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LOCAL ENERGY MATTERS

Local Energy Matters: Baseline Solar Market Analysis for Duluth, Minnesota

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April 2015

Ecolibrium3 is a 501(c)3 organization dedicated to leading and inspiring change for a sustainable and equitable future.

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solarmarket PATHWAYS

This report was prepared under DE-EE0006908 as part of the Local Energy Matters: Solar Market Development in Duluth, MN project.

NOTICE

Acknowledgments
The authors wish to thank the U.S. Department of Energy (DOE) for the sponsorship and guidance of this work. We also appreciate the data collection assistance of the following individuals and organizations.

- Paul Helstrom, Minnesota Power
- Anthony LeVanda, Portland State University
- Minnesota Power
- State of Minnesota Department of Commerce
- PV System Owners
- PV System Installers

List of Acronyms
MIM- Made in Minnesota
MP- Minnesota Power
PUC- Public Utilities Commission
PV- Photovoltaic

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Project Background

The *Local Energy Matters* project works to advance solar deployment in the City of Duluth, MN- a cold-climate community of 86,000. Duluth currently has minimal solar installation and relatively high solar soft costs. The project has convened a cross-sector stakeholder group to benchmark the current market, implement best practices for solar deployment and soft cost reduction, develop pilot deployment programs in residential rooftop, community solar, and commercial industrial sectors, work with the local electricity provider to determine appropriate sites for utility scale developments, and will complete a 5-Year Solar Market Transformation Plan at the conclusion of the three-year project period. This work is being conducted under a Solar Market Pathways grant from the US Department of Energy.

The technical approach to the *Local Energy Matters* project recognizes the following:

- Considerable work has been accomplished regionally and nationally to establish best practices and case studies for solar market development and soft cost reduction.
- Duluth can apply these practices and lessons learned through smart process and program design.
- Adapting best practices to a community must include a review of specific challenges and opportunities within that community and experienced by stakeholders.
- Applying capacity in the form of staffing to facilitate a stakeholder process, complete baseline analysis, and develop programmatic options can accelerate a community's solar market.
- A comprehensive community process model and the policy, financing, and program development results of that process can serve as case studies for successful replication in other communities.
- Completing defined demonstration projects can provide test cases to further refine policy, practices, and processes which can result in lower price points for scaling solar development.

To advance the solar market in Duluth a stakeholder process has been created to develop a Solar Market Transformation Plan. Development of the plan will include work on the following:

- Creation of a partnership with the local IOU electric utility to determine opportunities for solar installation within Duluth that will help the IOU to meet or exceed their 1.5% solar standard by 2020 including 10% (of 1.5%) as small-solar distributed generation.
- Integration with energy efficiency programs including utility Conservation Improvement Programs, the Duluth Energy Efficiency Program, low-income weatherization, and Duluth's entry into the Georgetown University Energy Prize competition.

    - Development of educational opportunities and streamlined process for institutions that have expressed interest in building or hosting solar arrays on municipal, school, housing authority, and university buildings.
    - Incorporation of grassroots effort from the interfaith community to take the pilot church energy efficiency program to the next step by creating solar opportunities.
- Engagement in revising Duluth's Comprehensive Plan and year-long City-designated land use planning processes to incorporate energy generation overlay.
- Completion a City policy review and incorporation of solar-friendly practices in the City housing and resiliency plans.
- Development a framework for solar installation in a historic neighborhood as part of an energy pilot and identification of appropriate brownfields redevelopment sites.
- Exploration of different financing options for solar installations and develop additional options as needed to accomplish 1 MW of installed capacity.

During the first year of the three-year project, the focus is on benchmarking and program development including benchmarking current installed capacity, financing, costs, policies, procedures, and processes including permitting, inspection, and interconnection. This initial benchmarking period will produce recommendations for soft cost reductions and pilot program development. The overall objective for this budget period will be completion of demonstration project designs, including marketing strategies, financing, developer RFP's and a streamlined pathway from individual project design to interconnection for residential rooftop, community solar garden and commercial/industrial installations. Also, during this period, the stakeholder group will pursue the potential for a utility-scale solar development within the City of Duluth.

Focus of Report

This report establishes a baseline analysis of installed capacity by sector, installed cost history, financing used, project phase timing, and barrier analysis in order to identify areas of opportunity for cost reduction, market needs, and best areas of future focus for advancing the Duluth market.

Methodologies

Initially, it was anticipated that the easiest method for baselining installed capacity would be research into city of Duluth building permits. This methodology is easier to apply in a single municipality than in a broader state or region due to the number of permitting offices and potentially different data formats. After compilation of installed PV systems through building permits, follow-up with system owners and Minnesota Power, the electric IOU for Duluth, was proposed to better understand cost history, financing/incentives, project phasing/timing, and any barriers encountered. However, after initial research into city permitting data, it was determined that additional data sets would be needed in order to determine current

installations and progress with the additional benchmarking. In the end, local data to understand the development of the Duluth solar market came from five sources.

Data Sources and Issues

City of Duluth Permit Data – Solar installations in Duluth require a city permit, and those permits become part of the public record. The City of Duluth has an electronic global search mechanism that dates back to 1992. This system can be searched by word command, however after working with the system it was clear that although solar permit data could be located if the file contained "solar" or "photovoltaic," there has not been consistency over time in permit applications, descriptions, and/or filing. Systems may have had electrical permits and/or building permits, but were unable to be located when solar specific terminology was not used. In addition, after additional resources were consulted, it was clear that less than half of the grid-tied solar installations in the City of Duluth had associated City of Duluth permits.
As Ecolibrium3 compiled the data sources together, it became apparent that many individual solar systems were not included within the permit data, and in fact only 48% of the individual grid-tied solar systems identified by the state and Minnesota Power were found to have matching city permits, limiting the usefulness of permits as a primary data source.

Utility Data – Minnesota Power, an investor owned utility (IOU) that includes Duluth in its service territory, in response to a request from Ecolibrium3 provided a comprehensive report regarding its history with grid-tied solar, including rebate programs, demonstration projects, market capacity, outreach programming and interconnection policy. This report is attached in Appendix A.

Minnesota Department of Commerce – Minnesota Power reports its interconnected solar installations to the state of Minnesota through the Department of Commerce, at which point the data becomes public record. The state also had records of solar installations in Minnesota Power's service territory from 2004-2011, when the state ran a solar rebate program. The Department of Commerce provided Ecolibrium3 with these records, which are provided in Appendix B.

Individual interviews - City of Duluth permit data does list the owner of the property for individual installations, which allowed Ecolibrium3 to interview individual owners of solar systems. Approximately 1/3 of identified permit holders were interviewed to inform the baseline analysis yielding valuable insight into many aspects of solar project development in Duluth. Ecolibrium3 also made contact with local solar system owners through hosting a public solar information session in February 2015 and other outreach activities.

Installer interviews – Ecolibrium3 has been in contact with 6 installers that have served the region and sought input from them in aspects of market development. While specific quantified market information in terms of number and type of solar installations in Duluth was not shared, their experience on process is included within the insights gained during the individual interviews.

Data Findings

Focus: Grid-tied Solar PV

The focus of this analysis is on grid-tied solar photovoltaic generation. While there are other types of solar applications in the Duluth solar market, comprehensive data sets that measure direct PV applications and solar thermal are either incomplete (city permit data) or nonexistent (at the state and utility level due to the lack of a grid interconnection process). However, city permit data that we do have available indicates that direct PV (not grid tied and directly running mechanical applications such as fans or lights) applications and solar thermal play an important role in the Duluth solar market. City permits pulled for various types of solar applications can be found in *Table 1: City Solar Permit Type.*

Table 1: City Solar Permit Type

Solar Type	Space Heating	Direct PV	Hot Water	Grid-tied Solar PV
Existing City of Duluth solar permits	7%	11%	18%	64%

Although the focus of the *Local Energy Matters* project is grid-tied systems, it is anticipated that continued individual and installer interviews will shed more light upon the significance of solar market applications other than grid-tied solar PV. The remainder of the baseline analysis focuses on grid-tied PV.

Solar Capacity By Sector

Duluth appears to have installed its first grid-tied solar PV systems in 2002, when the city of Duluth and St. Louis County mounted small arrays on public buildings. Since that time until the end of 2014, Duluth's total amount of grid-tied solar PV has grown to 256 kW of total capacity. This represents 34% of the total grid-tied solar capacity (762 kW) in Minnesota Power's entire service area. Of the 58 grid-tied systems noted in Duluth, the largest individually metered system is 13.1 kW at Hartley Nature Center, a city of Duluth building. Production from this array can be monitored by the public at http://hartleynature.org/building/energy_tracking.html. The largest array consists of 3 individually-metered 10kW systems sited together on a St. Louis County building as part of a utility research project designed to analyze output of three different panel manufacturers.

Residential and Commercial Sectors – Minnesota Power reported that within its service area, 41% of solar capacity is fulfilled by commercial systems, averaging 7.77 kW in size, and 59% of capacity is occupied by residential systems at an average size of 4.51 kW. While complete grid tied solar sector data specifically for Duluth was not acquired, we can make inferences based on the data that is available.

Tax-exempt public entities, including the city of Duluth, St Louis County, and the University of Minnesota Duluth, represent many of the largest arrays in the city and account for over 22% of Duluth's solar capacity.

State data that exists for Duluth from 2004 to 2010 indicates only 2 commercial installations, both of a relatively small size (under 3 kW), and only account for 6% of solar installations in that time period.

In 2014, commercial applications in Minnesota Power service territory consisted of 2 installations, but this time accounted for 15% of installations, and the size of the arrays went up to an average of 8.86 kW.

From this data we can confirm that small residential systems are and have been the dominant sector in Duluth in terms of number of systems and capacity, followed by public tax-exempt organizations. We can also see that commercial systems have been historically uncommon and when installed, were of a similar small size to residential systems. However, 2014 install data does indicate that this trend may be changing, with commercial entities accounting for a larger share of new installations and an increase in the capacity per array.

Community Solar Sector – There are no historical or current community solar installations in the Minnesota Power service area. While 2013 state legislation does allow Minnesota Power to develop a community solar garden program, it is not mandated to do so, and other types of community solar platforms that could conceivably exist within the current state solar legal framework have not been installed. At the time of this report, Minnesota Power has not filed a Community Solar Program with the Minnesota Public Utilities Commission. Conversations do indicate their interest in filing a voluntary program in the summer of 2015. In anticipation of a potential filing, Ecolibrium3 has worked with the Portland State University's Urban Sustainability Accelerator Program to commission a report on options in the Minnesota Power territory. A description of Minnesota's current Community Solar Garden program as it applies to Xcel service areas and possibilities for community solar options within Minnesota Power's service territory conducted by Anthony Levenda is presented in Appendix C, "Community Solar Gardens in Minnesota (and Beyond)."

Utility Scale Sector - There is not a historical or current application in the Minnesota Power service area of a utility-scale solar installation. Minnesota Power has stated its intent to build a 10 MW utility scale installation at Camp Ripley (Appendix A, Other Demonstration Projects, pg. 4), but at this time has not stated if Duluth would also be a potential host site for a utility scale solar installation.

