and the utility. Net Present Value (NPV) analysis can be used to model the value of the customer's investment over the term of the subscription. Simple payback is typically easier to calculate and understand than other financial analysis methods such as NPV or internal rate of return (IRR), but this method does not account for the time value of money, panel output degradation, customer credit rate changes, inflation, risk, financing, or the benefits of the investment after the payback is achieved.

28. See <https://www.cdfifund.gov/Pages/default.aspx>



## ***Transferability of Subscriptions***

The typical operational lifetime of solar panels is 25 years or more. Paying for a long-term subscription can be a main concern of customers who choose to move within or leave the service territory during the program lifetime. While these customers may be unable or unwilling to subscribe for the entirety of the program, transferability can be an attractive program design component. The utility might allow customers to do the following with their subscriptions:

- transfer to a new electric account held by the owner
- resell to another customer
- donate to a non-profit customer (e.g., church or school)
- gift to a friend or family member

Transferability adds flexibility to a community solar program and may help to address customer concerns and needs.

## ***Partnership Opportunities***

Community partnerships can play a critical role to access project capital and gain program participants, particularly LMI customers. Community organizations like schools, religious institutions, hospitals, tribal entities, and charitable organizations serve the dual role of both institutional power purchasers and also key community institutions and thought leaders. Utilities seeking a potential anchor tenant may find it helpful to start with key community organizations like these who have both large power demands and a variety of motivating factors for participating in solar programs (e.g. cost savings, environmental sustainability, community wellbeing). Often times, these organizations have access to special funding resources (e.g. grants, loans, membership bases) to support investment in renewable energy and energy efficiency that businesses and residents cannot access. Membership networks like alumni, donors, tribal members, and congregations extend beyond a utility service territory. These groups can provide organizational investment in community solar programs. In addition, it may be possible to develop “donor models” where panels subscriptions are purchased and donated to qualifying non-profit organizations, resulting in tax deductions for individual donors. This can be an effective technique to engage businesses and philanthropic groups seeking to support community organizations.

### **SUNWISE COMMUNITY SOLAR PROGRAM:**

The Nebraska Public Power District (NPPD) is a public power utility that piloted its first community solar project in 2017. NPPD held several forums to disseminate project information and use feedback to best design their community solar program. In this model, program participants can purchase shares of solar energy from the community solar system that offsets a portion of their home’s electricity demand. NPPD owns the system and charges subscribers an enrollment fee that is returned 3 years after the enrollment date. Subscribers are charged a monthly rate, paying a premium for solar energy vs traditional power. However, this rate is locked in for 25 years, such that subscribers will not see rate increases that a traditional customer would. NPPD is currently accepting applications for two additional community solar programs located in Venango and Kearney, NE.

On the other hand, partnering with these organizations can help project teams promote the program to key target audiences. For example, human service organizations and religious institutions may already have lists for and relationships with income qualified households eligible to participate in programs targeting LMI customers. This can help reduce the soft costs of recruiting participants as well as identify potential members most likely to participate in the program. These organizations can serve as champions within the community by promoting community solar participation to their individual memberships.

### ***Energy Efficiency***

Projects might also consider integrating energy efficiency programs for community solar subscribers. Energy efficiency improvements require initial investments that can be significant. This is especially true for LMI populations. Because energy efficiency improvements usually generate positive returns on investment, community solar programs that use solar returns to finance efficiency projects may ultimately benefit customers, especially LMI customers, more than would the return on their solar investment alone. An on-bill financing purchasing option with 0% interest could be a way to help fund this. This way community members could realize energy efficiency savings without having to self-finance the up-front cost. Public power utilities can also partner with community organizations to identify opportunities to market energy efficiency to LMI households (see the above section on Partnership Opportunities). Public power utilities can establish a charitable donation arm of the community solar program to facilitate tax-deductible donations towards the program at large or for the benefit of LMI households specifically. Donations can be used to offset the upfront cost of energy efficiency measures.



#### **POWERED BY THE NORTHERN SUN:**

The Marquette Board of Light and Power is a public power utility that started the first community solar program in the Upper Peninsula of Michigan. Through a utility ownership model, they successfully launched their program in 2017 without taking advantage of the 30% federal investment tax credit to reduce cost. MBLP clearly identifies in the customer agreement that if the customer wants to claim any tax credit for their investment into the system, it is the sole responsibility of the customer to do so and the utility does not offer advice on tax credits. A great example of making the customer fully aware of potential opportunities while avoiding liability for the utility.

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# Program Implementation

## *Soliciting and Evaluating Proposals*

Once the utility has identified a feasible site and the desired capacity of the solar array, it's time to solicit, evaluate, and select proposals from installers. Below are some key points to remember through this process:

- If a public power utility is unfamiliar with local or regional solar PV installers, find renewable energy networks or associations to help solicit installers and/or advertise the request for proposals (RFP).
- Provide specifications on the system requirements and details regarding the installation site in the RFP. Things to consider include: system capacity, tilt angle, azimuth, panel type, inverter type and configuration, system output voltage requirements, monitoring capabilities, installer certifications and experience, operation and maintenance training, external disconnects, security fencing, warranties, energy production estimate, system efficiency, racking design, foundation/anchor type, commissioning, and final landscaping.
- Warranties will vary for separate components. Identify warranties for PV modules, power inverters, optimizers (if used), racking systems, and workmanship.
- Be prepared to provide site maps, soil analysis, and location of adjacent trees, buildings, etc.
- The installer may require additional site prep to ensure proper grading and access roads for heavy equipment to the site. If needed, check to see if it is included in the proposal.
- Developing specifications and providing site information for the project will help return comparable proposals. This will make the evaluation and selection process easier and reduce the amount time and analysis on behalf of the installer. Be sure to allow enough time for development of the proposals depending on the information the utility can provide.
- Once the proposals are received, consider the following items in the project timeline before the unit can be commissioned: evaluation of the proposals, preparation a recommendation and presentation to the governing board for approval, site preparation, interconnection, and testing.

A sample RFP evaluation matrix and an RFP template can each be found in Appendices F and G.

### ***Program Administration, Operation and Maintenance***

Alongside securing program funding, it is important to determine who will administer the community solar program. Utilities, or third parties such as solar installers/developers can fill this role. An important step is to first determine the public power utility's capacity for program administration. This is especially significant if your program utilizes different customer financing options: upfront, on-bill, or a combination of these.

Marketing and outreach is an administrative role that should be started at the genesis of and carried out throughout the lifetime of the program. Conducting a feasibility study is an effective way to start customer outreach with surveys and community meetings. Marketing efforts are needed to communicate program design information to the customers so they can decide if they want to participate. Reaching and convincing LMI customers to participate in the program can be challenging, but contact through ongoing partnerships with community organizations can help the utility facilitate communications and avoid skepticism about opportunities that may sound too good to be true to LMI customers<sup>29</sup>.

Once the program is up and running, ongoing outreach and marketing may be needed to fill open subscriptions or promote renewable energy educational opportunities in the community. In addition to typical outreach channels such as bill inserts, radio & television ads, and social media, web access monitoring can be used to promote the program, keep customers engaged, and provide an educational resource for schools.

The utility will also have to develop and maintain customer application forms and/or contracts for the lifetime of the program. Customer contracts should contain specifics on availability, eligibility, subscription length, method of bill credit, subscription transfers, energy credit rates, and payment options. Legal review of contracts developed for a community solar program is highly encouraged before issuing them to customers.

Operation and maintenance is relatively low for solar PV systems in comparisons to other generators, but the utility needs to consider managing vegetation control, cleaning panels, angle adjustment (if capable), snow removal, component failures, and vandalism in order to keep the system operating at maximum capacity.

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29. NREL. 2018. Design and Implementation of Community Solar Programs for Low and Moderate-Income Customers. <https://www.nrel.gov/docs/fy19osti/71652.pdf>

## UPSTART Case Study Example

The Upper Peninsula Solar Technical and Research Team (UPSTART) formed with the purpose of extending access to renewable energy technologies, and community solar in particular, to rural and small-town communities and low-to-moderate income households in Michigan's Upper Peninsula. The team began by partnering with two neighboring villages—Baraga and L'Anse (see Figure 3). In both cases, the village managers oversee operations of the public power utilities for their respective municipalities as opposed to an independent utility commission. Each village manager expressed interest in developing a community solar project but did not want to move forward without understanding whether the broader community would support such a program. Additionally, moving forward required designing a program that was accessible and attractive to community members. Each village partnered with UPSTART to achieve explore developing and designing a community solar program.

UPSTART's tasks were to: 1) conduct a technical site analysis and an initial techno-economic feasibility analysis to assess the project's viability in these villages, and 2) conducting a social feasibility study by engaging the community to identify both support for and sociocultural barriers to the project. The goal was to help each public power utility to design a program that was accepted by the community and suited community needs first.

Baraga and L'Anse are remote, rural communities, located about 5 miles apart. Each village has a population of roughly 2,000. At first glance, these cases do not seem to present viable locations for community solar programs. They are characterized by high proportions of low-to-moderate income households (43% and, 66% respectively)<sup>30</sup>. There is relatively low solar irradiation (3.4-4.4 kWh/m<sup>2</sup>/day<sup>31</sup>), and residential electric rates are low in comparison to neighboring electric utilities (\$0.1211 and \$0.1250/kWh, Village of L'Anse and Village of Baraga Utility respectively). All of these factors can reduce the return on investment.



Figure 3. The Villages of L'Anse and Baraga are located 5 miles apart in the Keweenaw Bay in the Upper Peninsula of Michigan.

30. Please see [https://www.michigan.gov/mshda/#/ul\\_45866](https://www.michigan.gov/mshda/#/ul_45866) for LMI housing information

31. See NREL Geospatial Data Science: <https://www.nrel.gov/gis/data-solar.html>

## ***Policy Context***

Michigan state policy does not currently include any supportive community solar policies or programs. However legislators proposed a bill in 2018 to change this<sup>32</sup>. Michigan does not allow power purchase agreements that are not included in the Public Utility Regulatory Policies Act, 1978. Instead, solar equipment leases are allowed, which essentially function like a power purchase agreement. This means that community solar program design and development is typically left to the utility's discretion.

L'Anse and Baraga each operate a municipal electric utility that serves Village residents. This local ownership allows the village flexibility to design and construct a community solar program if each village supports the project. This helps to mitigate some challenges that may surface with solar project development in other Michigan regions, such as permitting requirements, interconnection, site control and zoning.

## ***Community Solar Study Findings***

UPSTART conducted a series of key interviews and forum discussions to understand how both communities felt about the possibility of community solar project in their village. The primary goals were to get a general sense of what issues could arise if each Village pursued a community solar program. UPSTART used forums as way to spread information about the potential project as well as obtain feedback about community concerns. The team used interview and forum discussion information to design the community survey and incorporate community specific program design components.

### **L'Anse**

Overall, the L'Anse community expressed positive feelings and support for our proposed community solar program. The community felt the program was important to help the community be forward thinking and strive for a cleaner future. They felt that this project would make the community's needs and interests a priority, something not quite experienced in the past. Finally, they felt that this project would instill community pride, maintain their young population, and overall increase education.