Installed Cost Analysis

Complete cost data was more difficult to obtain throughout the period of solar installations in the City of Duluth. Data sources included city permits applications (which can cause a bias toward lower costs to avoid permitting fees), rebate applications to the State of Minnesota and Minnesota Power, and owner provided data.

The small sample size of installations with well documented costs and variability of project size make a complete determination of cost in Minnesota Power territory during the analysis period difficult. However, a trend to significant cost reductions during this period is clear. Duluth's first solar installation in 2002, atop its main city library, had an install cost of $11.25/watt, whereas in

2014, Minnesota Power service area residential systems had an average install cost of $3.99/watt, a reduction of 65% in 12 years.

By combining the average installed cost per watt basis supplied by Minnesota Power with median installed cost per watt data from the DOE (Tracking the Sun VII, 2014), we can get an approximation of how the Minnesota Power service area compares to state and national numbers in terms of cost per installed watt.

Chart 1: Avg./Median Installed $/watt for Minnesota Power service, Minnesota, and the United States, 2007-2013

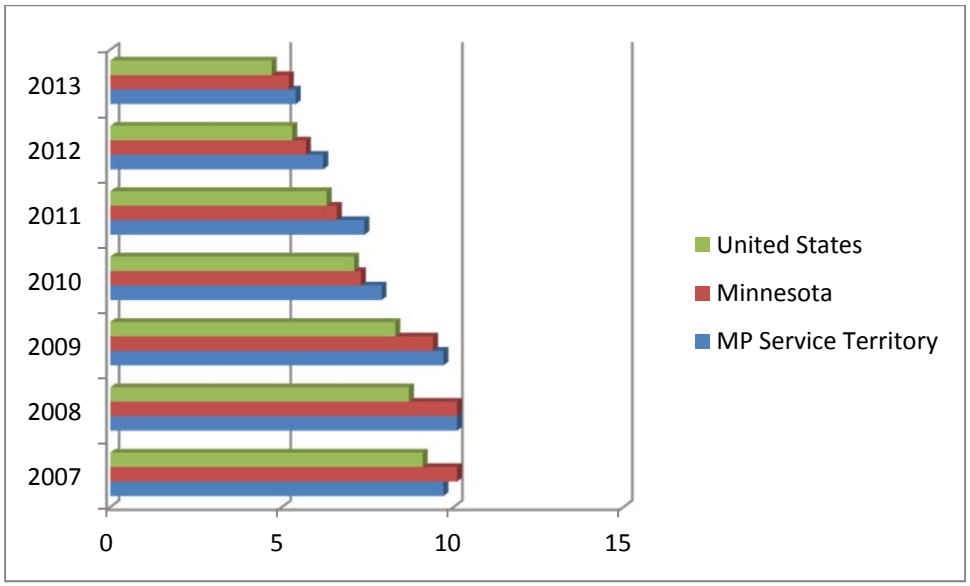

Table 2: Avg./Median Installed $/watt for Minnesota Power service, Minnesota, and the United States, 2007-2013

	2007	2008	2009	2010	2011	2012	2013
MP Service Territory*	$9.7/w	$10.1/w	$9.7/w	$7.9/w	$7.4/w	$6.2/w	$5.4/w
Minnesota^	$10.1/w	$10.1/w	$9.4/w	$7.3/w	$6.6/w	$5.7/w	$5.2/w
United States^	$9.1/w	$8.7/w	$8.3/w	$7.1/w	$6.3/w	$5.3/w	$4.7/w

* Average installed $ per watt, see Appendix A, page 7.

^ *Median installed $ per watt, from Barbose, Galen, Darghouth, Naim, and Weaver, Samantha. Tracking the Sun VII: An Historical Summary of the Installed Price of Phtotvoltaics from 1999 to 2013. Lawrence Berkeley National Laboratory, 2014.*

Average or median install costs exist in a wide range of possibilities. In 2014, new installations in the Minnesota Power service area averaged $3.86/watt for the commercial sector and $3.99/watt for the residential sector. However, the range of installed costs varied widely in the residential sector, from $3.02/watt to $5.31/Watt. Additionally, based on interview data,

residential installations specifically in Duluth in 2014 ranged from $4.70-$5.85/watt. Further investigation is warranted to discern the disparity between the 2014 MP service market average cost and the higher cost figures noted from individual solar installations conducted within Duluth in 2014.

Financing and Incentives

Information about local financing of solar installations came primarily from individual interviews. Interviewees used a wide range of financing to pay for solar projects, but most often solar installation owners paid for "out-of-pocket" installation expenses from their own financial resources rather than with a loan product.

We use the term "out-of-pocket" because what became apparent is that very few solar projects have moved forward without state or utility rebates, and that the amount of rebate available, both in terms of the individual dollar amount per project and the overall amount of money for an annual rebate program, has had a large impact on the solar market (Appendix A, Minnesota Power Solar Rebates chart, pg. 7). While the State of Minnesota and Minnesota Power rebate was stable (2004 – 2010), the number of projects in the Minnesota Power service area fluctuated, but few proceeded without rebates. As the state solar rebate program ended in 2010 and Minnesota Power changed their rebate program in 2012 and 2013, the amount of projects directly correlated to the amount of rebate money available.

Solar Market Demand – In 2014, Minnesota Power adjusted its Solar Sense program by lowering rebates and overall program funding. This occurred at the same time the state of Minnesota entered the market with a new rebate program, the Made in Minnesota (MIM) Production Credit. The MIM rebate operates on a lottery system for its applications. This creates a measurement of market demand compared to previous rebates offered by the state and Minnesota Power that were handled on a first come, first serve basis. A snapshot of all interested parties can be identified due to the lottery structure, where previously, once the rebates were fully subscribed, the number of additional interested projects was unknown. In 2015, Minnesota Power moved its Solar Sense program to a lottery program along the same lines as the MIM production credit.

Table 3: Minnesota Power Solar Sense and MIM rebate program applications and awards, 2014-2015

# of solar PV projects	2014 Applications	2014 Awards	2015 Applications	2015 Awards
MIM PV Credit - Residential	28	7	31	3
MIM PV Credit - Residential	23	1	15	2
MP Solar Sense- Commercial			32 (combined)	6
MP Solar Sense- Commercial			32 (combined)	5

Based on these figures demand far exceeded rebate availability in 2014 and 2015, indicating that a market need for alternative financing and/or incentives for solar projects.

Barriers Identified

Although difficulties with process and opportunities for program adjustments were identified by the City of Duluth building inspection office, installers, state solar staff, and Minnesota Power, the focus for the barrier analysis has been conducted through the viewpoint of the system owners. This is possible in a nascent market where utility-scale and community garden models are not yet in play. Each accomplished project has been directed by an individual system owner instead of a solar developer and/or the utility. As the *Local Energy Matters* project advances and other solar models are contemplated and or used, tracking will occur on additional barriers encountered for each model. The following barriers and relative impact on projects were identified through the individual interview process, and are ranked in the low, moderate and high category based on the frequency of response among interviewees. Understanding historically what barriers existed that resulted in non-completion (non-interconnection) of projects is not possible due to lack of records, but is a data point that will be tracked moving forward as interested parties are identified during the *Local Energy Matters* project.

Low

Snow Load – While most parties interviewed indicated that snow loading on panels was not a barrier to installation or production, those with fixed mounted panels on low pitch roofs did indeed indicate that it was a barrier to adequate overall annual production.

Structural Load of Roof – Again, few parties indicated that this was a significant concern. It did emerge as a concern among older commercial buildings and churches with flat roofs as a barrier to solar, based on the increased cost to modify the roof to comply with city code if a solar array was installed. It is expected, from interviews with installers, that this is a major factor in elimination of potential projects from consideration and should be tracked going forward. Installers indicated strong recommendations against solar if they determined roof condition was not appropriate. Because these systems were then not installed, the barrier-identification sample group ranks the barrier lower than actual if the data were to include all interested parties.

Medium

Interconnection – The connection process to the grid was brought up in 25% of the interviews, with a much higher rate among individuals that did installations in the last few years. Issues identified were higher costs and requirements than anticipated, length of time to interconnect, and the linkage of general utility electrical safety concerns on a specific site to the solar interconnection. One interviewee has filed a complaint to the PUC regarding additional expenses required by the utility for interconnection. Results from that filing are not yet available.

Operations and Maintenance - Owners of mature systems noted issues of failure of mechanical systems, including inverters and monitoring systems that were unaccounted for long periods of time and became barriers to production.

High

Cost – The high initial capital investment of solar PV systems was constantly referred to, both in terms of the need for rebate acquisition and to shorten financial payback. Financial payback in particular is the standard metric of value referred to by interviewees, and without rebates or tax incentives is very long in this market, 20-25 years, even with the decline in installed solar costs. This is mainly due to the very low retail cost of electricity in Minnesota Power service territory compared to state and national averages (EIA Electric Power Monthly, March 2015).

Table 4: Electricity Rate Comparison, Minnesota Power, MN, US, Jan 2015

Residential Electric rates	cents/kwh
United States^	12.1
Minnesota^	11.51
Minnesota Power*	9.91

^ Electric Power Monthly, March 2015; average cost.
* Standard metered Minnesota Power resident using 650 kWh.

Rebates – Along with cost, availability of rebates dominated interviewee concerns. While the rebates, along with federal tax credits, remain the most sought after way to reduce financial payback, the limitation of program funding for both Minnesota Power Solar Sense rebates and MIM Production credit rebates, along the uncertainty of rebates based on a lottery system, effectively blocks market development as those rebates are sought after but unsure. Potential customers that do not receive rebates plan to wait to refile until they do, and as a consequence installers have limited periods of intensely busy activity followed by long periods of inactivity while clients await lottery results or a year delay as they refile.

Complexity - Most interviewees touched on complexity as a barrier to solar installation, and topics of uncertainty ranged from misunderstanding the potential solar resource to installer selection to rebate acquisition. In fact, many interviewees related that the process was overwhelming, and that if clear and consistent steps could be made available to the consumer, it would greatly assist in forwarding the case for solar in the region.

Conclusion

The solar market baseline analysis illuminated areas of the solar market that had not previously been coalesced, including current market solar capacity, latent demand, the average size of individual arrays, and the market installed cost compared to state and national averages. The analysis also identified paths of inquiry to further investigate local barriers to solar installations, including:

- Finding best practices to alleviate potential snow load, roof structure, and interconnection difficulties

- Exploring financing options that can alleviate the "rebate headache" that persists in this particular solar market.
- Discerning the elements of process that will be most helpful in assisting consumers in understanding the value of prospective solar installations.

The *Local Energy Matters* project and stakeholder group will use this baseline data and barrier analysis to develop next steps and lines of inquiry. 2014 & 2015 data will be added as it becomes available.

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Local Energy Matters: Appendix A

Minnesota Power Solar Installation Report

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March 25, 2015

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RE: SunShot Initiative – Solar Market Data Request

This letter is in response to Ecolibrium3's requested information from Minnesota Power (MP) in regards to past and current solar energy programs. Minnesota Power has a long-standing history of encouraging the adoption of renewable energy options such as solar photovoltaic systems and remains committed to encouraging solar as an important and growing part of the energy landscape. We look forward to collaborating with Ecolibrium3 on this SunShot Initiative project.

I. Background – Solar Rebate Program

Minnesota Power has offered a small scale renewable program within its Conservation Improvement Program ("CIP") budget since 2004. The program includes incentives for solar photovoltaics (PV), wind, biomass, and solar thermal. The solar aspects of the program were originally modeled after the state solar rebate program, matching the state rebate amount of $2,000/kW and leveraging the state review process as a prequalification; thereby minimizing internal administrative costs. A rebate cap of $4,000 was in place until 2011, at which time the cap was lifted to $20,000. In its inception year, 13 solar PV systems received funding through SolarSense. The Minnesota Solar Electric Rebate Program, administered by the Minnesota Department of Commerce State Energy Office (MNSEO), was discontinued in 2011.

In light of a downward trend in the participation level in SolarSense by customers and the change in availability of state program funds, Minnesota Power determined that it was prudent to reconsider its program design and rebate structure. The state program's demand and rebate subscription levels oftentimes exceeded available funds, demonstrating interest in solar energy, but resulting in an ebb and flow nature to interest in the SolarSense program. This proved to be challenging; however, in Minnesota Power's view, the complete absence of a state rebate program for solar would inevitably have a negative impact on Minnesota Power's SolarSense program, if kept as originally designed.

To inform the program design process and explore potential program enhancement options, Minnesota Power commissioned a study to identify program design and implementation best practices. The insights gained through this research effort were informative to Minnesota Power's rebate structure redesign. Overall, the SolarSense program was intended to support the adoption of solar electric energy by encouraging more installations by customers while also reinforcing the objectives of the Conservation Improvement Program (CIP) through which Solar Sense is funded - that being "conservation first".

A new tiered structure to the program was chosen and piloted in 2012. Below are tables showing the tiered structure the rebate took on in 2012 and the incentive level for each tier by year. The incentive cap was, and still is, $20,000 or 60% of the total cost of installation, whichever is less.

2012:		
Base Rebate	$2,000	kW
Bonus Incentives:		
NABCEP Certified Installer	$250	kW
Minnesota Made	$1,000	kW
Non-profit/Tax Exempt	$500	kW
Energy Efficiency	$1,000	kW
Total Possible Incentive	$4,750	kW

Based on insights from the 2012 pilot, rebate tiers were slightly modified and continued in 2013 as follows:

2013:		
Base Rebate	$1,000	kW
Bonus Incentives:		
NABCEP Certified Installer	$800	kW
Minnesota Made	$800	kW
Non-profit/Tax Exempt	$500	kW
Energy Efficiency	$800	kW
Total Possible Incentive	$3,900	kW

In 2013, the Minnesota State Legislature enacted legislation creating a new incentive program called “Made in Minnesota”. This program is administered by the Minnesota Department of Commerce and uses funds from Investor Owned Utilities (IOUs) and Xcel Energy’s Renewable Development (RDF) fund. In accordance with statute, Minnesota Power contributes 5% of its minimum required CIP spending to the Made in Minnesota program annually. The program began in 2014 and will run through 2023. Made in Minnesota is a production-based incentive meaning that the incentive amount is based on system performance over time. Customers participating in this program will receive payment for the production of the system

annually for 10 years. More details about Made in Minnesota are available at www.mn.gov/made-in-minnesota.

As the Made in Minnesota program diverted funds from the SolarSense budget, rebate levels were adjusted as follows:

2014:		
Base Rebate	$1,000	kW
Bonus Incentives:		
NABCEP Certified Installer	$500	kW
Non-profit/Tax Exempt	$500	kW
Total Possible Incentive	$2000	kW

II. Other Demonstration Projects

Minnesota Power has made many efforts to advance the use of solar energy in Minnesota. A few higher profile projects are summarized as follows:

Hartley Nature Center ("HNC") Distributed Generation Project

This project, located in Duluth, Minn., was completed in 2002. Using Minnesota Power CIP funding, HNC installed a 11.5 kW roof-mounted photovoltaic (PV) system, a 2.5 kW PV tracker system and an eight-ton geothermal heat pump system to provide heat and power for its new facility. In addition, it has installed a state-of-the-art, real-time performance monitoring system that provides energy and environmental data in electronic format for a kiosk display and HNC's website.

Recently the inverters for this system have begun to malfunction. HNC is currently undergoing planning on how to incorporate newer inverter technologies and achieve better solar access for the modules.

Rebuild Minnesota—Renewable Energy for Sustainable Communities (Lake Superior Zoo)

The Department of Commerce, Rebuild Minnesota, along with the City of Duluth ComfortSystems, Lake Superior Zoo, and Johnson Controls began a collaborative effort in 2002 for a renewable project to be located at the Lake Superior Zoo. In 2005, the Lake Superior Zoo installed a 2.9 kW solar PV system on the roof of the parking pavilion used to park the zoo maintenance vehicles. The PV system provides electricity to charge the electric utility vehicles used at the zoo.

In addition to the solar PV system, the Lake Superior Zoo installed a solar thermal water heating system used to provide hot water for the animal barn. The system consists of 40 evacuated vacuum tubes and two 80 gallon storage tanks. The system is designed to provide up to 60 percent of the water heating needs for the

animal barn. This system is currently not operating due to a combination of 2012 flood damage and an accident in which a bank of tubes was shattered.

Educational displays, including an interactive kiosk centrally located within the main zoo building, are used to demonstrate the relationship between energy, the built environment, and the natural process that animals use to conserve and use energy. An interactive solar electric (PV) display was also located at the PV shelter, allowing visitors the opportunity to interact with a working solar panel and learn more about the relationship of solar radiation, sun angle and shading effects.

St. Louis County Government Services Building Solar PV Research Project

Minnesota Power and St. Louis County have a long history of partnership in implementing energy-saving projects at County facilities. The Government Services Building in Duluth is a prime example of how Minnesota Power and the County have collaborated. The building has been undergoing major renovations that will result in an estimated 60% energy savings for the building. The county had planned to add solar power to the building for many years. In light of the major energy efficiency upgrades and intentions of the County to pursue LEED certification, a plan to install a 30 kW PV system came together. This installation highlights how the County and Minnesota Power applied the principle of the Pyramid of Conservation. The pinnacle of the Pyramid is installation of renewable energy systems, following the methodic incorporation of cost-effective energy efficiency. The solar PV project was installed in late 2013 and early 2014. Minnesota Power contributed funding to the project, and continues to supply staff support to the effort.

The solar PV project includes three different module manufacturers in approximately 10 kW arrays. The Natural Resources Research Institute (NRRI) was hired to analyze qualitative and quantitative outcomes of the project. Minnesota Power is working closely with NRRI to monitor and provide data about the project. NRRI makes quarterly reports about the findings. At the conclusion of three years, a public report on the findings will be released.

Camp Ripley- Utility Scale Solar

Minnesota Power and the leadership at Camp Ripley are moving forward with a utility scale solar development on base property. This is Minnesota Power's first ever utility scale solar project. This project is phase one of a three phase relationship, with other phases focusing on energy efficiency and microgrid integration. The project will be a 10 megawatt solar system and will contribute about 1/3 of the Minnesota Power's goal of 1.5% of solar energy by 2020. The project is still in development. It is expected to be in service before the end of 2016.

This brief overview of some of Minnesota Power's efforts to understand and implement solar within its territory do not reflect an exhaustive list to describe all efforts that may have been undertaken. These examples are related to a limited timeframe for projects that have fallen under the Conservation Improvement Program. These examples do show Minnesota Power's long-standing interest in exploring opportunities to engage new and emerging technologies.

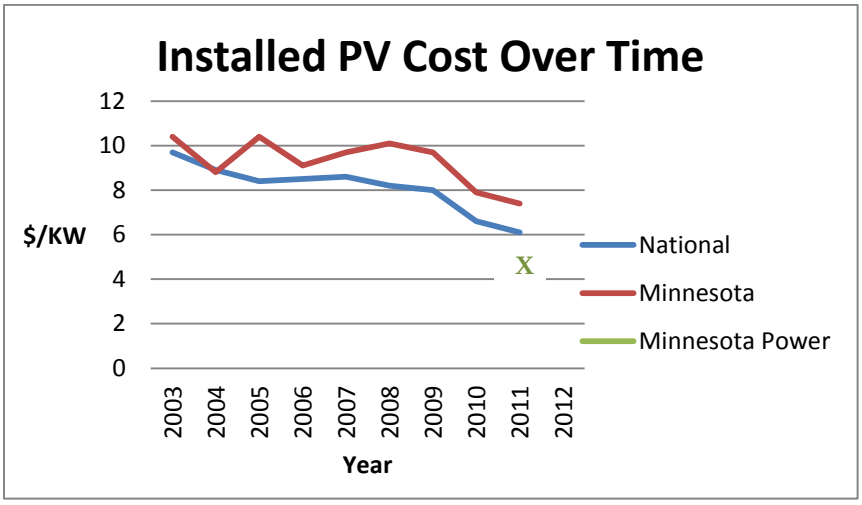
III. Installed Capacity

Minnesota Power's service territory has 132 interconnected photovoltaic (PV) installations with a capacity of 762.1 kilowatts (kW). In Duluth specifically, there are 58 systems installed with a total capacity of 256 kW. Minnesota Power also has incentivized solar thermal systems through the SolarSense program. To date 10 solar thermal systems have been installed with the SolarSense program. The breakdown for residential and commercial systems for the entire Minnesota Power territory is presented in the table below.

Type	# of systems	kW
Commercial	40	310.76
Residential	92	451.34
Total	132	762.10

The graph below illustrates the declining cost in solar PV installations. The downward trending costs have a large effect on the need and level of an incentive program. As the SolarSense program continues to evolve, Minnesota Power will re-evaluate the most effective incentives for the budget and installed capacity goals.

Installed PV Cost Over Time[1]



[1] National and Minnesota data derived from: Barbose, Galen L, Darghouth, Naïm, and Wiser, Ryan H. Tracking the Sun V An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2011, 2012.

IV. Data from Program Years

The following section includes data from the SolarSense program since its inception in 2004. This information is valuable as a baseline for the experience of the program and future trends.