Many considerations emerged from this portion of the study: trust with the utility, environmental/sustainable thinking, local ownership, affordability, and leadership. Trust was a big cited factor in support for the program. Others focused on the environmental benefits from utilizing cleaner energy sources. All income levels in the community must be able to participate in this program. Local ownership with the potential to provide community training was a positive for the community. Minor concerns such as more information and transferability were outweighed by all the potential positives that could influence community member's support for community solar. We compiled these considerations into three main themes: (1) environmental benefits, (2) economics/affordability, and (3) local empowerment. Focusing program design and structure around these three themes should provide the greatest success in L'Anse.

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32. Please see [http://www.legislature.mi.gov/\(S\(bqb5euxs5wamxdsi244ve301\)\)/mileg.aspx?page=GetObject&object-name=2018-HB-5861](http://www.legislature.mi.gov/(S(bqb5euxs5wamxdsi244ve301))/mileg.aspx?page=GetObject&object-name=2018-HB-5861)

## Baraga

The community generally felt positively (beyond economic reasons) about the idea of Baraga doing a community solar project. The study uncovered several important considerations that overlap with the Village of L'Anse, as well as novel findings compared to L'Anse. Community members liked the idea for a combination of reasons, primarily combining environmental benefits with social benefits.

Economic concerns are huge and may ultimately be the deciding factor on participation. Stakeholders felt residents will want specifics on the cost to buy into the program, the payback period, whether or not the investment is guaranteed, and to clearly understand the economic risks and benefits. Many respondents associated energy efficiency projects with solar PV in general. Respondents indicated a lack of knowledge surrounding the energy efficiency programs or projects available from the village utility or other sources (state or federal funding). Baraga community members were generally seen to have an ingrained culture that is resistant to change. Respondents felt that there was not enough awareness of solar electricity, which could ultimately reduce willingness to adopt a community solar project. Inertia could be a real problem; people need to be willing to go out of their way to do something different. Also, building trust in the community is a process that takes time. Many stakeholders did not understand the dynamics between WPPI Energy and the Village. This led to notions of distrust on who ultimately will benefit from this project. Respondents liked the possibilities for community empowerment, pride, and developing local control associated with community solar. Many felt that businesses or industries could be attracted to the village if they were aware of a community solar program availability. While respondents cited economics as the main driving factor for program adoption, they felt others might adopt beyond financial motivations.

### *Community Survey*

In order to collect information on utility customers' interest in participating in a community solar program, UPSTART partnered with the Villages of L'Anse and Baraga to conduct community surveys. The primary goals of the surveys were to develop estimates for the number of customers willing to participate in the a program, identify desirable program options, identify barriers to program participation, and generate baseline estimates for potential customers' willingness to pay to participate in the program. This information was used to select program options and to develop financial model scenarios for the project to help utilities determine if community solar program were economically feasible for their communities.

In order to deliver the survey to potential respondents, UPSTART mailed survey information to each utility's customer mail file. For L'Anse, customers received information about the survey on their monthly utility bill notice followed up by door-to-door reminders. In Baraga, paper surveys were mailed directly to the customers' billing address. Additional rounds of surveys were mailed in partnership with the local Keweenaw Bay Indian Community. Both surveys were successful at achieving reasonable demographic representation of each village.

Both villages generally supported community solar and were in favor of each Village starting a community solar program. The Village of L'Anse community members were likely to subscribe if multiple financing options were available while Baraga respondents varied on which financing option they supported; respondents who favored a high up-front cost, did not favor on bill-financing and vice versa. In L'Anse, support for community solar varied by income, age, and knowledge of renewable energy systems. In Baraga, predictors of community solar support include its potential benefits for the community, knowledge of community solar, higher income, younger community members,

and status as a tribal member. In both cases, community members felt they need more information to be comfortable with moving forward with a community solar program. Finally, energy efficiency measures were included in both community surveys. Village of L'Anse community members reported taking weatherization efficiency steps but were interested in doing more such as energy audits and water heater efficiency upgrades. While the Village of Baraga community members were generally unfamiliar with energy efficiency programs, illustrating an area to provide more information and how to access particular available programs.

### ***Partnership Opportunities***

Through a series of community meetings, UPSTART identified several potential community partners who expressed interest in promoting the community solar program to their respective membership bases and serve as potential anchor subscribers for the program. Representatives from local schools, churches and tribal organizations expressed an interest in connecting their members with the community solar program as well as promoting the program as a means to support investment in their own organization. During meetings with local business associations, community business leaders suggested that they saw the community solar program as an attractive option to support to local community organizations.

The Keweenaw Bay Indian Community (KBIC), a local tribal entity in the area, expressed a strong desire to help its members access solar energy in an effort to pursue environmental preservation goals. KBIC has aggressively pursued investments in solar technology on its own territory but was interested in exploring opportunities to support solar access for members not living on tribal lands. By engaging KBIC leaders during the project development process, UPSTART established a partnership to distribute surveys to tribal residents in Baraga to determine tribal members' interest in community solar. The information collected helped to demonstrate additional support for a potential utility community solar program in Baraga.

### ***L'Anse/Baraga Program Design and Implementation***

There are two significant findings in regards to financing options from this feasibility study: (1) existing community solar programs are more successful when they offer multiple financing options to participants and (2) our specific community survey respondents are in favor of a program with multiple financing options to meet the needs of all community members.

### ***Utility Ownership Models and Funding***

UPSTART explored multiple ownership models to improve project and subscription costs for Village utility customers. This included:

- Third party ownership with a tax equity partner
- WPPI ownership
- Village ownership utilizing low-interest or no interest loans
- One village owns while the other has access to panel subscriptions (this would increase program size resulting in lower program costs)
- Combined system ownership between the villages.



The latter four options would not allow the villages to access any tax benefits associated with owning the solar PV system, but third party ownership would provide that opportunity. Due to the relatively small size of the proposed array, the team found that it was difficult to find developers willing to take on a 100 kW system but yet be dynamic enough to be a tax equity partner.

As the project was developing, L'Anse was able to obtain (1) a grant from the Michigan Department of Agriculture and Rural Development (MDARD) to reduce system costs equivalent to the 30% renewable energy tax credit and (2) approval from WPPI Energy for 0% financing. Consequently, UPSTART moved forward assuming the system would be owned and operated by the Village utility in L'Anse.

### ***Developing the Financial Model***

For this project, conducting a feasibility study was highly beneficial towards understanding the needs of the customer base for rate design and subscription options. The study's surveys provided feedback from the customer base on how many accounts want to participate, how many panels they would subscribe to, and what price points would promote participation. Data from the study suggested that multiple subscription options would be better to meet the needs of the customer base and increase participation, but a higher number of payment plan options also increases the burden on utility billing staff and complexity of the program.

Based on the initial Community Solar Design report (Appendix A) and participation estimates from the community during the feasibility study, the team targeted a 100 kW array for the program. The Village of L'Anse issued a request for proposals to determine installation costs. The proposals were evaluated (Appendix F) and a proposal was selected to determine installation costs and capacity per subscription (watts/panel). The utilities involved in this project wanted to create a program that included an affordable LMI carve out, was profitable for all subscribers, and had a net zero profit/loss for the utility. To create this model, NPV analysis was utilized. This was also helpful to create a financial model that kept a positive cash flow for the utility for the life of the program. The table below illustrates suggested program pricing. In addition to the hard solar PV equipment installation costs, we also included other soft costs and influences into the equation: interconnection, site development, customer credit rate, maintenance, insurance, marketing and administration.

<b>L'ANSE COMMUNITY SOLAR SUBSCRIPTION OPTIONS AND SAVINGS ESTIMATES*</b>				
<b>Payment Plans (per panel)</b>	<b>Upfront Payment</b>	<b>Monthly Payment</b>	<b>Bill Credits from Solar over 25 Years</b>	<b>Net Savings over 25 Years</b>
Upfront payment	\$ 385	\$—	\$910	\$525
Upfront + 10 year on-bill financing**	\$250	\$1.75	\$910	\$450
Income Qualified 10-year on-bill financing**	\$—	\$1.75	\$910	\$700
Income Qualified 25-year on-bill financing**	\$—	\$0.90	\$910	\$640

\*Credits will vary depending on system performance.

\*\*Income qualifications apply to this payment plan.

Table 1. Suggested program pricing.

UPSTART's community research identified a strong interest by utilities' customers to participate in a community solar program; however, responses from the survey indicated that many customers were unable or unwilling to pay for the full cost of the program. This is a common challenge in LMI communities where many customers lack the disposable income to pay for the full cost of installing solar technologies. By conducting community-based research, UPSTART was able to identify the gap between the cost of implementing local community solar program and the community's capacity to pay for the program and then make the business case for additional support from state agencies. In addition to the MDARD grant and 0% financing, a limited amount of incentives based on a rate of \$0.08/kWh were available through the Village's Efficiency United program. These funds were also included in the NPV evaluation.

### ***Subscription Contracts***

Through a technical assistance grant obtained by UPSTART through the U.S. Department of Energy SunShot program, a third party consultant was hired to draft a contract the utility would issue to subscribing customers. Based on feedback from the feasibility study, transferability of subscriptions was a key concern to be addressed in the contract. Other items addressed in the contract include: eligibility, length of contract, capacity per subscription, subscription costs, LMI qualifications, and depreciation schedules.

### ***Energy Efficiency***

UPSTART contracted with Lotus Engineering and Sustainability, LLC to develop a roadmap for defining integration of income-qualified programs and energy efficiency elements to best serve the needs of all community members. The community surveys also gauged which energy efficiency measures residents and businesses completed. The UPSTART team and the Village of L'Anse Electric Utility identified an opportunity to utilize the community solar garden to drive reduced energy costs for low-income households and encourage investments in energy efficiency across the community. For these programs to be successful, particular attention must be given to making resources on efficiency accessible to the LMI community, whether that is through free information and outreach, volunteer teams providing donated weatherization services, or affordable financing tools to support larger efficiency investments in the home. Table 2 provides an overview of the recommendations by program aspect affected and population affected. By leveraging relationships with other local organizations supporting the LMI community or focused on reducing energy burden, such as KBIC, Baraga Houghton Keweenaw County Action Agency (BHKCAA), and WPPI Energy, UPSTART can successfully develop a regional model for an energy efficiency program.

# Recommendations and Considerations for Public Power Utilities

## Recommendation 1: *Build Flexibility Into the Entire Process*

It is important to recognize that the community solar program development process is not linear. It requires constant reflection and iteration. This begins at the team development stage, all the way through program design and implementation. Throughout the process, different needs can arise that current team members cannot fill. Community feedback may require necessary changes to the feasibility study and/or program structure. Some communities may be underrepresented in community forums and surveys. In this instance, public power utilities should consider changing strategies- a few examples include holding multiple, smaller meetings to accommodate community members schedules, attending community organization gatherings, changing survey length, or conduct neighborhood follow up survey canvassing- to elicit greater participation and community feedback. Over time, changing community needs can result in changes to the community solar program. Building flexibility into the community solar development process can bring the program more success.