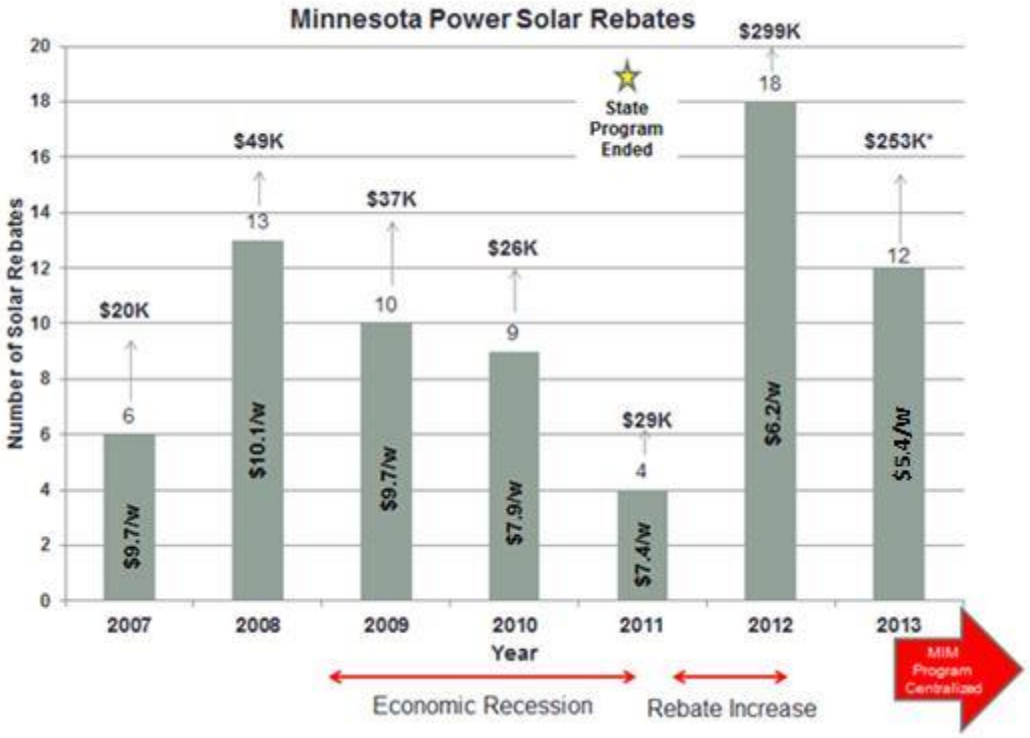
Solar Rebate Statistics by Year				
		Average		
Year	Number of Rebates	Unit Size	Rebate	Total Rebates
		(kW)	($/kW)	($)
2004	13	2.09	1,709	46,512
2005	7	1.94	2,092	28,472
2006	8	2.81	1,423	32,000
2007	5	3.12	1,284	20,000
2008	13	6.44	1,093	49,280
2009	10	3.50	1,080	37,840
2010	8	4.98	705	26,820
2011	4	4.19	1,828	29,382
2012	18	6.21	2,685	299,847
2013	15	7.00	2,251	236,373
2014	9	10.76	1,524	147,685

Made in Minnesota[2]

Program Year	Systems Approved	Systems installed in 2014	Capacity approved	Capacity installed in 2014
2014	8	4	108.72	52.48

[2] These figures represent first year results for Made in Minnesota in Minnesota Power's service territory. There were some difficulties with system installation completion in the first year of Made in Minnesota, largely due to product availability. Four of eight systems awarded funds have been given extensions until June 1, 2015.

The graphic below illustrates program years 2007-2013. It shows total number of systems installed, average installed cost on a per watt basis, total rebate amounts, and important date notes.



As interconnection applications tend to cease when rebate program dollars are consumed, there is no record of interconnection applications that have been rejected or denied.

V. Solar Fleet

The Minnesota Power fleet of customer-owned solar installations has many variations across the 132 installations. Systems have great variability in regards to tilt, azimuth, and ground or roof mounted. Many manufacturers for racking, modules, and inverters are represented in the mix. There are a few dominant installers in MP's service territory which has added some consistency to product choice and deployment methods. Still, generalizations on installations are difficult to make. One of the most common module manufacturers used is Kyocera. Inverters commonly used are from Fronius or SMA. There are many examples of custom-made racking in the field. There are many systems installed that meet an industry standard default maximization tilt of 45 degrees.

Minnesota Power has performed on-site reviews of all interconnected solar PV systems in its service territory. The review has provided key insights into system performance, customer experience and system modifications including deactivation, component changes, and expansions. MP is currently reviewing and analyzing this data to inform programs moving forward.

VI. Customer Engagement and Outreach

In 2014, Minnesota Power formed a Renewable Program area to serve as a primary point of contact and source of information for customers about renewable energy options for their homes and businesses. This includes a Renewable Program Analyst and a Renewable Program Lead. These individuals are available to answer interconnection, rebate program, and technical questions regarding the solar process. Internally, they work with experts within Minnesota Power on solar processes including program design, billing, metering, and interconnection. They also actively engage with local installers, inspectors, and other community stakeholders regarding solar and the overall process.

Renewable Programs in the first year of existence has implemented several initiatives to enhance customer education and simplify processes. A pilot program in 2015 is called Solar Energy Analysis. This program offers Minnesota Power customers the opportunity to have a conversation with and site visit by Minnesota Power personnel to discuss the potential for solar at their own home or business, along with site-specific considerations relevant to their potential system implementation and interconnection. Customers are provided with a summary of the visit that may be shared with installers as they move forward with projects. Another effort to educate customer decision making is the publishing of a solar workbook. This guide to installing solar in Minnesota Power's service territory aids the customer decision-making process as they consider installing a solar system. Renewable Program staff also directed a new updated website, in order to create a more user-friendly experience.

Providing educational opportunities about renewables is very important to Minnesota Power. For example, Minnesota Power routinely offers educational sessions about solar at the annual Energy Design Conference & Expo, which just celebrated its 25th year. In 2015, this conference offered a full course track on solar energy. The Energy Design Conference is held yearly and attended by well over 500 contractors, architects, students, and citizens. Another opportunity for teachers was offered by the Boulder Lake Environmental Center with funding from the Minnesota Power Foundation. This renewable energy workshop was held in the summer of 2014 and provided training and ideas for hands on renewable energy classroom lessons for teachers. Minnesota Power's Renewable Program team provided classroom lecture time to this effort as well. This workshop has been funded again in 2015 due to the positive response from the workshops. Some other efforts by Minnesota Power include participation in UMD student group projects, attendance at local events providing information on program offerings, and continual exploration of other opportunities to inform customers. There are many more resources on the MP website for customers interested in solar energy systems for their homes or businesses.

Internally, Renewable Program staff continually work to understand and improve interconnection and reporting processes. Clarifying standards for interconnection, establishing a new database for installations, and developing new online tool for applying for interconnection are examples of how the Renewable Program team is working to streamline internal processes at Minnesota Power. Many of the efforts internally will be reflected to customers in a smoother experience for implementing their renewable energy projects.

VII. Interconnection

Interconnection processes and requirements for distributed generation, including solar PV systems, are described in the State of Minnesota Interconnection Process for Distributed Generation and State of Minnesota Distributed Generation Interconnection Requirements, located at the following link.

http://www.mnpower.com/Content/Documents/CustomerService/DistributedGeneration/dg-application-process.pdf

Minnesota Power's Interconnection Process for systems 40 kW and under is also posted on the website. A link is provided below for the detailed information on process and timelines customers can expect during an interconnection.

http://www.mnpower.com/Content/Documents/Environment/RenewableEnergy/interconnection-process.pdf

VIII. Conclusion

Minnesota Power views renewable energy as an important and growing part of the energy landscape. We strive to provide customers with the tools and resources to make informed choices about their investments in energy efficiency and small-scale renewable technology such as solar. Minnesota Power continues to work diligently to further clarify and streamline the interconnection process. By enhancing customer communication efforts, Minnesota Power is helping to align customer expectations with achieved results. Efforts to streamline the interconnection process coupled with increased transparency and communication will help to ensure that distributed generation systems continue to be installed in a safe and reliable manner in the future.

Thanks for the opportunity to share this information and we look forward to working with Ecolibrium3 as part of its grant under the SunShot Initiative.

Sincerely,

Paul Helstrom, Renewable Program Lead
Minnesota Power
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Duluth, MN 55802
218-355-3227

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LOCAL ENERGY MATTERS

Local Energy Matters: Appendix B

Minnesota Department of Commerce Solar Rebate Data

Ecolibrium3 is a 501(c)3 organization dedicated to leading and inspiring change for a sustainable and equitable future.

2304 W. Superior Street, Duluth, MN 55806
218.336.1038, www.ecolibrium3.org

solarmarket PATHWAYS

This report was prepared under DE-EE0006908 as part of the Local Energy Matters: Solar Market Development in Duluth, MN project.

2014 Solar Installation Update Data from MN Department of Commerce

SolarSense

Year Complete	Quarter	Customer Category	Total # of Interconnections	Total kW Installed	Total Installed Cost
2014	1	Commercial	1	9.84	$39,096.00
		Residential	0	0	N/A
	2	Commercial	0	0	N/A
		Residential	2	24.73	$74,581.40
	3	Commercial	1	8	$29,822.48
		Residential	2	25.95	$94,687.12
	4	Commercial	0	0	N/A
		Residential	3	28.5	$136,034.77

Made in Minnesota

Year Complete	Quarter	Customer Category	Total # of Interconnections	Total kW Installed	Total Installed Cost
2014	1	Commercial	0	0	N/A
		Residential	0	0	N/A
	2	Commercial	0	0	N/A
		Residential	0	0	N/A
	3	Commercial	0	0	N/A
		Residential	2	7.72	$41,000.00
	4	Commercial	0	0	N/A
		Residential	0	0	N/A

No Incentives

Year Complete	Quarter	Customer Category	Total # of Interconnections	Total kW Installed	Total Installed Cost
2014	1	Commercial	0	0	N/A
		Residential	0	0	N/A
	2	Commercial	0	0	N/A
		Residential	1	9.84	N/A
	3	Commercial	0	0	N/A
		Residential	1	6	N/A
	4	Commercial	0	0	N/A
		Residential	0	0	N/A

Totals

Year Complete	Quarter	Customer Category	Total # of Interconnections	Total kW Installed	Total Installed Cost
2014	All	Commercial	2	17.84	$68,918.48
		Residential	11	102.74	$346,303.29

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Local Energy Matters: Appendix C

Portland State University Community Solar Gardens in Minnesota (and Beyond) Report

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Community Solar Gardens in Minnesota (and Beyond)

By Anthony Levenda[1]
January 12, 2015

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List of Figures

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List of Tables

Acknowledgements

This report was made possible through the work of many others. This report cites and reproduces work from numerous sources including the National Renewable Energy Laboratory, the US Department of Energy, the Community Power Network, Minnesota's Clean Energy Resource Team, and many others. The 2012 NREL report, "A Guide to Community Shared Solar: Utility, Private, and Nonprofit Project Development" provides most of the substantive background for this report.

The author would like to thank the Duluth Energy Futures Project Team for directing this report's goals and content. The Urban Sustainability Accelerator team was immensely helpful in providing detailed feedback and essential comments to improve the outcome of this research report. The author, however, takes all responsibility for any errors or issues in the report. Please direct questions or concerns to anthonylevenda@pdx.edu.