Recommendation	Program Aspect Affected		Population Affected	
	Solar	Energy Efficiency	LMI	All
<b>Program Enrollment and Structure</b>				
Dedicate a certain number of solar blocks to LMI community	X		X	
Streamline paperwork and enrollment process	X	X	X	X
Provide 0% interest on-bill financing option	X		X	
Partner with local organizations to connect with LMI community	X	X	X	
Allow organizations to donate solar blocks to LMI community	X		X	
Facilitate tax-deductible donations	X		X	
<b>Participant Engagement in Energy Efficiency</b>				
Reduce overall energy consumption		X	X	X
Develop energy education toolkit		X	X	X
Behavioral change programs		X	X	X
Develop local weatherization team		X	X	X
<b>Financing Energy Efficiency</b>				
Allow donations to LMI investment fund	X		X	
Energy efficiency on-bill financing		X	X	
Identify and partner with funders		X	X	X
Build-out information in online format	X	X	X	X

Table. 2 Recommendations by program and population affected.

### **Recommendation 2: *Emphasize Community Involvement***

A characteristic of community solar is to promote local ownership of energy systems for and by the community within which they operate. Therefore, it makes sense to involve community members at every stage possible. Community members can provide accurate feedback on what sort of program would work in their community. They can be used to recruit program participants through peer-to-peer marketing in a worker co-op or volunteer model. The public power utility can build into an RFP that a portion of the labor for the community solar installation must come from training community members. This can provide valuable skills for underemployed community members to seek employment in general construction jobs or specifically the solar industry. Finally, the community solar array can be a source of an educational program with the community school system- to teach students about energy use and solar energy.

### **Recommendation 3: *Provide a Program That Is Affordable***

Many community solar programs are still only accessible in affluent communities. This can be directly linked to the affordability of the program. It is important for local governments and public utilities to design a program that capitalizes on all available options to decrease program costs. Additionally, program administrators should include a way to qualify low income participants beyond a FICO score (i.e. history with electric bills). Options to consider include:

- Partner with a developer and/or tax equity investor or seek out state, federal, and private grant opportunities to lower program costs.
- Provide multiple financing options—especially those that can be accessed by income qualified households or non-profit facilities
- Partner with community organizations or businesses to build a donation option in the model
- Consider utilizing an anchor customer: Selling a large portion of panels from the system to an individual customer can reduce the cost liability to the utility and can spur/promote subscriptions from other customers.

### **Recommendation 4: *Program Design Components***

Every community is different with respect to the program design considerations. It is important to listen to community feedback and incorporate these considerations into the community solar program design. The following describe some components that often surface during community solar program design for a small rural public power utility, but utilities may encounter other considerations not included in this list.

- **Transferability:** A common concern in many existing programs, customers want to know what will happen to their subscription if they move away, can no longer afford the subscription, or simply do not want a subscription. Public power utilities should account for the many different scenarios in the design of the program.

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- **Ease of participation and transparency:** Complicated community solar program design and sign up can create confusion and frustration for customers. Make the participation process as easy as possible for customers. Community members can also make a more informed decision with more information about the potential project. It is important for municipalities provide as much information as possible to help community members either accept or reject a project.
  - **Length of program & number of subscriptions:** These design components can directly influence the affordability of the system. The length of program can be varied to consider and suit different participation interests. The number of subscriptions available will determine the amount of benefits experienced by each customer, but the utility can choose to limit number of subscriptions to allow great distribution of community solar benefits.
  - **Financial model:** Rate design and program pricing is a tricky balancing act between:
    1. creating opportunity for LMI customer participation without shifting too much cost to non-LMI subscribers
    2. offering enough pricing/financing options to the customers while keeping the program manageable for the utility
    3. installing a system big enough to capitalize on economy of scale installation costs and customer demand without incurring liability to the utility with an unsubscribed program
    4. designing a program that is a reasonable investment for both the customers and the utility for the life of the program.
  - **Operation and maintenance:** Some utilities may not have the capacity, skills, or knowledge to operate and maintain a community solar array. The utility can consider contracting with the solar developer for these services or provide employee training (i.e. through developer). Training could also be provided to under and unemployed community members to create job opportunities within the community.

### **Recommendation 5: *Integrate Energy Efficiency Measures***

Implementation of energy efficiency should always be the first step before considering installation of renewable energy generation. A good avenue to introduce energy efficiency into the community is through a survey on energy efficiency awareness and community outreach. The utility can supplement survey findings with a broader community toolkit to both educate community members on available opportunities as well as learn which energy efficiency measures households need to address to reduce energy costs. Taking this a step further, utilities should consider how to integrate energy efficiency programs into their community solar program design.

**Recommendation 6: *Engage In Community Partnerships to Build Capacity***

Often times, a utility's internal capacity (limited time, financial resources and expertise) represents a significant barrier to developing community solar programs. Many utilities do not have staff equipped and/or available to conduct community-engaged research to determine the social, technical and economic feasibility of a community solar program and it can be cost prohibitive to hire third-party consultants to do the work. Establishing partnerships with local universities, planning agencies, nonprofit organizations, state agencies and other groups can help access resources to assist with evaluating and planning community solar programs. In some cases these groups may be willing to partner or lead the evaluation at little to no charge to the utility. Similar to UPSTART's work, the process can help develop a coalition capable of accessing financial resources for additional research and program implementation.

# Appendices

## A. Community Solar Design Report

### Design of Community Solar Array System for the Village of L'Anse

Alternative Energy Enterprise—Solar Team Report  
Summer 2017

Submission Date: 8/12/17

Instructor: Jay Meldrum

Team Members

Elliot Vickers

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#### 1. Introduction

The objective of the AEE solar group during the spring/summer semester of 2017 was to research and design a solar array based on multiple realistic constraints with a unique investment opportunity for the community of L'Anse. Primary goals for this project are as followed:

1. Designing the solar array – including project site selection, array sizing, panel orientation, monitoring system, inverter options, and racking system
2. Developing a detailed community investment scheme including payback model.

A 25-50 kW solar array system was appropriately designed based on size and location of the installation site as well as of the L'Anse customer community. Criteria considered for the design of this array include technology, supplier and cost. The team wanted to use the newest technology on the market and the city of L'Anse wanted the ability to monitor how

each panel is performing. Suppliers typically offer discounted or reduced pricing when large bulks of the system components are ordered through them. Cost was considered when deciding between different brands and different suppliers.

Community participants will contribute a one-time up-front investment payment that will have a scalable return. Participants will receive a credit on their electric bills that is proportional to 1) their contribution and 2) how much electricity the solar project produces. Although the utility company will own the solar system itself, participants' investments buy rights to the benefits of the energy produced by the system.

## **2. Motivation**

In 2008, the Michigan Legislature passed Public Act 295, the Michigan Clean, Renewable and Efficient Energy Act. The purpose of PA 295 is "to promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following: (a) diversify the resources used to reliably meet the energy needs of consumers in this state; (b) provide greater energy security through the use of indigenous energy resources available within this state; (c) encourage private investment in renewable energy and energy efficiency; and (d) provide improved air quality and other benefits to energy consumers and citizens of this state" (MCL 460.1001). In 2015 the act required Michigan electric providers to ramp up their use of renewable energy in order to obtain 10% of their electricity sales from renewable resources. This has created an incentive for utilization of alternative energy sources in communities around Michigan.

Solar energy is a mature technology and a rapidly growing global market, having many potential economic, environmental, national security, and social benefits for community members. Most Michigan citizens interested in utilizing solar energy do not have the access to a proper site for a renewable energy system. The National Renewable Energy Laboratory (NREL) studies estimate 20% to 30% of homes or businesses in the states are suitable for solar energy. Many sites are shaded or not oriented in the proper direction. The complexity of installing a renewable energy system is a barrier for many, as they often require a large up front cost that makes it difficult for many homeowners or businesses to get involved. For these citizens, and those interested in community/economic reinvention, Community Solar is a viable alternative.

The incentive for this project is magnified due to the economical climate in the Upper Peninsula of Michigan. The western Upper Peninsula faces some of the highest energy costs in the contiguous United States due to unique factors such as low population density, state government concentration on the Lower Peninsula, and the harsh winter climate. This, combined with the infant economy and average low-income households, results in slow development for a majority of the region. In order to ensure continued economic development and prosperity, a cheaper form of energy is a necessity. The Upper Peninsula has a unique availability for solar due to its expansive wilderness. Furthermore, the existence of small towns and villages makes community solar an extremely viable option. Due to the rural development patterns, a majority of the community tends to stay in a specific town for generations on end. This makes the economic climate perfect for solar, as the residents are not as worried about the return on investment taking 20 years to recuperate. L'Anse, MI faces an interesting electric utility scenario as they have a lower electric utility rate, provided by WPPI Energy, than the Michigan average, as seen in table 1. However, most residents of the area are in the Low Median Income (LMI) tax bracket, which makes it difficult to pay off large electric bills due to harsh winters. This particular scenario combined with the eagerness to invest creates not only a demand for cheaper energy, but also a demand for community solar.



**Table 1. L'Anse electricity costs compared to Michigan and the national average [1]**

National Average	Michigan Average	L'Anse Average
\$0.12/kWh	\$0.14/kWh	\$0.12/kWh

Community solar is a great option for these small communities as they can easily install a 50 kW system, and grow upon it after the community is reassured of the proof of concept. Community solar continues to be a viable option for renewable energy due to its many payback schemes.

### 3. Background

In communities across the United States, people are seeking alternatives to conventional energy sources. Whether they aim to increase energy independence, invest against rising fuel costs, cut carbon emissions, or provide local jobs, they are looking to community-scale renewable energy projects for solutions. Advances in solar technology, an increase in federal and state tax incentives, and new financing models have made solar projects including community solar projects, more financially feasible.

The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) defines Community Solar as "a solar-electric system that provides power and/or financial benefit to multiple community members." [6] Under a community Solar Program, the actual generation of renewable energy does not occur at the customer's home or business site. Instead, the customer subscribes to a portion of a shared renewable energy facility located elsewhere in the community, and the power generates results in each subscriber receiving their portion of the benefit based on their investment.

Community Solar participants do not need to be familiar with the complexities involved in implementing a renewable energy project. They can rely on professional developers to design, install, operate, and maintain the renewable energy system for optimal performance – especially since the developers will rely on the system's performance to make their share of the profit. The developer will handle all the local permitting and approvals, while taking advantage of any available tax credits, rebates, and other incentives to maximize the financial return to all participants.

This project is focused on providing an opportunity to invest in clean and efficient energy production for the community of L'Anse. By introducing this project we also hope to educate this community, as well as other communities in the area, on how to reduce energy consumption, save money, and reduce their carbon impact. The solar project is a way for the L'Anse community to control their electric utility costs while helping to reduce their dependence on fossil fuels and energy companies.

With increasing demands for cleaner energy production methods, there's a growing need for creating "green" energy options that are currently inaccessible. Solar energy arrays are large and become controversial when installed in plain sight within a community. This can limit members of a community from installing solar panels where it would be most beneficial – on their own property. The primary purpose of community solar is to allow members of a community the opportunity to share the benefits of solar power even if they cannot or prefer not to install solar panels on their own property. Project participants benefit from the electricity generated by the community solar farm, which costs less than the price they would ordinarily pay to their utility. Upon completion, this project can serve as a model for other communities around the area to invest in solar energy.

## 4. Results

The solar group examined project site selection and array sizing prior to completing technical design. The design options were wide-ranging; panel orientation, monitoring system, inverter options, racking system, economic analysis, and community investment business models to name a few. The group also performed solar data calculations, system advisor model analysis, structural calculations, feasibility analysis, and system modeling.

### 4.1 System Description

Many people who are interested in utilizing solar energy to reduce their energy bills are unable to install their own system, or it may be difficult to do so for a variety of reasons. For example, many do not own or have access to a proper site for a renewable energy system, are inhibited by large up-front costs, and/or are deterred by the complexity of installing and maintaining their own system. The purpose of this system is to provide an opportunity for the community of L'Anse to overcome some of these obstacles to support renewable energy production while reducing their overall energy bills.

During the spring semester of 2017, the solar team initially designed the solar array system to meet constraints defined by the project needs. A total system size of 25 kW and 50 kW was designed to be installed in an industrial park off Lambert road in L'Anse, MI. The park has nine open lots in which one of the lots will be used for the solar array system. By taking into account the clearing of small shrubs, trees, and uneven land, it was determined that the system would be most beneficial if placed in the most southwest corner of the park, seen in figure 1. The placement was determined to avoid the large majority of shading patterns of surrounding trees and potential future buildings. The area estimate of the proposed 50 kW system using the NREL System Advisory Modeling program was found to be 0.3 acres, while the area of the smaller 25 kW system will be about 0.2 acres. The system should be installed on lots 5 and 6 in figure 1 for optimal placement.

### Figure 1. Proposed Industrial Park Lot Description

### 4.2 System Design

Last semester the team worked to determine the components of the system that would be most beneficial to use in order to keep costs low while maintaining high efficiency, in addition to ensuring the system would stay operational with minimal maintenance costs for 25 years. The following section describes our recommendations for each component of the system. These recommendations should be considered a point where future design decisions may be based off.

#### a. Solar Module Selection

Due to the number of solar module manufacturers and the various models they each produce, selecting the best solar panel for this project was an extensive, time consuming process. The team started this selection process by creating a parts comparison spreadsheet that contained all the solar panels the team could find. This spreadsheet also contained technical information about each panel such as efficiency rates, operating conditions, warranty details, and panel sizes and weights. Once this spreadsheet was completed, the team created a list of important criteria on what the best solar panel for this project would have. This list of criteria included operational conditions that would last in a cold weather climate with heavy snow and high winds, long lasting warranties from credible companies, and high efficiency at a low price. At the end of the spring semester we narrowed down the selection of solar panels to two panels, the Sunmodule XL SW 340 and SolarWorld YI240P from Yingli Solar. By lowering the power size of the panels, we lose efficiency, however the pricing per panel goes down while we increase the amount of shares that will be available to members. After further investigation, we have determined that there are three ideal choices for the specific design of the array, shown in table 2. To minimize installation/maintenance costs and increase efficiency, we recommend using the Silfab SLG335M-PT solar panels.

Table 2 shows the price difference between each panel option as well as the power output of each.

		Watts	\$/ea.	\$/Watt	Amt Needed		Total Price (\$)	
					50 kW	25 kW	50 kW	25 kW
Panel Options	SolarWorld SW345 XL Mono	345	306	0.89	146	73	44,676	22,338
	Silfab SLG335M-PT	335	220	0.66	150	75	33,000	16,500
	Silfab SLA285M-PT	285	182	0.64	176	88	32,032	16,016

**Table 2. Solar Panel Options for L'Anse Community Solar Array**

For optimal energy production, photovoltaic systems must be positioned to capture the maximum available sunlight, and the modules must be free of shading. Solar array systems can be designed using solar panel orientation of portrait or landscape. When making the decision between which orientation to design our system with, we took into account the amount of snowfall in L'Anse, the desired solar tilt angle, and the amount of panels desired on each racking system. We determined that orientating our solar panels in landscape would be most beneficial for our system, as it will produce more energy throughout the year, as well as keeping the total height of our mounted array system smaller to allow for smaller spacing between racks.

#### b. Inverter Selection

To harness the DC electricity produced by the solar array it needs to be converted to AC via a central DC to AC inverter. With just a central inverter, the array only produces as much electricity as the least productive panel. To correct this, power optimizer will be utilized. Power Optimizers are DC-to-DC inverters that maximize the power production for each solar panel by constantly monitoring the maximum power production point of each module individually [2]. The panel monitoring can be recorded and sent to a computer to be reviewed, which is something that the city manager and WPPI desired. For this system there will be a single power optimized connected to two panels, which will then connect to a central inverter. An example of how these are connected can be seen in figure 2. For two solar panels at 345 W each, the power optimizer will need to be able to handle 690 W; chosen for this is the Solaredge P700 power optimizer capable of handling 700W and 125V [2]. To convert the DC to AC for the entire array, we will be using Solaredge SE10KUS central inverter. These central inverters can handle up to a 1.3 DC to AC conversion ratio, which means it can convert 130% of the DC electricity provided to AC. This will help us by only needing four central inverters instead of five to handle the 50 kW load. Data sheets for the P700 power optimizer and the SE10KUS inverter can be found in Appendix A. Table 3 below shows the pricing comparison between the P600 and the P700 power optimizers, dependent on which solar panel choice is used, along with the pricing of the central inverter that is to be used.

		\$/ea.	\$/Watt	Amt Needed		Total Price (\$)	
				50 kW	25 kW	50 kW	25 kW
Power Optimizers	SolarEdge P600-2NA4ARL	40.29	0.067	88	44	3545.52	1772.76
	SolarEdge P700-2NA4ARX	79.27	0.113	75	38	5945.25	3012.26
Central Inverter	SolarEdge SE10KUS-480	1250.23	0.125	5	2	6251.15	2500.46

**Table 3. Power Optimizers and Central Inverters Price Comparison**

One other option that was considered for converting DC to AC was micro inverters. Micro inverters are able to convert DC to AC at each individual solar panel with no need for a central inverter. This would allow each panel to convert its own current. Using micro inverters would also eliminate the dependence that the solar panels have on each other when using a central inverter. It would also decrease safety hazards because the current is being converted through multiple different locations in the solar system. Several different models of enphase micro inverters were considered. Each different model varied minimally in efficiency, price and other specifications. Sourced from multiple different distributors, the cost of each micro inverter would be around \$130. Because of this, it was concluded that micro inverters would not be a viable option for this solar system.

**Figure 2. Example of four solar panels connected to two power optimizers before being connected to the central inverter.**

Due to their lower cost and similar if not better power production Power optimizers were chosen over micro inverters. The greatest factor that was considered for the inverter design was cost efficiency. The power optimizers were proved to be the most cost efficient option, for each power optimizer is estimated to be \$80.

### c. Racking System

In order to best mount this 50kW system, there were several considerations taken into account. The main requirements for the system were its strength to withstand high snow loads and its ability to tilt seasonally. The best choice for this was a fixed racking system, specifically DPW Solar's MPM-G2 H mounting system, seen in figure C.1 of Appendix C. This system is beneficial due to its rudimentary and easy to use design, giving strength without sacrificing cost. This system will be approximately 144 panels, or 48 subarrays, as each subarray holds 3 panels vertically in landscape. These subarrays are then connected in a long chain, and easily tilted by two people. Overall, the system will be around 1200 feet long, split into two 600 feet sections, with around 20 feet between the two sections. This allows for the most exposure for the panels throughout the entire year, and gives space for the maintenance workers to maneuver between the panels. Also, this array is easily expandable due to its small, dense configuration. The racking system allows four feet of clearance from the bottom of the lowest panels to the ground at the max tilt of 55 degrees. This gives enough space to accommodate the average snowfall of L'Anse, MI. Although the racking system can tilt between 0 and 55 degrees, it will be fixed at 47 degrees to optimize power generation throughout the year.

### Figure 3. Average Annual Snowfall in L'Anse by month [4]

As seen in figure 3, the average snowfall is much higher in L'Anse than in the rest of the state or the country. That being said, L'Anse is not subject to heavy lake effect snow like the rest of the Keweenaw Peninsula due to its location on the bay. This results in long periods of snowfall but generally lower accumulations, allowing 4 feet of clearance to be more than enough.

#### d. System Modeling

It was decided that the team create a 3D model for each individual component. The individual components were created using NX software. Drawings produced by the manufacture of each component were used in creating the NX models. Once each individual model was completed an assembly was created. This assembly can be seen below in figure 4. Creating this assembly allowed the team to visualize the complete community solar array. This is necessary to ensure that all separate components physically work together. This assembly will also be used when it comes time to ask the community members to invest in the community solar array. This allows the community to see what they are investing in.

The array shown here is only 21 panels, and is approximately 58 feet long and 13 feet tall while tilted at the optimal angle of 47 degrees. This gives 4 feet of clearance from the bottom of the array to the ground at the arrays fullest tilt, during winter.

### Figure 4. Community Solar Array Model Assembly

#### 4.3 System Costs

Utilizing results compiled from various solar equipment suppliers as well as NREL's system advisor model (SAM), the solar team has come up with a spreadsheet that details the overall cost of the 25 and 50-kilowatt system. Figures 4 and 5 show a detailed summary of the cost mentioned, including the average costs of modules/inverters/power optimizers from solar equipment suppliers, along with the estimated cost per watt for installation labor and overhead as well as the balance of system equipment (including electrical components, wiring, etc.). The estimation shown in the figures below are calculated with our recommended solar panel (Silfab SLG335M-PT) and power optimizer (SolarEdge P700-2NA4ARX). We did not include the pricing for land costs since the city already owns the area that the array will be placed on. The estimation shown is subject to slight variation, due to the fact that we included an approximate \$15,000 (\$9,000 for the 25 kW system) for racking system costs. The estimate does not use the price of the racking system we received a quote from due to the fact that after talking with Peninsula Solar, it was recommended we used a different racking system. Using a system from MT Solar will reduce the cost of the racking while increasing efficiency for installation labor. This estimation can be considered overestimates, and it should be noted that we do not expect the cost of the system to exceed \$2.80/Wdc for the 50 kW system or \$2.87/Wdc for the 25 kW system.

Figure 5. 50 kW Detailed System Costs

### Figure 6. 25 kW Detailed System Costs

#### 4.4 Solar Power Production

The System Advisor Modeling program is beneficial when looking to estimate accurate results on how much solar power a system will produce. The program gathers weather data from the local area the system is to be placed and estimates the shading losses as well as losses from snowfall. The results for the 50 kW system, shown in table 4 and figure 7, as well as the 25 kW system, shown in table 5 and figure 8, are dependent on the type of components used in the system. For this estimation the Silfab335 panels and the P700 power optimizers were used in conjunction with the SE10KUS power inverters. The total capital cost is taken from what was determined in figures 5 and 6.

Results from the simulation run in the SAM program, shown in table 4 and 5, estimate that the annual solar power produced by the 25 and 50 kW systems is 28,546 kWh and 56,925 kWh, respectively. Additionally, from these tables we can observe that the real levelized cost of energy for the power produced by the 50 kW and 25 kW systems are \$0.0862/kWh and \$0.0873/kWh, respectively. From figures 7 and 8, the highest month of energy production for the systems will be July while the lowest month will be December. These results are based on average weather patterns for the Houghton area, so it should be noted that we might expect higher energy production in the winter months due to a lower annual snowfall in the L'Anse area.