The Urban Sustainability Accelerator (USA) at Portland State University helps cities implement sustainability projects, to move their proposals from a concept, a plan, a policy or action item, to reality. USA focuses on *implementation* of adopted sustainability policies, plans, and goals. The assistance USA provides is of every type: technical, strategic, administrative, legal and political. The USA team believes urban sustainability projects should naturally and logically incorporate economic development as well as social justice dimensions. The project is made possible by the generous support of the Summit Foundation and the Institute for Sustainable Solutions at Portland State University.

Introduction

This report addresses the need for a "knowledge base" about community solar options for Duluth, Minnesota. This study was commissioned by the Duluth Energy Futures team as technical assistance for their project in conjunction with the Urban Sustainability Accelerator.

The recent Minnesota Public Utilities Commission's decision to enable community solar gardens was passed into law by the Minnesota Legislature in 2013. Minnesota Statute § 216b.1641 (Article 10, Section 2) is the basis for the Community Solar Garden (CSG) Program, but it only applies to Xcel Energy, Minnesota's largest electric utility. It prompted the establishment of their Solar Rewards Program as per Minnesota Statute § 116C.779.

Xcel Energy received an overwhelming response to the announcement of its CSG program, with 427 applications for 420 megawatts of total capacity in just two weeks after its December 12th, 2014 launch date. Once constructed, these community solar gardens will allow energy consumers to subscribe to solar gardens and receive credits on their bills for their portion of energy produced by the PV systems, ranging anywhere from 200 watts to 120 percent of their annual electricity usage.

Duluth's electric utility, Minnesota Power, unlike Xcel, is not mandated to purchase electricity generated from community solar gardens. Therefore, other strategies may be pursued. This report provides background for the numerous models that exist for community solar: Virtual Net-Metering or State Legislation Model; Utility-Sponsored Model; Special Purpose Entity Model; Non-Profit Model; and other emerging models. It follows the US Department of Energy evaluation criteria guidelines for community solar along three dimensions: Cost & Benefit Allocation, Tax and Finance Considerations, and Other legal issues.

Community Solar Program Models

Community Solar is defined as a solar-electric system that, through a voluntary program, provides power and/or financial benefit to, or is owned by, multiple community members. Rooftop systems are not an option for everyone, and only 22 to 27% of residential rooftop area in the US is suitable for hosting an on-site photovoltaic (PV) system due to structural, shading, or ownership issues. [2]

There are a number of different models or approaches for developing a community solar project, including:

- **Utility-sponsored projects**
- **Special-purpose entity**
- **Non-profit projects**

[2] See www.nrel.gov/docs/fy09osti/44073.pdf, p. 4 .

And there are several other emerging approaches which are permutations of the above, or different models altogether:

- Virtual net metering via state-level legislation
- Bulk purchase programs
- Group billing
- Joint ownership
- Crowd funding

Each model/approach is described below.

1. Utility-sponsored Projects

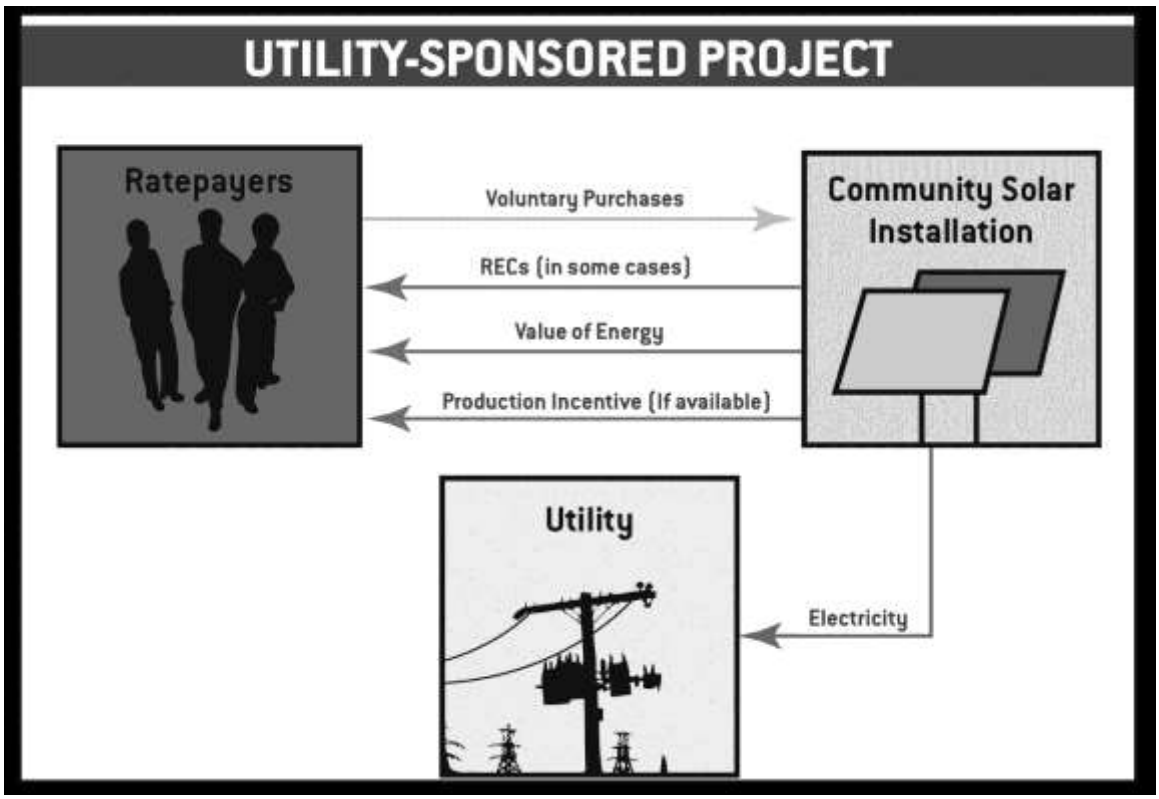

Figure 1: Utility Sponsored Project. Please see http://www.nrel.gov/docs/fy11osti/49930.pdf, p. 8

- **Utility-Sponsored Model:** A utility owns or operates a project that is open to voluntary ratepayer participation. These often have different enrollment options: Single upfront payment, payment spread out on an installment plan, or a monthly subscription with no upfront fees. The participating customer has no ownership stake in the solar system. Rather, the customer buys rights to the benefits of the energy produced by the system. [3] Examples include:

[3] Note that utility-sponsored community solar programs are distinct from traditional utility "green power" programs in that "green power" programs sell RECs (Renewable

- ***Tucson Electric Power- Bright Tucson Program*** **(Tucson, AZ)**
  A program in which utility customers purchase solar power in "blocks" of 150 kilowatt hours (kWh) per month. Customers can buy some or all of their power through the program, reducing or eliminating their energy use from conventional resources.

- ***Farmers Electric Cooperative's Solar Garden Program*** **(Kalona, IA)**
  The cooperative invites its customers to buy part of a "solar garden" located at its main office building in exchange for a reduction on their monthly bill.

- ***Inland Power & Light*** **(Spokane, WA)**
  Developed a program for Community Solar in which customers are able to purchase a one-time, up front stake in the PV system and are then issued monthly credits and State financial incentive payments for the life of the PV project.

- ***Sacramento Municipal Utility District's Solar Shares*** **(Sacramento, CA)**
  A fixed monthly price program for customers who want to offset their electricity use with locally produced solar energy via a "solar farm" or solar garden. Unlike Xcel's program, SMUD Solar Shares PV systems are owned by the municipal utility, not a solar service provider.

Discussion: Minnesota Power may take on this sort of community solar program; however, most examples of utility-sponsored projects are in cooperative or municipal utilities. Minnesota Power may want to meet a least a part of their required solar resource load through this approach. The City of Duluth and UMD could advocate for this approach as it provides opportunities for utility customers to purchase and support renewable energy through Minnesota Power.

Energy Credits) from a variety of renewable energy resources, whereas utility community solar programs sell energy or rights to energy from a specific solar installation, with or without the RECs.

2. Special Purpose Entities

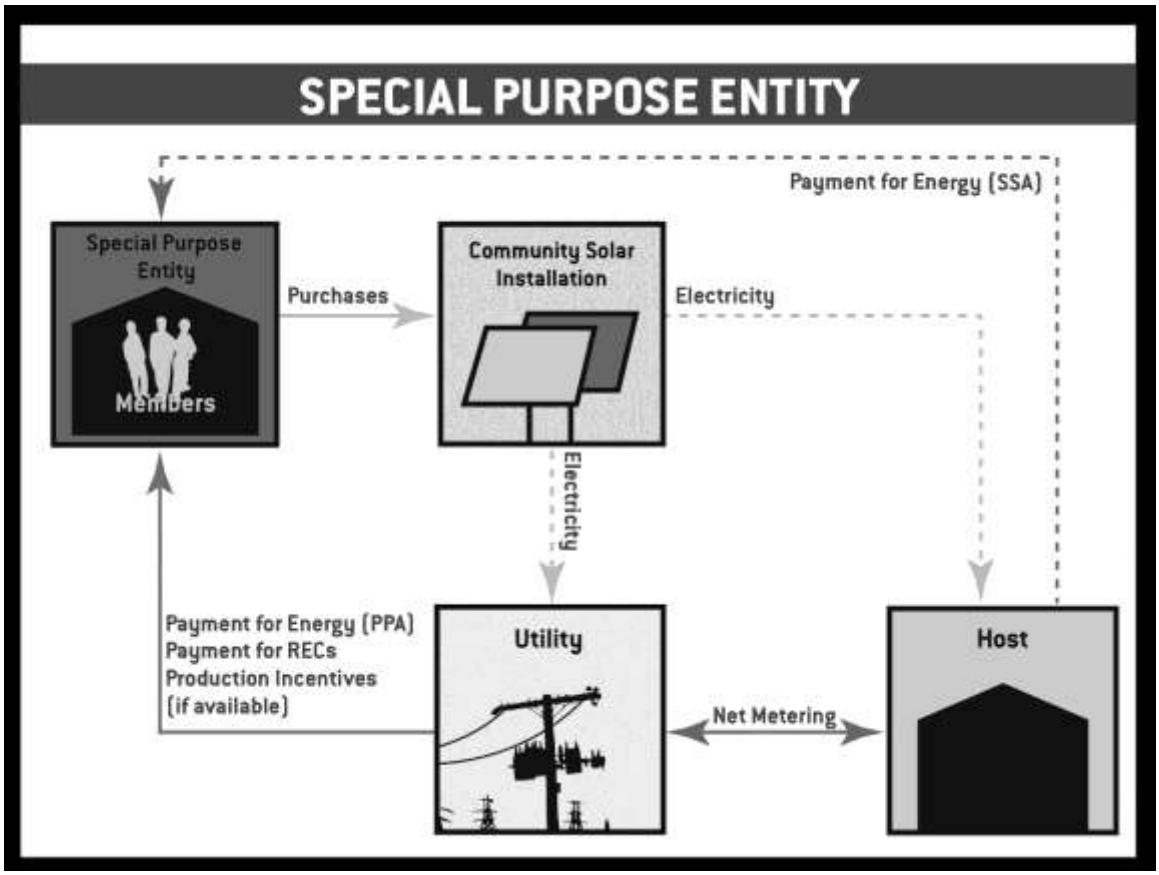

Figure 2: Special Purpose Entity. Please see http://www.nrel.gov/docs/fy11osti/49930.pdf, p. 13

- **Special Purpose Entity (SPE) Model:** In an SPE model, individuals join in a business enterprise to develop a community shared solar project. It allows the group to take advantage of tax incentives available to commercial solar projects. A number of business entities are able to be a participant-owned community solar project. Examples include:

    - ***University Park Community Solar LLC*** **(University Park, MD)** ***and*** ***Greenbelt Community Solar*** **(Greenbelt, MD)**
      Both are limited liability companies of Maryland residents that developed a solar power generation site on buildings in their community.