**Table 4. Summarized 50 kW Simulation Results from SAM**

<b>50 kW w/ Silfab335 Panels</b>	
<b>Metric</b>	<b>Value</b>
Annual energy (year 1)	56,925 kWh
Capacity factor (year 1)	13.00%
Energy yield (year 1)	1,141 kWh/kW
Performance ratio (year 1)	0.76
Battery efficiency	0.00%
Levelized COE (nominal)	10.90 ¢/kWh
Levelized COE (real)	8.62 ¢/kWh
Electricity bill without system (year 1)	\$826,025
Electricity bill with system (year 1)	\$822,141
Net savings with system (year 1)	\$3,884
Net present value	-\$31,296
Net capital cost	\$139,632
Equity	\$0
Debt	\$139,632

**Figure 7. Monthly Energy Production of 50 kW System**

**Table 5. Summarized 25 kW Simulation Results from SAM**

<b>25 kW w/ Silfab335 Panels</b>	
<b>Metric</b>	<b>Value</b>
Annual energy (year 1)	28,546 kWh
Capacity factor (year 1)	13.10%
Energy yield (year 1)	1,152 kWh/kW
Performance ratio (year 1)	0.76
Battery efficiency	0.00%
Levelized COE (nominal)	11.03 ¢/kWh
Levelized COE (real)	8.73 ¢/kWh
Electricity bill without system (year 1)	\$826,025
Electricity bill with system (year 1)	\$824,079
Net savings with system (year 1)	\$1,945
Net present value	-\$16,076
Net capital cost	\$71,096
Equity	\$0
Debt	\$71,096

**Figure 8. Monthly Energy Production of 25 kW System**

Detailed “Cash Flow” results from the SAM simulation for both the 25 and 50 kW systems can be seen in appendix D. The tables show the time relative cash flow of various aspects of the system over the life of the panels (25 years). Most importantly the tables show the energy production after every year and the subsequent electricity savings. This is assuming a system performance degradation rate of 0.5%.

#### *4.5 Initial Installation Design*

Up to this point, the solar team has determined a couple different design options for the community solar array that will work best for the project. Going forward, the group should constructively decide on which options to use using input from the social science study as well as from the solar installation companies we receive bids from. The solar team determined using a DPW racking system for mounting the solar panels, however once WPPI and the Village of L’Anse have accepted a bid, input on which type of racking system would be most cost beneficial for the project should be taken into account. As the project develops more in the next year, discussions with solar installation companies should continue to receive further recommendations on the array design as well as a more accurate estimation of installation time and total price.

#### *4.6 Community Solar Program*

The basic ownership, legal, financial, and operational parameters for different types of utility, special purpose entity (SPE), and non-profit Community Solar project models are understood, and have been well-described by the U.S. Department of Energy (DOE), the Interstate Renewable Energy Council (IREC), and others. This section will highlight some successful Community Solar Business Models that characterize the majority of Community Solar projects currently in operation and in development, as well as recommendations on what will work best for the community of L’Anse. Community Solar in L’Anse can be done using a number of different approaches. The utilities can use the “Buy Power,” “Buy Panels,” or “Lease Panels” approach.

“Buy PV Power” is a community solar business model that focuses on simplicity and accessibility for community participants, and control and scalability for utilities. In this model, buyers pay a specified price to purchase “blocks” of solar power. The cost of these blocks is added to the customer’s monthly bill, and the value of the energy of the solar power purchased is deducted from the customer’s monthly bill. If a customer’s purchase of solar power exceeds its actual energy usage in a given month, the customer receives a credit that is applied against future bills.

In the “Lease PV Panels” community solar business model, utilities lease specific numbers of PV panels to community participants for a long period, typically up to the warranted lifetime of the panel. A utility or third party owns the PV panels and is responsible for initial financing, construction, operation, and maintenance. Customers agree to pay the up-front cost to effectively lease one or more panels for a specific period of time, which can be 20 years or more, depending on the warranted lifetime of the panel. Once the lease purchase is made, the customer receives an electric production credit of those panels on their energy bills. Credits can appear either as kWh deductions or as financial credits. If power produced by a lessee’s panels exceeds actual energy usage in a given month, the customer receives a credit that is applied against future bills. Customers do not pay maintenance or replacement fees, or costs for insurance, as these stay the full responsibility of the owner-utility.

With a “Buy Panels” community solar business model, community participants actually purchase one or more solar panels located at a Community Solar farm. This is a true ownership program, not a lease, which results in a superior payback for the participants. The proportional solar power those panels generate are credited monthly to the purchaser’s utility bills for the warranted life of the system, which can last up to 50 years. Credits can appear as kWh deductions, but they are more commonly financial credits. Maintenance, insurance, and other costs associated with the upkeep of the solar panels are all covered as part of the rate negotiated with the utility. The participants in the program do not have to maintain the panels, inverters, or incur any additional costs associated with this program. Participants simply buy the solar panels. The utility or project developer for the panel’s useful life maintains the panels, which can be longer than the warranted life of the panel. One of the main disadvantages to this type of business model however is that most of the time it is beyond financial reach for rate payers due to the higher up-front cost of the panels to cover total installed cost.

There are various projects currently in running and in development in Michigan and surrounding areas. These projects can be used as a reference in the development of our community solar program by seeing what has worked well in these projects, and what can be improved.

- **CHERRYLAND COMMUNITY SOLAR PROGRAM**

Cherryland currently has 3 programs offered including community solar, buy-all sell-all and net metering. The way the community solar program works is by using a “lease panels” business model where the customers purchase a panel subscription to the community array and receive bill credits for their share of the solar array’s output. Based on their system size, a panel subscription (335 Watts per panel) costs either \$600 up-front or \$10 per month for five years. In return for a subscription, customers receive \$0.10 per kWh on their monthly bill for the panel’s output. With average solar output, customers should procure around \$40 a year in credits. They have a subscription term of 15 years, after which members will stop receiving solar credits. The customers have the option to cancel at anytime. If their subscription is cancelled, customers will receive a refund, calculated by determining the subscription amount paid and subtracting the amount of credits paid as of the date termination. Once paid off, participating members receive a \$200 rebate for their panel subscription. The Cherryland community solar program is part of Wolverine Power Cooperative’s SpartanSolar project, which has a goal to add 10 megawatts of solar to Wolverine’s portfolio. This is on a scale much larger than the L’Anse project, and as such,



there are benefits available to them that may not be available. For example, if a customer cancels their subscription, it will be easier for Cherryland to sell off that share.

- **MARQUETTE COMMUNITY SOLAR PROGRAM**

The Marquette Board of Light and Power is currently developing a community solar garden in a location optimally positioned for solar exposure at their service center in Marquette. The system will feature 480 315-watt solar panels that will be available for a one-time upfront purchase cost of \$499 per panel, of up to 30 panels. This relates to about \$1.59 per watt for purchases of 1-30 (315-watt) panels. This program will use a program similar to that of cherryland, a “lease panels” business model, where participating members will purchase a panel subscription and in return receive credits on their monthly bill. Each customer that purchases a panel will be credited \$0.0633 per kWh produced by their panel, which can be estimated to about \$24 per year for a period of 25 years. The payback period of the customers’ investment is 20 years on the 25-year lease.

- **BRIGHT TUCSON COMMUNITY SOLAR PROGRAM**

Tucson Electric Power is a larger utility company with more than 400,000 customers in southern Arizona. This program is based on a “buy PV power” business model that enables utility ratepayers to purchase blocks of 150 kWh/month of solar power for a fixed price for 20 years. The 150 kWh block of power equates roughly to the output of a 1 kW PV system, however they have upwards of 12 MW of solar power available with around 10,026 energy blocks available. The program provides customers with an easy, low cost, and highly scalable way to purchase locally generated solar power. Unlike the programs mentioned before, this program does not require customers to lease panels themselves, and instead they buy the power produced for a cheaper price than their original utility bill. Participants pay a premium of \$3/block (\$0.02/kWh) and then pay a “base fuel charge” around \$0.03/kWh. This results in an affordable PV power cost that will be cheaper than many customers’ at slightly more than \$0.05/kWh. Customers can purchase enough blocks to offset all their energy needs. Solar blocks directly offset base energy usage and can be banked to offset costs in future months. This type of program can be very beneficial to community members that participate, however it requires a larger investment from the utilities and third party investors to create a system large enough to provide enough shares for the community. After researching these business models and some projects that have been developed using these models, there are a couple different methods the group could use for this project. For example, the “Lease Panels” business model can work well for utilities that want to offer ratepayers the ability to purchase up front the power produced by a specific number of PV panels that are owned by the utility. The Village of L’Anse would invest the initial up-front capital to purchase and install the solar array system and retain control of the PV panels after the life of the panels. The “Lease Panels” model works well for the ratepayers of L’Anse who want to support the increased use of PV and who would like to use PV as a hedge against future base fuel costs, but who do not have specific financial payback needs or expectations. The social study to be conducted over the next few months should give us a better idea of the type of method that will be most beneficial for the community of L’Anse.

Based on the estimates for cost of the fully installed system, there will be around 150 panels/shares available for community members to purchase. Based on the community interest, there is the option to increase the shares by decreasing the wattage of panel used, which will increase the amount of panels and subsequently the amount of shares to about 176 shares. The up-front investment required by community members to “lease” a panel will be around \$700-900 depending on the final design decisions made.

## 5. Future Work

Now that the majority of the design aspect of the project is upon completion and recommendations have been made on the type of community investment scenario the project should move forward with have been made, community interest must be accurately gauged along with a fully developed community solar program. Richelle Winkler and her social science students will be working with the community of L'Anse over the course of the next year to determine what options will be most beneficial for the community to take advantage. Along with WPPI Energy, Village of L'Anse, and WUPPDR, a finalized loan application through Superior National Bank will be available to community members that may not have the funds for shares up-front. The team will be working to complete the SunShot competition to receive state grant funding for the project, while guaranteeing the system is completed in the best interest of the community. Installation of the array should be on schedule to be completed by early fall 2018.

## 6. Conclusion

Across the United States communities are seeking alternatives to conventional energy sources. Whether they aim to increase energy independence, invest against rising fuel costs, cut carbon emissions, or provide local jobs, they are looking to community-scale renewable energy projects. The community solar project in L'Anse will be an ideal model for future projects in Michigan that shows an affordable PV panel system can be created for community members in a low to median income. It will help to promote the use of alternative energy around the area, while consequently lowering the utility rates for participating community members.

The objectives this semester was to research and design a 50 kW solar array based on multiple realistic constraints for the community of L'Anse. For the technical design of the solar array, there were five main areas of design considerations: array location, panel selection, inverter selection, monitoring system, and tracking system.

The city of L'Anse has a proposed an industrial park in which the team proposes that the array is placed in lots 5 and 6 in the southwest most corner of the park. The type solar panel that will be used has been narrowed down to three choices between 285 and 340 watts. For converting the DC electricity from the array to usable AC, depending on which solar panels are used, either the Solaredge P700 or the P600 power optimizers will be used in conjunction with 2-4 Solaredge SE10KUS Inverters. The system was originally designed to fit with DPW's MPM-G2 H mounting system, however, other options will most likely be utilized to decrease cost and increase reliability for the installation. The design for the racking system will be used as a reference on how the system should be installed, however, different railing and securing hardware will be used. For this proposed 50 kW system, the today cost is estimated to be \$139,631.80.

The community solar investment program should follow closely to that which Cherryland did. It would be most beneficial for the low to median income households of L'Anse to be able to buy shares for \$700-900 a panel and receive monthly credits back depending how much the panel produced that month. With this type of program, community members should be expecting about a 15-20 year payback period, while seeing average savings of \$15-25 a year on their electric bills.

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## B. Interview Protocol and L'Anse Summary

Review consent statement and ask if it is OK if you record.

*Thank you for being willing to take the time to talk with me. Its really important to our project team to hear from community leaders, like yourself, early in this process of figuring out if it makes sense for [insert location] to move forward with a community solar project. We are really now just getting started analyzing the feasibility of the project, in terms of whether people in the [insert location] area would be interested. We'll be able to come back to you with a lot more specifics in another six months or so.*

*To start, I hope that you could tell me a little about yourself and your organization.*

1. How long have you lived and/or worked in the [insert location]?
2. One of the reasons that I wanted to talk with you is because we know that [FILL IN ORGANIZATION HERE] is an important organization in the [INSERT LOCATION] community. Can you describe your organization's role in the community?
  - a. What are its key activities or major goals?
  - b. What would you say is its range of influence? Or how does the organization impact people in the [insert location] area?

*I'd like to shift now and talk about your thinking on energy efficiency.*

1. Are you aware of any available and/or accessible energy efficiency programs or incentives? If so, please describe them.
2. Have you completed any energy efficiency projects (either in your home or business)?
3. Can you think of any energy efficiency projects you would like to pursue? What are they?
4. Finally, do you know someone who has completed or is currently pursuing energy efficiency projects?

***Now I'd like to move to your thinking on solar PV systems in general and then we'll get to talking more specifically about a potential project with the [INSERT LOCATION].***

1. Can you tell me about any knowledge you have of solar-powered electricity?
2. What do you think about solar powered electricity? What do you see as the advantages/disadvantages?
3. If you were to weigh the plusses and minuses of adopting solar powered electricity for your own organization or about encouraging other people or businesses to do so, what would be the key things that you would consider?
4. Have you ever heard about *community solar* programs?
 

If yes...

  - a. Can you generally describe what you know? [don't worry, this isn't a test! J]
  - b. Where have you heard about community solar?
  - c. What do you think of community solar? [advantages/disadvantages]

***Now, I'd like to tell you a little bit about what a community solar project in [INSERT LOCATION] would look like.....  
[explain what kind of project the Village is considering using bullets below...]***

- Customers (businesses and residential) who are served by [insert location] utility would be eligible to purchase shares in the system. Those who purchase then earn returns on the \$ made from the generation as it is sold to consumers.
  - It won't cost customers who choose NOT to buy in any money. They will keep paying their usual rates. Rates for those who choose not to buy in won't increase due to installing this system.
  - We are working on coming up with a financing plan that would work best for Village residents. But essentially, residents would pay an amount to subscribe to the program (this would vary based on how many shares are purchased). Then, once the system is producing and selling into the grid, the bill would also have a positive balance (again depending on # of shares purchased) that is the return on investment as the system produces power and sells back into the grid.
  - Only customers of [insert location] utility could participate.
  - The goal of the community solar project is for folks to offset part of their electricity usage not all; so to offset fully, a 10kW system; this allows a larger number of people to offset part of their usage.
  - This is not a for sure thing to happen yet. The Village and their energy provider (WPPI Energy) are interested in making it happen. But, it will only go forward if we get positive results in this feasibility study. We are doing feasibility study for two reasons:
    1. to see if [insert location] utility customers are likely to buy shares. They won't do this if people don't want to participate.
    2. to determine how best to design a program that makes people want to participate and especially makes it possible for low-to-moderate income households to be able to participate.
5. Do you have any questions for me at this point about the project under consideration in [insert location]?
  6. Now that you know a little more about how this potential project would work, do you think this could be a good thing for [insert location]? Why or why not?
  7. What sort of opportunities do you think a community solar project like this could provide for community members?
  8. What sort of challenges can you envision that might come up?
    - a. Follow up: can you describe any pushback that could happen?
  9. I know its hard to say without numbers in front of you (which I don't have yet), but generally speaking, do you think organizations and residents would be interested in buying in? Why or why not?
  10. What do you think would be reasons that your organization (or others) might want to participate?
  11. What do you think would be the greatest barriers to participating for your organization and/or others?
  12. Can you think of any important things that would be important in terms of how this thing were set up (program design) that would make it more attractive for organizations and residents to participate?
  13. Would your organization be interested in being further involved as we work through the program design possibilities and/or would you be interested in being contacted to consider purchasing shares once all the specifics are figured out if it looks like they are going to go forward with the project?
  14. Is there anything else that you think I should know? Or do you have any questions for me?
  15. We are hosting a Community Forum sometime [insert date]. We will provide some basic information about the project idea in a short presentation. Then, we'll spend most of the time hearing feedback in small groups. Everyone is invited. We would like to get as many people there as possible, and we would especially like to invite you and anyone else that you think might be interested. Would you be willing to help us get the word out about this meeting if we forward you some flyers and a promotional email? Are there any other channels of communication that you would suggest?
  16. We will host another community meeting in the spring and another community meeting in the fall where we share initial results of the feasibility study and ask for more feedback. We can let you know more when it gets closer.

THANK YOU so much for taking the time to talk with me and sharing your insights.

# L'Anse Community Solar Feasibility Study

## Project Report: Key Informant Interviews

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Richelle Winkler, Associate Professor of Sociology and Demography, Michigan Tech University

August 25, 2017

### Introduction

This report summarizes the process and results of a set of key informant interviews in the L'Anse, Michigan area conducted by Emily Prehoda at Michigan Technological University in summer 2017. Emily worked as a representative of the Upper Peninsula Solar Technical Assistance and Research Team (UPSTART), which includes the Village of L'Anse, Western Upper Peninsula Planning & Development Region (WUPPDR), WPPI Energy, and Michigan Technological University. UPSTART is evaluating the social and economic feasibility of implementing a community solar project in L'Anse.

The purpose of this specific interview project was to gain insight and understanding into how L'Anse area community members feel about the possibility of beginning a community solar project in their village. The key questions we sought to answer were:

1. How do L'Anse residents and business owners feel about a community solar project in their community?
2. What problems/obstacles/hurdles might come up in if the Village pursues a community solar project in L'Anse?
3. What cultural, economic, social, or institutional factors could impact the success of a project?

Interviews were conducted as a way to get a general sense of what issues could arise. One interview with a KBIC tribal leader aimed to uncover lessons learned and insights that the tribe experienced through the process of recently installing a large tribal solar PV system. The interviews are not meant to be representative of the community's feelings. Rather, they are to provide the team with a sense of key issues that will need to be considered moving forward.

This report includes a brief summary of methods and results. It concludes with a discussion of implications of these findings for the project team's continuing work. Interview protocols are included in Appendixes.

### Methods

Emily interviewed five stakeholders in the L'Anse community with varying backgrounds. Interviewees range from living and working in L'Anse from 1 year to about 77 years. The interviewees represented organizations whose role in the community was to improve the community in some way through small business, health and social services, or general community relations. Interviews were conducted from June to August 2017. Interviews were audio recorded and lasted, on average, 30 minutes long. The audio files were then partially transcribed to highlight key themes or ideas surrounding the potential community solar program. One informant interview was conducted with a KBIC member. This interview served to provide information regarding solar PV installation process in the neighboring town. The interviewee provided direct knowledge and experience regarding the success and shortcomings of these previous solar PV projects.

## Results

Most interviewees had some basic knowledge of solar power, recognizing that solar photovoltaic (PV) systems harness energy from sunlight and use it for electrical generation. Overall solar was considered a good investment for the individual homeowner, but interviewees saw lack of sunlight and heavy snow as a disadvantage to solar power in this area. Most interviewees also had a general understanding of what community solar entails. They were generally able to describe how community solar works, at a basic level.

Major themes that participants brought up are highlighted (in bold) and described in some context in the summary that follows. These themes are then discussed in the Implications section.

### *Concerns/Limitations*

Participants' concerns about doing a community solar project in L'Anse were more about the local community's acceptance than about the viability of the system itself. Most interviewees discussed an **unwillingness to change**, and described this as the "culture of the community" or "the attitude of some residents." The community's trust in outsiders is low- so coming in and building something as third party, with no backing from the L'Anse community leaders would be difficult. The village is home to a large population of **low to moderate income** individuals who may be unable to afford the upfront cost for participating in a program like this. Therefore the program should be tailored in way to make it attractive for those individuals as well as others.

### *Overall Perceptions of the Project Idea*

Overall the interviewees considered the Village of L'Anse community solar project to be a good idea for the community. Reasons for support included: increasing or **instilling pride in the community**, opportunity to bring young people back, increasing community education, and developing a more **sustainable** energy source. Challenges circled back to getting the community to (1) care about the electrical situation enough to seek out alternative options, (2) lowering the resistance to changing the current system they already have, and (3) trusting the project team. Stakeholders also felt that **cost** would be a huge determining factor in the success of this project. Particularly for low income individuals, allowing them to pay longer on the solar panel shares might make participation more attractive.

Most organizations were interested in further involvement in some fashion. Some might serve as a medium for communication facilitation, partnership, or just be interested in purchasing shares in the potential program.

### *Questions Participants Raised*

- My question would be- the sun is only out here minimally, a lot of time it is gray. So does that matter? We don't have a lot of sun days, we have a lot of cloudy days so what does that do to the amount of energy that is produced? What about snow glare? Does that bounce more rays?
- At what point are you looking for this investment to come people? Right away?
- Or is this something that you're going to be building and this a project that is going to be completed?
- Is this an investment that I stand to lose something or is it a guarantee gain?
- Are they looking to try to lower the rates for people, they are looking to reduce what people are being charged, but also get a return on the investment?
- What's the approx up-front cost?
- Would a person have to buy a whole panel?
- Would there be an option to buy in at another time? Optioning in or out of the program might be a helpful recruiting tool
- How is it coming in a as payback? If people become reliant in the summer time on a certain amount coming in and it gets to be February and then all of a sudden that's not there, and there is an extra 30 and 40 dollars. Then you're going to get lashback from that.

### *Lessons from KBIC Projects*

**Leadership** was seen as the most beneficial component to project success. This was something the KBIC project struggled with. Their leadership system responsibilities were spread out over several positions which took more time for completion along with overlap of duties. Another challenge with direct implementation was **local versus non-local labor**. Some tribal members who were involved were able to provide labor, but they lacked technical skills that directly translate to solar PV; therefore, outside contractors had to be included in the process, challenging the balance of labor and ultimately project completion. Ultimately the project has been a success due to **economic benefits, community empowerment, and energy independence**.

## Summary & Implications

Respondents generally felt positively about the idea of L'Anse doing a community solar project. The interviews uncovered several important themes that the UPSTART team should consider in designing and marketing a potential community solar program.

L'Anse community members were generally seen to have an ingrained **culture that is resistant to change**. Respondents felt that this could reduce peoples' willingness to adopt community solar. Inertia could be a real problem- people need to care enough to go out of their way to do something different. The team might couple selling shares with messages about why this is important to community members. The team might also attempt to connect community solar to ideas that locals are more familiar/experienced with and feel positively about, presumably reducing the "newness" of the idea.