    - ***Sidwell Friends School*** **(Washington, D.C.)**
      A project in which members of the community invested in a solar system installed on the Sidwell Friends School by purchasing "solar bonds."

    - ***Clean Energy Collective, LLC*** **(Carbondale, CO)**
      A for-profit company that develops community-owned renewable energy solutions for electric utilities and their customers.

- ***My Generation Energy, LLC*** **(South Dennis, MA)**
  A different example formed from existing business endeavors.

Discussion**:** SPEs are a broad category for many different approaches to community solar. The City and UMD may be interested in advocating for a Power Purchasing Agreement (PPA) in which the SPE sells the electricity to the utility; a Solar Services Agreement (SSA) in which the SPE sells the electricity to the system host (landowner, City, etc); a Virtual Net Metering approach wherein the SPE assigns kWh to utility accounts per agreement with utility; or a group billing approach wherein electricity produced is netted against SPE members' group bill.

An example of an SPE approach including 3 or 4 congregations in Duluth was discussed by Bret Pence of Ecolibrium3. Between these sites, only 1 has good characteristics (solar insolation, no shading, etc) for siting a PV system. An SPE may be developed to allow the 4 churches to each get the benefits of the system. One approach is discussed by AIRE to allow this sort of SPE to work. However, they will need to be aware of financing, tax and legal issues.

SPEs can be financed in several ways. For a *community SPE*, potential financing structures that maximize federal tax incentives include:

- **Self-financing**: A community SPE finances the project with equity invested by community members. In order to fully use federal tax benefits, the SPE needs to have enough community investors that have sufficient tax appetite to use federal tax incentives.

- **Flip Structure**: In this scenario, the community SPE partners with a tax-motivated investor in a new special purpose entity that owns and operates the project. Initially, most of the equity comes from the tax investor and most of the benefit (as much as 99%) would flow to the tax investor. When the tax investor has fully monetized the tax benefits and achieved an agreed-upon rate of return, the allocation of benefits and majority ownership (95%) would "flip" to the community SPE (but not within the first five years). After the flip, the community SPE has the option to buy out all or most of the tax investor's interest in the project at the fair market value of the tax investor's remaining interest. To be considered an accredited investor, an individual must have either: 1) a net worth of more than $1 million or 2) an annual income of $200,000 ($300,000 jointly with a spouse) in each of the most recent two years and a reasonable expectation of having the same income level in the current year.

- **Sale/Leaseback:** In this scenario, the community SPE (as the developer of the project, the site host, or both) installs the PV system, sells it to a tax investor and then leases it back. As the lessee, the community SPE is responsible for operating and maintaining the solar system and has the right to sell or use the power. In exchange for use of the solar system, the community lessee makes lease payments

to the tax investor (the lessor). The tax investor has rights to federal tax benefits generated by the project and the lease payments. The community SPE may have the option to buy back the project at 100% fair market value after the tax benefits are exhausted.

3. Non-profit Projects

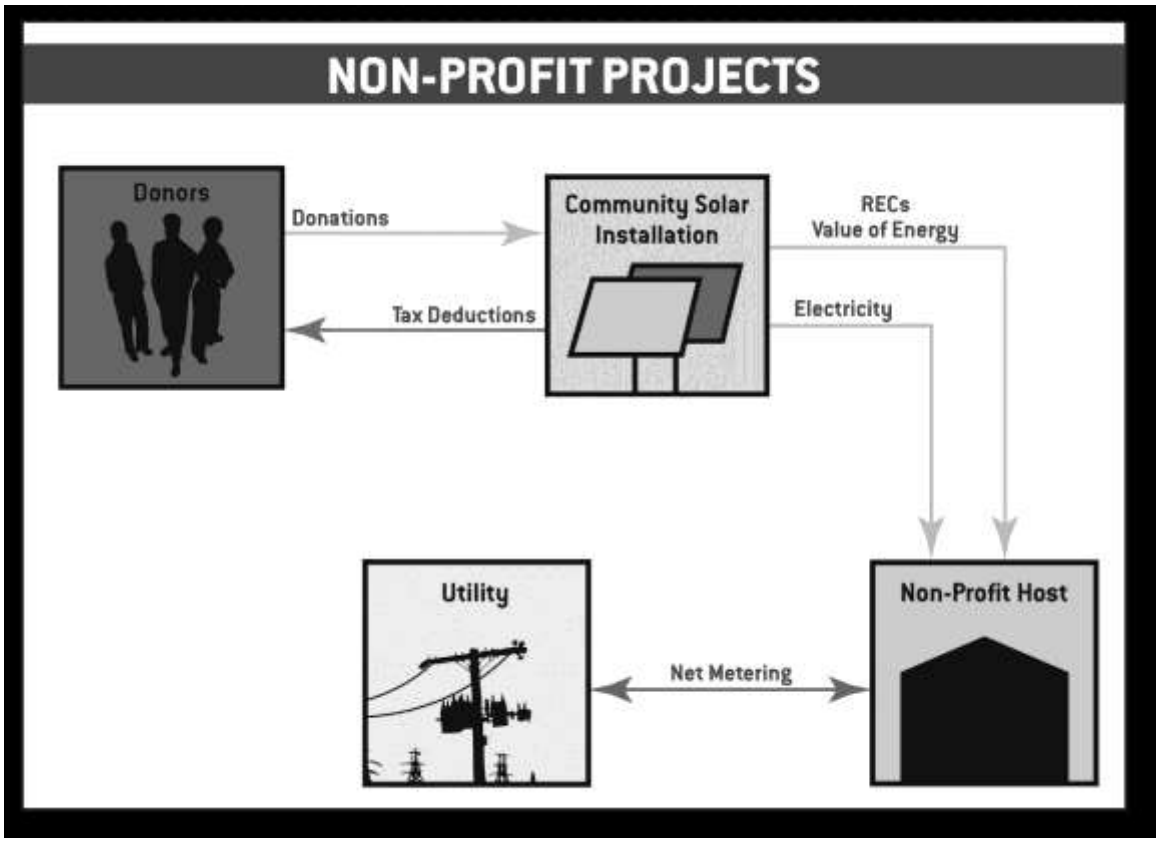

Figure 3: Non-Profit Projects. Please see http://www.nrel.gov/docs/fy11osti/49930.pdf, p. 19

- **Nonprofit ("Buy a Brick") Model:** A charitable nonprofit corporation administers a community shared solar project on behalf of donors or members. Examples include:
    - ***Grid Alternatives*** **(Oakland CA, and multiple states)**
      A nonprofit that helps multi-family apartment buildings go solar and allows residents to save money on their utility bills.

    - ***DC Solar United Neighborhoods*** **(Washington, D.C.)**
      A coalition of neighborhood solar coops that organize neighborhood solar bulk purchases to help neighbors save money and navigate the installation process.

Discussion: This approach will apply to Duluth only if projects are identified with nonprofits with significant funding and donors willing to participate.

Table 1: Overview of Program Models (adapted from

	Utility	Special Purpose Entity	Non-Profit
Owned By	Utility or 3rd party	SPE members	Non-profit
Financed By	Utility, grants, ratepayer subscriptions	Member investments, grants, incentives	Donor contributions, grants
Hosted By	Utility or 3rd party	3rd party	Non-profit
Subscriber Profile	Electric rate payers	Community investors	Donors
Subscriber Motive	Offset personal electricity use	Return on investment, offset personal use	Philanthropy, return on investment
Long-term Strategy of Sponsor	Offer solar options Add solar generation (RPS)	Sell system to host Retain for electricity production for life of system	Retain for electricity production for life of systems

Other emerging approaches include:

- **Virtual Net Metering via State-level Legislation**
  States legislate that utilities must provide customers with the option of virtual net metering, with implementation varying between states. Virtual net metering allows multiple homeowners to participate in the same metering system and share the output from a single facility that is not physically connected to their property (or their meter). This scheme goes a step beyond net metering, which allows individuals to sell excess energy produced by their on-site solar system back to the utility grid and receive credits on their electric bill. Examples include:

  - ***Xcel Energy's Solar*Rewards Community Program***
    As referenced above, this is the primary program for Minnesotans interested in Community Solar. It provides incentives to stimulate the development of community solar gardens in Xcel's Minnesota (and Colorado) service territory where existing state-legislation mandates Xcel to purchase energy produced from CSGs. Please see Figure 4 below.

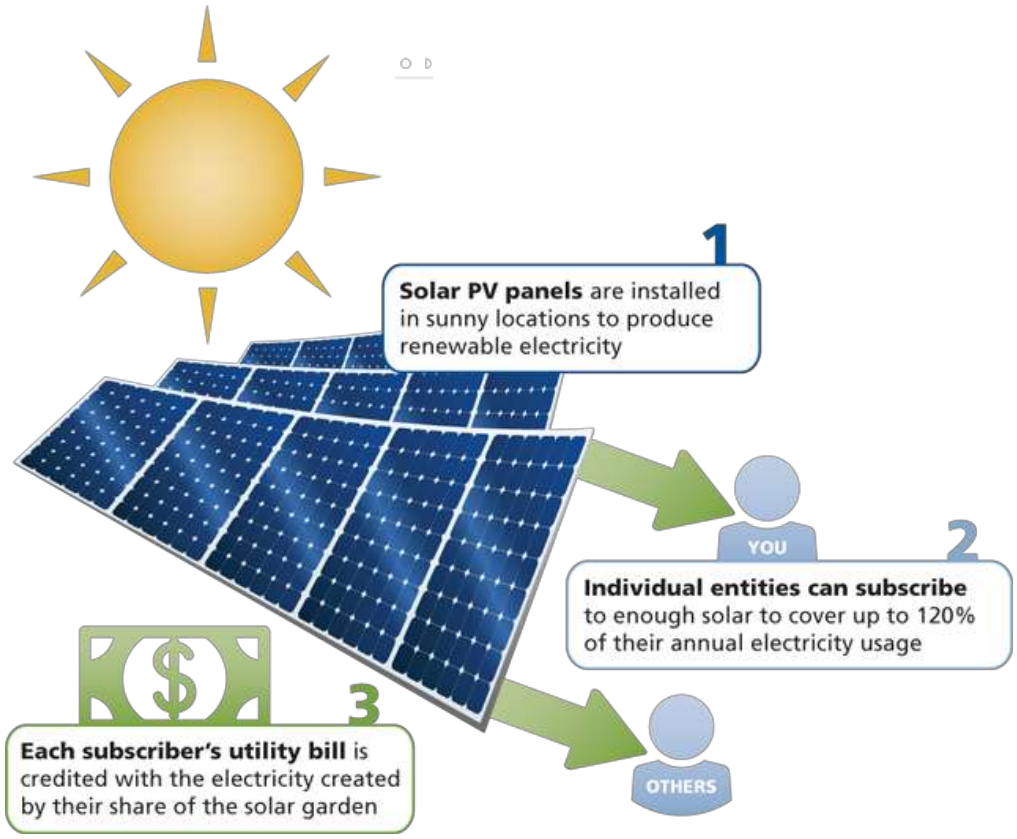

Figure 4: Diagram of Minnesota's CSG Program for Xcel Customers. Please see http://www.cleanenergyresourceteams.org/solargardens .