Also, **building trust** in the community is a process that takes time. The team should collaborate with trusted organizations as much as possible. This is also related to the importance of leadership. Leaders need to be trusted. At the same time, roles need to be clearly identified and overlap limited.

**Sun days**. The idea that solar doesn't work well with the amount of cloudy winter days and snow that we receive in L'Anse area (western Upper Peninsula) needs to be clearly addressed. UPSTART will need to make clear that this does work here and show evidence to support that argument.

**Economic** concerns are huge. Residents will want specifics on the cost to buy into the program, the payback period, whether or not the investment is guaranteed (or is their potential for loss?), and to clearly understand the economic risks and benefits. **Costs** should be reduced as much as possible, especially for low-to-moderate income participants. **Financing** programs or no up-front cost could be really important for getting participation from lower income residents. Similarly, **flexibility** is valued—programs might be designed to have multiple options for how much to buy in, financing, transferring, and timing for opting in or out. The possibility for bringing **economic returns** is also important and attractive, but the upfront costs and details of the payback will be just as important.

Respondents liked the possibilities for **community empowerment**, local control, and energy independence associated with community solar. These are factors that the team could emphasize in marketing. They focused on local benefits and designing to increase the local returns as much as possible, including the possibility of hiring local labor.

A community solar program could be a sense of **community pride** for L'Anse. It could be seen as a leading UP community and a leading small community nationwide. For a town like L'Anse (that is a little beat down by recent and long-term job loss and historical population loss), this could be a really important factor. They need a victory. It may improve the



popularity of this idea if the team can connect this project to local community and economic development—local jobs, local generation, \$ circulated locally, local skills and education opportunities, etc.

Finally (but not least important), **sustainability** is important. Respondents liked that this is a sustainable, green energy and local energy source. This is something that at least some L'Anse community members will identify with and find important convincing reason to buy in.

## **C. Community Meeting Protocol**

1. What do you like about the idea of L'Anse doing a community solar project?
2. What concerns you about this idea or makes you think it might not work?
3. If this happens, do you think you will buy one or more shares for your home/business? Why or why not?
4. What are some things that the team really needs to consider in designing a program?
5. Do you think that L'Anse should move forward with this? Why or why not?

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## D. Community Survey Protocol

### Community Solar Survey

The Village of Baraga/L'Anse is considering a community solar program and would like your feedback through this short survey, which should take no more than 10 minutes to complete. The Village has partnered with Michigan Technological University and the Western Upper Peninsula Planning and Development Region to gather input from residents and businesses. By completing the enclosed questionnaire you will help the Village make important decisions about community solar power in Baraga/L'Anse.

The survey includes questions about your interest in participating in a community solar program and factors that may influence your decision to participate. The survey also includes questions about your interest and participation in energy efficiency projects. These questions will help us determine where to focus our efforts in designing a program for Baraga/L'Anse. Participation in this survey is voluntary. You are free to skip any questions you choose and to stop completing the survey at any time. Responses are confidential and do not commit you in any way.

To thank you for completing the survey, we would like to offer you a **\$5 Baraga County Gift Check** which can be spent at any Baraga County businesses. To receive your gift check, simply return your completed survey to the Baraga Village Office by mail, in person or online. We will make the combined results from this survey available to the community through a final report and in a presentation to the community.

If you have any questions about this survey or the proposed program, call Brad Barnett at (906) 482-7205 or email [bbarnett@wuppd.org](mailto:bbarnett@wuppd.org). If you have any questions regarding your rights or to register a complaint about this project, please contact the Michigan Tech Institutional Review Board at (906) 487-2902 or by email at [irb@mtu.edu](mailto:irb@mtu.edu) or Dr. Chelsea Schelly at [cschelly@mtu.edu](mailto:cschelly@mtu.edu). This office oversees the review of the research to protect your rights and is not a participant in this study.

Thank you so much for your help!

Sincerely,  
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Email: [cschelly@mtu.edu](mailto:cschelly@mtu.edu)

### Instructions for Completing the Survey

We ask that the adult (over the age of 18) in your household with the next upcoming birthday complete this survey. Please complete the following questions to reflect your opinions as accurately and truthfully as possible. Carefully read each question and indicate your response according to the question's instructions. Please clearly mark your response to each question to ensure that we gather the best information possible.

**How to Return the Survey:** Completed surveys can be returned

- In person to the Baraga Village Office
- By mail using the provided envelope (postage included)
- Online at [www.surveymonkey.com/r/BaragaSolar](http://www.surveymonkey.com/r/BaragaSolar).

Thank you for your time and responses!

## COMMUNITY SOLAR IN BARAGA/L'ANSE

Across the United States, there is growing interest in producing electricity using solar technology, which converts sunlight into electricity. Community solar programs are designed to help residents and businesses access the benefits of this technology. While there are many different types of community solar programs, most include:

- A large group of solar panels is built in **one** sunny location.
- Households or businesses can choose to buy a subscription to the panels' energy production.
- Participants earn their money back on their utility bill as **credits** based on the number of subscriptions purchased. Credits **reduce the amount you pay** on your electric bill.
- Participants receive credits for **20 – 25 years**.

These programs allow for greater participation in solar energy, without requiring the purchase and installation of solar equipment for one's own home or business. The Village of Baraga/L'Anse is considering developing a voluntary community solar program for its electric utility customers. If a program were developed, it would **not** change electric utility rates for customers who don't participate.



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## SURVEY QUESTIONS

1. Before receiving this survey, did you already know about community solar?

- Yes
- No

2. Do you know anyone (including your own household) who currently owns solar panels for their home or business?

- Yes
- No

3. How important is it to you that your electricity comes from renewable energy sources?

- Very important
- Somewhat important
- Neutral
- Not very important
- Not important at all

4. Are you in favor of the Village developing a community solar program for Baraga/L'Anse electric utility customers?

- Yes
- No
- I don't know

## COMMUNITY SOLAR PARTICIPATION

To participate in a community solar program, participants must purchase a subscription. There are two primary ways to subscribe: **pay upfront** and **pay-as-you-go**. In a **pay upfront** model, a subscriber purchases a subscription through a **onetime fee**. The participant receives the subscription benefits (utility bill credits for energy produced) for the length of their subscription.

In Baraga/L'Anse, participating customers would receive approximately a **\$30 credit per year** on their electric bill for up to 25 years.

5. Using the table below, please indicate how likely you would be to purchase a subscription based on the following up-front costs. Please indicate a response for each price.

Pay Upfront Price per Subscription	Very likely	Likely	Neutral	Unlikely	Very unlikely
<b>\$100</b>					
<b>\$200</b>					
<b>\$300</b>					
<b>\$400</b>					
<b>\$500</b>					
<b>\$600</b>					

6. How many subscriptions would you consider purchasing using the upfront payment option?

Number of subscriptions= \_\_\_\_\_

A second payment option is **pay-as-you-go**. In a **pay-as-you-go model**, a subscriber pays in installments, which adds a monthly fee to the customer's utility bill until the subscription is paid off. No upfront payment would be required.

For Baraga/L'Anse customers, a **pay-as-you go** option would add a **monthly fee around \$10 per month for 60 months**. Participants would still receive the **annual \$30 credit** for up to 25 years.

7. How likely would you participate in a community solar program in Baraga/L'Anse if a **pay-as-you-go** option like the one described above was offered?

- Very unlikely
- Unlikely
- Unsure
- Likely
- Very likely

Customers could choose to purchase **more than one** subscription. Each subscription would add a monthly fee to your electric bill and receive approximately a \$30 annual credit for up to 25 years. For example:

- **1 subscription = \$10** per month fee for 60 months and a **\$30** annual credit for up to 25 years
- **2 subscriptions = \$20** per month fee for 60 months and a **\$60** annual credit for up to 25 years
- **5 subscriptions = \$50** per month fee for 60 months and a **\$150** annual cred for up to 25 years

8. How many subscriptions would you consider purchasing using the pay-as-you go option?

Number of subscriptions = \_\_\_\_\_

9. How likely would you be to donate a community solar subscription to the following organizations/individuals? Recipients would receive credits to their electric bills based on the energy generated from the donated shares:

	Very likely	Likely	Neutral	Unlikely	Very unlikely
<b>Local school</b>					
<b>Local church</b>					
<b>Local charity</b>					
<b>The KBIC</b>					
<b>The Village of Baraga/L'Anse</b>					
<b>Friends or family</b>					

## ATTITUDES TOWARD COMMUNITY SOLAR

There are many factors that can influence an individual's decision to participate in a community solar program. The questions below will help us identify potential barriers to community participation.

10. Please indicate your level of agreement to each of the following statements by checking the box that best fits your opinion.

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Purchasing a subscription is a good investment for my household or business.					
The upfront cost of the subscription is an important factor to me.					
\$600 per subscription is too expensive.					
The value of the annual credit is important to me.					

11. Please indicate your level of agreement to each of the following statements by checking the box that best fits your opinion.

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
It is important that my electricity comes from renewable sources.					
Baraga/L'Anse does not get enough sun to make this work.					
I don't know enough about the details to feel comfortable with this idea.					



12. Please indicate your level of agreement to each of the following statements by checking the box that best fits your opinion.

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
A community solar program would make Baraga/L'Anse a better place to live.					
A community solar program would attract more residents and businesses to Baraga/L'Anse.					
A community solar program would increase my pride in my community.					
I trust my village as an electricity provider.					

### ENERGY EFFICIENCY

13. Reducing the amount of energy you use is a great way to decrease your monthly electric bill and we're interested in creating programs to help you do that. To help us know where we should focus, please use the table below to indicate if you have taken any of the following actions in the past 5 years.

	Yes	No, but I would like to	No, and I have no interest in it	I don't know
Installed compact florescent lighting (CFL) to replace incandescent lighting				
Installed LED lighting to replace incandescent lighting				
Installed programmable thermostats				
Caulked/added weather stripping to seal windows, doors, and ducts				
Installed aerators on faucets and shower heads to reduce the use of hot water				
Added additional insulation in attic, walls, and or Flooring				
Wrapped water heater with insulation (or hot-water heater blanket)				
Replace older windows with energy efficient ones				
Installed high-efficiency water heater				
Installed high-efficiency HVAC (or furnace) unit				
Obtained an "energy audit" from a trained professional to identify opportunities for energy efficiency improvements.				

14. There are a number of organizations that offer programs to residents and businesses to save money on electric bills. However, they're not always well known. Please indicate which programs you're familiar with and if you've participated in them in the past.

Energy Efficiency Programs	I am not familiar with this program.	I know about this program, but I haven't participated in.	I have participated in this program.	I do not know if I have participated in this program.
Efficiency United - Energy Optimization & Rebates				
Michigan Saves - Loans for Energy Efficiency Projects				
B-H-K Community Action Agency—Energy Conservation Services				
St. Vincent de Paul - Energy Assistance Program				
KBIC Community Energy Assistance Program				
Other:				

15. Where did you find information about these energy efficiency programs? Please check all that apply.

- My utility  
 My village  
 My church  
 My neighbor  
 My friends/family  
 The internet  
 Other: \_\_\_\_\_

## ABOUT YOU

We need to ask you a few questions about your household. Your responses will be kept strictly confidential.

16. What is your age?

- 18-24  
 25-34  
 35-44  
 45-54  
 55-64  
 65-74  
 75+

- 
17. Are you a current customer of the Baraga/L'Anse Village electric utility (check all that apply)?
- Residential customer
  - Business/non-profit customer
  - Not a customer
18. How long have you lived (or owned property/business) in Baraga/L'Anse?
- Less than a year
  - 1-5 years
  - 6-10 years
  - 11-15 years
  - 16-20 years
  - 21+ years
19. Do you currently own property in the Baraga/L'Anse Village electric utility service area? Please choose one answer.
- Yes, I (or another member of my household) own this property, but I live elsewhere most of the year
  - Yes, I (or another member of my household) own this property and it is my usual residence/business
  - No, I (or another member of my household) rent this property
20. How many people, including yourself, live in your household?
- 1
  - 2
  - 3
  - 4
  - 5
  - 6 or more
21. Are you a member of the tribal community?
- Yes
  - No
22. Which of the following categories represents your household's typical yearly total income? Please choose one answer.
- Less than \$25,000
  - \$25,000-\$49,999
  - \$50,000-\$74,999
  - \$75,000-\$99,999
  - \$100,000+
  - Prefer not to answer
23. Are you:
- Male
  - Female
  - Prefer not to answer

Comments

Please let us know if there is additional information to help us understand your answers about the Village's potential community solar program.

Thank you for completing the survey!

Please provide your address below if you would like your \$5 Baraga County Gift Check mailed to you.

Address: \_\_\_\_\_

City, State, & Zip Code: \_\_\_\_\_

SAMPLE COMMUNITY SOLAR WORKPLAN

SAMPLE COMMUNITY SOLAR WORKPLAN												
Months												
	1	2	3	4	5	6	7	8	9	10	11	12
<b>Community Engagement</b>	*Initiate the identification of key informant contacts	*Survey design	*Community stakeholder survey implementation	*Survey data analysis	*Focus groups to interpret survey results				*Community Design Team			*Community information website update
<b>LMU Participation</b>	*Key informant interviews with LMU serving organizations to identify specific needs and barriers	*First survey design with LMU serving organizations to identify a set of key questions	*Partner with LMU organizations for outreach and recruitment		*Focus groups with LMU organizations to help interpret survey results	*Community LMU program options (i.e. community solar, leasing, etc.)			*Partner with LMU organizations for outreach and recruitment	*Key informant for LMU participants		
<b>Program Design &amp; Implementation</b>		*Develop potential program participation options				*Community program options (e.g. impact bonds, revenue modeling and other financing)		*Develop program financials (capital, operating, labor, etc.)		*Key administrator for program		*Key administrator
<b>Site Selection</b>	*Conduct preliminary site inventory	*Site evaluation	*Site selection and acquisition									
<b>Financing</b>	*Identify funding sources					*Apply for financing		*Receive financing				
<b>System Design &amp; Installation</b>	*System-level design evaluation				*Request capacity studies	*Request project system design *Procure key materials		*Phase 2B	*Apply for building permits and zoning variances (if applicable) *Award construction contract			*Installation
<b>Interconnection</b>											*Interconnection agreement	*Interconnection & interconnection
<b>Long-term management after install</b>							*Customer support process development		*Billing software modification		*Final maintenance plan	*Develop program goals

E. Timeline Example

## F. Request for Proposals Evaluation Example

Sample Comparison of Solar PV Proposals

Developer	#1	#2	#3	#4
<b>OVERALL SYSTEM</b>				
Capacity (kW), DC	120.0	103.6	100.7	110.5
DC to AC Ratio	1.20	1.04	1.01	1.11
Energy Output (kWh/year)	150,600	130,018	126,429	138,678
System Cost (w/o fence)		\$ 169,832.00	\$ 160,680.00	\$ 174,317.46
<b>\$/watt (w/o fence)</b>		<b>\$ 1.64</b>	<b>\$ 1.59</b>	<b>\$ 1.58</b>
Fence cost		\$ 28,720.00	\$ 17,500.00	\$ 17,500.00
Total installed cost	\$ 300,117.00	\$ 198,552.00	\$ 178,180.00	\$ 191,817.46
<b>Total installed \$/watt</b>	<b>\$ 2.50</b>	<b>\$ 1.92</b>	<b>\$ 1.77</b>	<b>\$ 1.74</b>
<b>PV PANELS</b>				
Panel Manufacturer	Canadian Solar	Neo Solar	CSUN	Heliene
Panel Rating (watts)	375	370	365	325
Number of Panels	320	280	276	340
Panel Type	monocrystalline	monocrystalline	monocrystalline	polycrystalline
Warranty - Panels	10 year product, 25 year linear on output	10 year product, 25 year linear on output	10 year product, 25 year linear on output	10 year product, 25 year linear on output
<b>INVERTER SYSTEM</b>				
Inverter Manufacturer	SMA Sunny	Solar Edge	Chint Power Systems	Solar Edge
String or Micro System	string	string	string	string
Number of Inverters	2	1	1	1
Inverter Input (kW DC STC)	75	135	150	135
Inverter Output (kVa AC)	50	100	100	100
Warranty - Inverter	10 years	12 years	10 years	12 years
<b>POWER OPTIMIZERS</b>				
Optimizer Manufacturer	N/A	Solar Edge	N/A	Solar Edge
Number of Optimizers	N/A	140	N/A	170
Optimizer Efficiency	N/A	99.5%	N/A	99.5%
Warranty - Optimizers	N/A	25 years	N/A	25 years
<b>RACKING AND MOUNTING</b>				
Ground Foundation/Anchor	Nuance anchors	poured in place concrete ballasts	driven post or concrete ballast	driven post
Adjustable or Fixed	fixed	fixed	fixed	fixed
Tilt Angle (degrees)	40	40	40	40
Azimuth (degrees)	180	180	180	180
Elevation Above Grade	36"	18"	48"	36"
Warranty - Racking	25 years	20 years	25 years	20 years
Warranty - Workmanship	1 year	15 years	1 year	5 years
<b>OTHER</b>				
Site Improvement	included	included	included	included
Fencing quote	included	included @ \$28,702	\$25 per linear foot	included @ \$32,800 for 50' x 600" area. Only need 50' x 300' area.
Additional Comments	Included geotechnical analysis and anchors for frost heave mitigation. Will perform a pull test on anchors for 100 MPH wind load.			Cost for geotechnical and soil analysis is included in the quote. The 100 kW central inverter consists of (1) 33.3 kW primary inverter with (2) 33.3 kW secondary units. Fenced area is the full 50' x 600' area.

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## G. Request for Proposals Template

[UTILITY NAME]  
SOLAR PHOTOVOLTAIC SYSTEM  
REQUEST FOR PROPOSALS

The [Utility Name] is seeking a price quotation for the design, purchase and installation of a [capacity] kWDC (at minimum) solar PV system at [location]. Interested parties may contact [name] at [phone number] for a copy of the scope of work and specifications and/or to make an appointment to inspect and view the project area.

All bids are due no later than [date]. The [Utility Name] retains the right to accept or reject any or all bids.

Bids to be remitted via hardcopy or electronically to:

[name, address, email]

[UTILITY NAME]  
SOLAR PHOTOVOLTAIC SYSTEM  
SCOPE OF WORK AND SPECIFICATIONS

### 1. GENERAL

The [Utility Name] is requesting proposals for the installation of a solar photovoltaic (PV) system. Target capacity of the system is [capacity] kWDC. The [Utility Name] will be also known as the OWNER in this bid document.

The CONTRACTOR shall provide a turn-key installation of a robust, operating solar PV system which will include equipment, materials, shipping, site preparation, labor, interconnection, commissioning, monitoring system accessible via Ethernet, and operation/maintenance training.

Selection of the CONTRACTOR proposals shall be based on the equipment selected, overall cost, maintenance requirements, system output, and visual appearance of the system. The OWNER reserves the right to reject any or all bids and to waive irregularity in the bidding or the bidding process and accept the bid that is most advantageous to the OWNER.

## 2. CERTIFICATION

Although not required, preference will be given to North American Board of Certified Energy Practitioners (NABCEP) certified installers. Respondents are encouraged to submit information indicating their qualifications to undertake the project in question. Company profiles, lists of relevant state licenses and industry certifications, proof of insurance, bonding safety ratings, project team background and qualifications, business references, and any solar project experience (e.g., total number and capacity of systems installed, differentiated by installation type; experience with certain technology brands; experience with grid interconnection).

## 3. PERMITS

The CONTRACTOR shall obtain all required local and state permits, certificates, or approvals as required for system installation by local and state jurisdiction. The CONTRACTOR shall request necessary inspections for installation and commissioning from the respective authority(ies).

## 4. SYSTEM DESIGN

The solar PV system will be comprised of a ground mounted array(s) with a capacity at or near [capacity] kWDC and a fixed angle rack with a tilt angle at or near [desired angle] degrees. The interconnection design shall have the power inverter(s), disconnects, and overcurrent protection installed in a suitable location. The CONTRACTOR will provide properly sized wires and conduit for AC connection to a [voltage] pad mount transformer provided by the OWNER. The system will have web based monitoring capability. Wiring methods shall comply with Article 690 of the National Electrical Code.

All proposals will also include line item costs for the installation of a suitable security fence and any required site preparation.

The system(s) and fencing will be located within in the [dimensions] area marked in the attached site plan. Include a drawing showing the number, arrangement, and location of the array(s) along with an electrical one-line drawing. The array(s) shall be placed within the marked area to avoid any shading on the panels from an adjacent array, fencing, or trees throughout the year.



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## 5. WARRANTY

The PV modules shall have a minimum 10 year product, 25 linear on output (10 year @90%, 25 year @ 80%) warranty. The power inverters shall have at a minimum a standard five year performance warranty providing repair or replacement in the event of failure. Racking shall have minimum 20 year warranty. The CONTRACTOR shall provide the Owner with a full one year warranty on the entire PV system including all materials, components, equipment, workmanship and labor. The contractor may include pass-through warranties from the manufacturers of the modules and inverter system components.

## 6. EQUIPMENT

Supply the PV modules as required for the approved PV system design. The modules must be tested and labeled by Underwriters Laboratories (UL) or another nationally recognized testing agency. Provide the following information in the submittal:

- manufacturer
- model
- number of modules
- generating capacity per module
- total DC and AC capacity rating
- NREL PV Watts energy production estimate

Supply the power inverter(s) as required for the approved PV system design. The inverter(s) must be tested and labeled by Underwriters Laboratories (UL) UL 1741 or another nationally recognized testing agency. Provide the following information in the submittal:

- manufacturer
- model
- efficiency
- anti-islanding capability
- rated output AC voltage
- DC input voltage range
- output frequency

Supply the information and specifications on balance of system components, including but not limited to:

- racking/support structure material
- racking/support structure design details/description
- racking structure foundation/anchor type
- array fastener material
- electrical components
- description of the web-based real-time monitoring system

## 7. SYSTEM ACCEPTANCE TESTING

The CONTRACTOR will provide system acceptance testing at time of commissioning. The testing will shall determine that the PV system is functionally operative and meets the design requirements. The tests shall also verify that the system, as installed, is safe for personnel and will establish or verify system energy and power rating.