- ***Washington, DC's Community Renewables Energy Act of 2013***
  Legislation in DC that allows virtual net metering throughout the District. DC Solar United Neighborhoods worked to pass this legislation.

There are also state virtual net metering laws in Massachusetts, Minnesota, and Delaware. Details are available at http://www.sharedrenewables.org/. Research Minnesota's policies on net-metering through the DSIRE website. (From DSIRE home page, click on your state, then scroll down to the Net Metering section under "Rules, Regulations & Policies".)

- **Group Billing**
  This emerging strategy for funding solar projects works through the utility. The utility produces group bills for all participants in the community solar project including all relevant charges. Then, output from the PV system is netted against the group bill and the remaining costs are split between participants according to their agreement. Similar to virtual net-metering CSGs, this approach allows multiple participants to receive net-metering credits from a single renewable facility. However, group billing is enabled by a different legal mechanism than virtual net-metering. Examples:

- ***Green Mountain Power and Central Vermont Public Service Territory***
  This approach enables 22 groups in Central Vermont Public Service and Green Mountain Power service territories have formed to share the output of a renewable energy system with system sizes ranging from 1.5 to 199 kW.

- **Bulk Purchase Programs**
  A bulk purchase is when community members form a group and use their collective buying power to save on the total cost of going solar. Typically, a group of homeowners or organizations goes through the process of purchasing solar systems together. The group selects a single contractor to install systems on each of their buildings, but each participant owns their own system and has their own contract with the installer. Another approach is for a group to purchase a batch of solar panels in bulk solar directly from the manufacturer. They can then contract an installer to install the panels, or complete the installation themselves.

  - ***Solarize Portland*** **(Portland, OR)**
    A solar panel volume-purchasing program led by three Portland-area neighborhood associations from 2009 to 2012. This volunteer-driven community effort brought renewable solar energy and the benefits of weatherization to almost 1000 Portland homes. The City of Portland's Bureau of Planning and Sustainability, Energy Trust of Oregon and Solar Oregon offered strategic and technical assistance to neighborhood organizations that were interested in operating a Solarize project. Communities interested can download the Solarize Guidebook to learn how to start a Solarize campaign in their neighborhood.

- **Joint Ownership**
  Similar to successful wind farm projects, this approach makes use of wholesale power sale arrangements usually available only to industrial customers.

  - ***Maine's Community-Based Renewable Energy Pilot Program***
    Allows "locally owned electricity generating facilities" with at least 51% ownership by "qualifying local owners" to elect one of two incentive mechanisms:

    1. Qualifying local owners can enter into a long-term contract to sell output from a facility to a transmission and distribution utility. The contract price for energy on average, weighted based on the expected output of a facility, may not exceed $0.10 per kWh. This price does not include a purchase of RECs. A significant downside of this approach is that a payment for power sales to a wholesale or retail purchaser results in taxable income at a federal level and possibly at a state level.

    2. Generation is virtually net metered to joint owners in proportion to the owners' stake in a system. For example, a 50% owner would

receive 50% of the net metering credits generated by a system though virtual net metering.

- **Crowd Funding**
  Mosaic is a "crowdsourcing" energy program that gives individuals, institutions, and other investors the opportunity to invest in a portfolio of solar or renewable energy projects. Mosaic functions like a "virtual renewable energy bank," soliciting investments for solar projects and making loans to be paid back, typically, over about 10 years. Mosaic collects a fee on every loan. It is similar to the crowdfunding platform Kickstarter, a Web site that matches creative ventures with financial supporters. In the case of Mosaic, with a minimum of $25, investors can earn a return. Mosaic crowdsources pools of money from individuals and institutional investors to invest in solar projects, with the goal of making them steady, risk-weighted returns. Co-founder of Mosaic, Dan Rosen, explains that although crowdsourcing has a warm, fuzzy, community-like sound to it, Mosaic is simply another innovative financial vehicle for bringing cold, hard cash into the solar industry.

- **Innovative Financial Products for Individuals**
  Many homeowners are looking into options for rooftop solar, but lack the upfront capital or access to loans or financing needed to get the system purchased and installed. Many new programs such as Solar City and Dividend Solar provide homeowners options to take advantage of financial instruments backed by various parties to get the PV system they desire. Solar City offers full-service-options, whereas, Dividend Solar is an example of an investment and financing platform that interlinks homeowners who want solar power and investors who want returns on their investment. Solar City offers Solar Bonds—a corporate bond backed by Solar City—very similar to Dividend Solar's financial product. These products allow individuals the opportunity to invest in solar, an opportunity that was usually only accessible to large investors, corporations, and institutions.

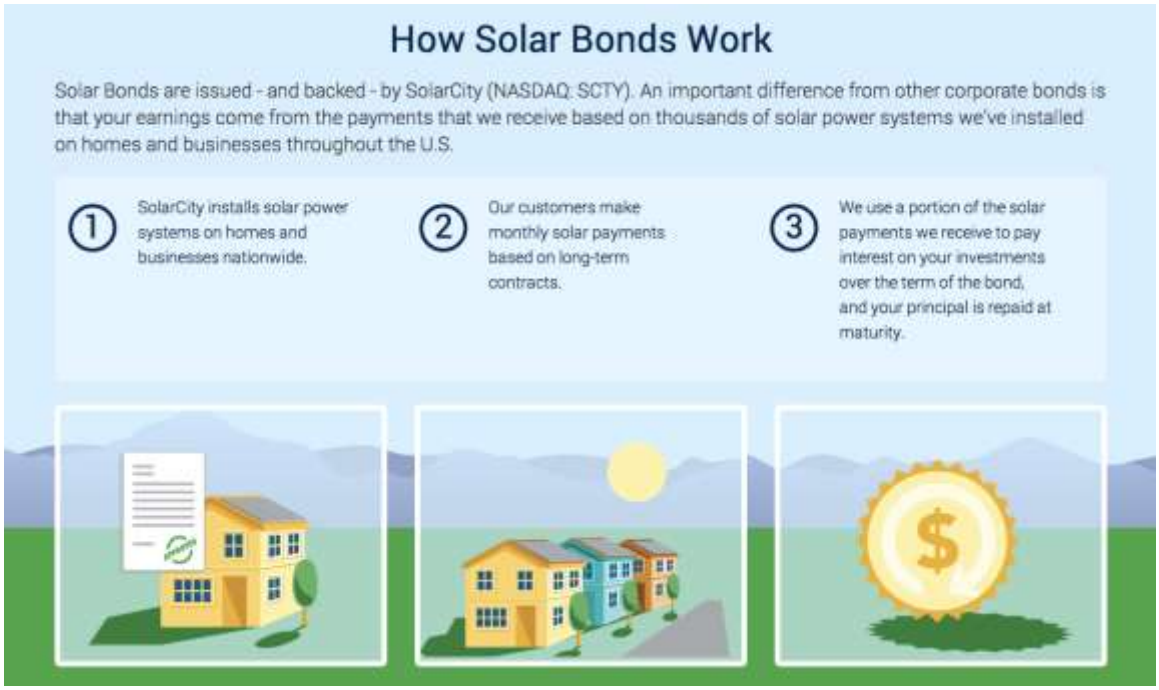

Figure 5: Solar City's "How Solar BondsWork." Please see https://solarbonds.solarcity.co

Discussion: These emerging and alternative approaches show the wide range of creative and innovative ways communities are financing and implementing solar. Of these, virtual net-metering approaches seem to have gained the most momentum for community solar, whereas, innovative financial products such as Solar Bonds seem to be gaining momentum for rooftop solar with individual household users. The location of projects, local and state level regulations, and numerous other tax and finance issues necessitate numerous models for implementation of PV systems at the rooftop, community, or utility scale.

Evaluation Criteria

Not all of these program models are designed to benefit the same groups of people equally. Decisions will have to be made regarding model choice based on who is involved and who is able to finance or fund the project. A number of criteria should be considered:

(1) Allocation of Costs and Benefits. Who will pay to plan, construct, and operate the solar system? Who will have rights to benefits, including the electricity produced, RECs, revenue from electricity sales, tax benefits, other incentives, and ownership of the project's assets (such as the solar system itself)? A table at the end of this section summarizes the options for allocating benefits within the structure of each sponsorship model. (See Table 2)

(2) Financial and Tax Considerations. Will money be raised through a solar fee on electricity bills, by equity or debt financing of a business entity, through charitable donations, or various other options? What kind of tax implications will there be for participants–e.g., will the project generate taxable income for participants? Will it generate tax credits or deductions for participants? (See Table 3)

(3) Other legal issues. How will the project design address securities regulation, utilities regulation, business regulation, and the complexity of agreements between various project participants? (See Table 4)

Numerous other criteria may be posed depending on Duluth's primary concerns. Of these, size, siting and design issues are central. These influence the costs, financing, ownership, organizational model, and efficiency of the PV system. Other technical criteria should be considered to enhance production efficiency and cost reduction.

Table 2: Allocation of Costs and Benefits (reproduced from http://www.nrel.gov/docs/fy12osti/54570.pdf, p. 32)

	Utility	Special Purpose Entity	Non-Profit
Electricity From Solar System	• Participant receives an estimated or actual kWh credit for their portion of project • Participant receives a monetary credit for the value of production for their portion of the project	• SPE sells the electricity to the utility (**PPA**) • SPE sells the electricity to the system host (**SSA**) • SPE assigns kWh to utility accounts per agreement with utility (**Virtual Net Metering**) • Electricity is netted against SPE members' **group bill**	• Nonprofit owner uses on-site and net meters • Nonprofit owner assigns to utility accounts per agreement with utility (virtual net metering) • Electricity from the system is netted against a group bill
Renewable Energy Credits	• Assigned to participants • Retired on participants behalf • Retained by utility	• Rights to RECs sold upfront • RECs sold on an ongoing basis • Retained for participants	• Rights to RECs sold upfront • RECs sold on an ongoing basis • Retained for nonprofit
Federal Tax Credits and Deductions	• Neither the commercial ITC nor the residential renewable energy tax credit is available • If the utility has a tax appetite, it may use the commercial ITC • Normalization accounting rules will impact the value of the ITC for regulated utilities	• SPE can pass benefits of Commercial ITC through to participants • Only of use if participants have a tax appetite for passive income offsets	• Project donors can deduct the donation on their taxes • Nonprofits are not eligible for federal tax credits
Accelerated Depreciation (MACRS)	• Not available to participants • An IOU may be able to use MACRS, provided they own the system • To qualify for MACRS, regulated utilities must use normalization accounting	• SPE passes depreciation benefits through to the participants, subject to passive activity rules	• Not useful to nonprofits
State and Utility Rebates and Incentives	• Utility may qualify and use rebates/incentives to buy down the project costs; benefits are indirectly passed on to participants	• SPE may qualify and use rebates/incentives to buy down the project costs or pass through to participants	• Nonprofit may qualify and use rebates/incentives to buy down the project costs

Table 3: Tax, Finance, and Other Legal Issues for Community Solar Models

	Utility	Special Purpose Entity	Non-Profit
Ability to Use Tax Incentives	• Dependent on utility characteristics • Co-ops, municipal, and public utilities are exempt, but can use Clean Renewable Energy Bonds • For-profit, investor-owned or privately held utilities can use ITC and depreciation	• Depending on type of business structure, SPEs need to be careful to fully use available tax benefits because community investors have limited tax appetite • Federal tax benefits are of limited use • Most investors/participants are passive and are subject to IRS passive activity rules	• Not eligible in general because tax exempt • Taxpayers can use deductions for charitable contributions to qualified organizations who may implement PV system
Securities Compliance	• Customer participation with utilities require careful consideration of customer-participant benefits in exchange for financial contribution • The receipt of credits on electric bills may constitute a return on investment and fall within blue sky laws (state laws that regulate the offering and sale of securities)	• Working within limits on the number of unaccredited investors if the project is to be exempt under securities laws is a major challenge • Exemptions require limits on the number of "accredited investors" and limits on number of participants	• N/A
Allocation of Incentives	• Utilities must consider whether and how these federal and state incentives/benefits will be passed on to customer participants and the tax implications of how the incentives are handled	• Depends on type of SPE and financing model	• Project donors can deduct the donation on their taxes • Nonprofits are not eligible for federal tax credits
RECs	• Customer-participants can only claim environmental benefits if they receive RECs • Utilities, however, have incentive to keep RECs to RPS compliance	• Rights to RECs sold upfront • RECs sold on an ongoing basis or Retained for participants	• Rights to RECs sold upfront • RECs sold on an ongoing basis • Retained for nonprofit

Community Solar Garden Service Providers in Minnesota

In Minnesota, there are already several CSG providers. A list of providers has been compiled by the organization, Clean Energy Project Builder and includes:

- Able Energy Co.
- Forteva Solar
- Innovative Power Systems
- Minnesota Community Solar (MNCS)
- Minnesota Renewable Energy Society
- Novel Energy Systems
- Rural Renewable Energy Alliance
- Solar Farm, LLC
- Sundial Solar
- TruNorth Solar

One example is Minnesota Community Solar (MNCS) who played an important role in advocating for the 2013 Clean Energy & Jobs legislation (mentioned at the start of this paper) that mandated that Xcel and other utilities purchase subscribers' electricity from CSGs. Their subscription model provides an excellent starting place to evaluate the possibilities for CSG's in Duluth. MNCS sold out both of the first two CSGs in Xcel's territory. They worked to use Minnesota solar panels, labor, and financing and have a commitment to focus on Minnesota development.

MNCS acts as an *intermediary* between the utility company, regulators, property owners (hosts), and customers/subscribers. Subscriptions are service contracts, not ownership of the physical panels. Subscribers purchase credits from MNCS and these are added to their electric bill over the length of the contract. Subscription amounts are based on current energy usage. Subscribers can choose how much of their energy use they would like to cover through the solar credits.

MNCS's subscription service for solar is based on a unit called a 'leaf'. Leaves are solar credits that are added to a subscriber's electric bill and are adjusted to the utility's rate changes.

Another organization, SunShare, provides a similar model. SunShare designs, builds, operates, and maintains CSGs, and customers simply buy energy in the same way they would from a utility. They offer custom energy plans and options for consumers based on their energy usage, then consumers choose and get a space reserved at a solar garden.

Xcel Energy Solar Rewards Program

Minnesota Statute § 216b.1641(Article 10, Section 2) is the basis for the Community Solar Garden (CSG) Program, but it only applies to Xcel Energy, prompting their Solar Rewards Program as per Minnesota Statute § 116C.779. Legislation regarding rebates for Solar PV Modules is Minnesota Statute § 116C.7791.

The new statute mandates the following:

Ownership. As detailed in Minnesota Statute § 216b.1641, the owner of the community solar garden may be a public utility or any other entity or organization that contracts to sell the output from the community solar garden to the utility under section 216B.164. There shall be no limitation on the number or cumulative generating capacity of community solar garden facilities other than the limitations imposed under section 216B.164, subdivision 4c, or other limitations provided in law or regulations.

Subscribers. As detailed in Minnesota Statute § 216b.1641, "subscriber" means a retail customer of a utility who owns one or more subscriptions of a community solar garden facility interconnected with that utility. Subscribers may live in a county adjacent to county where the solar garden is located.

Subscriptions. As detailed in Minnesota Statute § 216b.1641,"subscription" means a contract between a subscriber and the owner of a solar garden.

Credits. Subscribers receive a bill credit for the electricity generated in proportion to the size of their subscription. Each subscription shall be sized to represent at least 200 watts of the community solar garden's generating capacity and to supply, when combined with other distributed generation resources serving the premises, no more than 120 percent of the average annual consumption of electricity by each subscriber at the premises to which the subscription is attributed.

Grid Interconnection & Rates. The public utility must purchase from the community solar garden all energy generated by the solar garden. The purchase shall be at the rate calculated under section 216B.164, subdivision 10, or, until that rate for the public utility has been approved by the Commission, the applicable retail rate. A solar garden is eligible for any incentive programs offered under either section 116C.7792 or section 216C.415. A subscriber's portion of the purchase shall be provided by a credit on the subscriber's bill.

CSG Design. The solar garden must have a nameplate capacity of no more than one megawatt.

Definitions

Accelerated Depreciation. After ITC, this approach is the most important solar incentive. Depreciation is an accounting method to adjust for the fact that assets become less valuable over time. Typically, it provides value worth about 25% of the system cost. A nice discussion of depreciation is available at Carbon Lighthouse's website.

Investment Tax Credit (ITC). Section 48 of the Internal Revenue Code details how commercial, industrial or utility owners of PV systems can take a one-time tax credit equivalent to 30% of qualified installed costs. The federal government provides a tax credit worth 30% of the cost of your system. So if your solar project costs $1,000,000, you receive a tax credit worth $300,000. To use it you must have *"tax appetite,"* that is, owe at least $300,000 in federal taxes. To owe $300,000 in taxes, you need to have a very sizeable income. That's why large companies are the ones who own the solar projects. For 2009 and 2010, the ITC became a cash grant instead of a credit, so you didn't need to be hungry for tax credits. But the grant program ended in 2012.

Normalization Accounting. Normalization rules require regulated utilities to spread the benefits of investment tax credits throughout the useful life of the solar project in the ratemaking process. The utility's incentive for investment is the difference between the value it receives from the tax credit up front and the value it passes on to customers over time (i.e., the time value of money).

Power Purchase Agreements. A PPA is an agreement between a wholesale energy producer and a utility under which the utility agrees to purchase power (under particular rate structures and at particular times).

Solar Services Agreement. An SSA is an agreement between the system owner and the system site host, for the provision of solar power and associated services including design, installation, operation and maintenance, and other services to continue solar power production.

Securities. A security is an investment instrument or product issued by a corporation, government or other organization that offers evidence of debt or equity. Any transaction that involves an investment of money in an enterprise, with an expectation of profits to be earned through the efforts of someone other than the investor, is a transaction involving a security. Community solar organizers must take care to comply with both state and federal securities regulations, and preferably, to steer clear of inadvertently offering a security. (Further information on securities is provided in Section 4, Tax Policies and Incentives.)[4]

Further Resources

[4] See http://www.nrel.gov/docs/fy11osti/49930.pdf pg 4.

- Through DOE's SunShot Initiative, local governments are working to accelerate the adoption of solar energy technologies for a cleaner, more secure energy future. The website offers case studies, policy updates, and news of solar activities across the country.
- The Database of State Incentives for Renewables and Efficiency (DSIRE) is a comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.
- The Office of Energy Efficiency and Renewable Energy (EERE) works to strengthen the United States' energy security, environmental quality, and economic vitality in public-private partnerships.
- USDA Rural Development provides funding for the development and commercialization of renewable energy technologies in rural communities. The Rural Energy for America Program (REAP) offers grants and loans to help small rural businesses deploy renewable energy projects.
- The Bonneville Environmental Foundation (BEF) supports the development of renewable energy and watershed restoration and empowers people to shrink their carbon footprints. BEF's Project Management Group assists with the funding and construction of solar installations in communities throughout the Northwest.
- The American Solar Energy Society (ASES) is a nonprofit organization dedicated to increasing the use of solar energy, energy efficiency, and other sustainable technologies in the United States. This website is a good source for information about solar technology and professionals.
- The Interstate Renewable Energy Council (IREC) is a nonprofit membership-based organization that provides a national forum in which public and private organizations involved with renewable energy may gather, disseminate and exchange information and engage in cooperative efforts. IREC's website offers the latest policy and practical solutions for tough renewable energy issues.
- The Vote Solar Initiative works at the state, federal and local level to implement programs and policies that allow strong solar markets to grow.

Publications and Online Tools

- The Online Community Solar Tool, University of Oregon and The Resource innovation Group, is an online decision tool that provides a framework for making program development and design decisions.

- The Community Power Network offers examples and inspiration for community scale projects across the United States. The site includes a wiki to learn and share from other projects.

- Solar Resource Guide: An Overview for Congregations, California Interfaith Power & Light Network, July 2011.

- Solar Powering Your Community: A Guide for Local Governments, U.S. Department of Energy (DOE), 2012, includes case studies and lessons learned from Solar America Communities.

- "A Guide to Community Shared Solar: Utility, Private, and Nonprofit Project Development" (NREL), provides excellent information about implementing community solar and is the basis of much of this report.

- Community Solar Power: Obstacles and Opportunities, Institute for Local Self-Reliance, September 2010, profiles community shared solar projects, the policies that enabled them, and the barriers that remain.

- Financing Non-Residential Photovoltaic Projects: Options and Implications, Lawrence Berkeley National Laboratory, January 2009, examines the role of financial innovation in PV market penetration. This report looks at how financing structures currently being used to support nonresidential PV deployment have emerged as a way to extract the most value from a patchwork of federal and state policy initiatives.

- Lex Helius: the Law of Solar Energy (3rd Edition), Stoel Rives, 2009 (See especially, Chapter 7: Financing)

- Distributed Generation Interconnection Collaborative (DGIC), an excellent resource on interconnection and utility interfacing.