

Project Title: Innovative Power Systems, Inc. (EP4-11)

Contract Number: EP4-11

Report Number: 7 – Final Report

Report Date: September 22, 2017

Reporting Period: September 3, 2015 – November 15, 2017

Progress Summary: System Construction 100% Complete, System Energization 75% Complete

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Congressional District: Energy Innovation Corridor Sites – Minnesota US District 5

Congressional District: Innovative Power Systems Offices – Minnesota US District 5

“Project funding provided by customers of Xcel Energy through a grant from the Renewable Development Fund.”

FINAL PROJECT REPORT

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1 Executive Summary

Innovative Power Systems, Inc. (IPS) and WGL are proud to present the final report for the Renewable Development Fund (RDF) Project EP4-11, located within the Energy Innovation Corridor (EIC) in St. Paul, Minnesota.

This project successfully installed four separate commercial rooftop solar PV arrays totaling 967.27kw DC along the Green Line Light Rail line between St. Paul and Minneapolis, MN. The four sites include a 38.54kw DC system at 1000 University Ave, a 110.7kw DC system at 1919 University Ave., a 432.96kw DC system at 2550 University Ave., and a 384.6kw DC system at 1000 Westgate Dr. Each site was set up as a Power Purchase Agreement (PPA)/Lease in which IPS coordinated contracts between the building owners and WGL Energy, with WGL covering the cost of equipment and installation and the building owners signing a 15-year lease to purchase the produced electricity at a rate just below current Xcel prices.

The project was installed by Oxbow Sunworks and Muska Electric, both St. Paul, MN electrical contractors. Construction occurred between May and December 2016 with a few lingering electrical upgrades being completed in the Summer of 2017.

The EIC's mission to become a national model for transportation and energy infrastructure development within urban settings, made it an attractive place to locate the four installations. IPS shares the commitment to promote a transition towards renewable power, while also offering cost saving opportunities for its customers. Completing these projects has shown that large-scale commercial solar PV systems can not only be efficiently installed within a dense urban core, but also serve as an example of how private investment works as a strategy for commercial solar growth in Minnesota. The project is projected to generate 1,297,333 kWh of renewable power per year, close to 20,000,000 kWh over the lease term and approaching 27,000,000 kWh over the useable life of the PV panels. Additionally, the building owners benefit from the cost savings due to lower electricity rates in the agreed PPA, creating a competitive advantage within the area.

Final costs for this project came in at \$3.1M vs a budget of \$2.74M. The primary cost adders included a shortage of qualified installation labor due to the success of Minnesota Community Solar Gardens and the associated financing costs of extending the construction schedule.

1.1 Project Goals

In the application, Innovative Power Systems displayed their intent to install rooftop solar arrays in Xcel Energy's service territory to achieve the following goals:

- Install 967.27 kW (DC) photovoltaic capacity to demonstrate a development process utilizing private investment as a strategy for prudent commercial solar growth.
- Increase the penetration of solar energy in Minnesota.
- Establish a performance baseline for solar financing to quantify the true benefits of PV to the grid and to reduction in building demand during peak demand periods.
- Promote Minnesota-based solar energy technologies.

The attainment of each of those goals is described in more detail below.

1.2 Project Schedule

After the RDF Grant Contract signing in November of 2015, IPS brought on Oxbow Sunworks and Muska Electric to handle the module and electric installation respectively. Construction began in May 2016 and Interconnection was approved for all four sites by September of that year. Due to a few lingering electrical upgrades, commercial operation wasn't declared until November 17th, 2017.

Permits

- Building Permit – City of St. Paul
- Electrical Permit – City of St. Paul
- Interconnection Agreement – Xcel Energy

Construction Milestones

	1000 University Ave.	1919 University Ave.	1000 Westgate Dr.	2550 University Ave.
RDF Grant Contract Signed	November 2015	November 2015	November 2015	November 2015
Interconnection Study Start	January 2016	January 2016	January 2016	January 2016
Interconnection Approved	April 1, 2016	September 14, 2016	September 19, 2016	September 19, 2016
Construction Start	May 15, 2016	May 26, 2015	August 21, 2016	September 3, 2016
Final Modules Installed	September 20, 2016	June 6, 2016	September 22, 2016	September 27, 2016
Mechanical Completion	October 2, 2016	October 7, 2017	March 16, 2017	May 5, 2017
Electrical Inspection	October 3, 2016	November 6, 2017	April 10, 2017	May 23, 2017
Meter Installation	October 4, 2016	November 22, 2017	April 19, 2017	May 30, 2017
System Commissioning	October 5, 2016	November 27, 2017	April 21, 2017	May 30, 2017
Formal PTO From Xcel Energy	October 26, 2016	November 28, 2017	April 24, 2017	May 30, 2017
Commercial Operation Date	October 26, 2016	November 28, 2017	April 24, 2017	May 30, 2017

2 Project Goal Achievement

The achievement of each of the listed goals and objectives for the project are detailed below:

- *Install 967.27 kW (DC) of photovoltaic capacity to demonstrate a development process utilizing private investment as a strategy for prudent commercial solar growth.*

The successful installation of this project demonstrated how private investment can work in the commercial solar industry. Our use of creative financing was vital to the success of the project due to our ability to offer customers a ‘no money up front’ option with attractive net benefits from day one and substantial electricity savings for 25 years. These benefits helped IPS secure contracts with the four building owners along the EIC. Without those contracts, IPS wouldn’t have had enough roof space to install the required number of modules.

IPS and its financing partners now have experience with this private investment model that can be called upon for future projects. The development process used for this project can be studied and improved upon in order to use this type of financing to help further the adoption of rooftop solar across the state. A comprehensive timeline and list of milestones now exist as guides to build upon in the future. Seeing the success of this project will give other Minnesota solar developers the confidence to use this development process for their own projects.

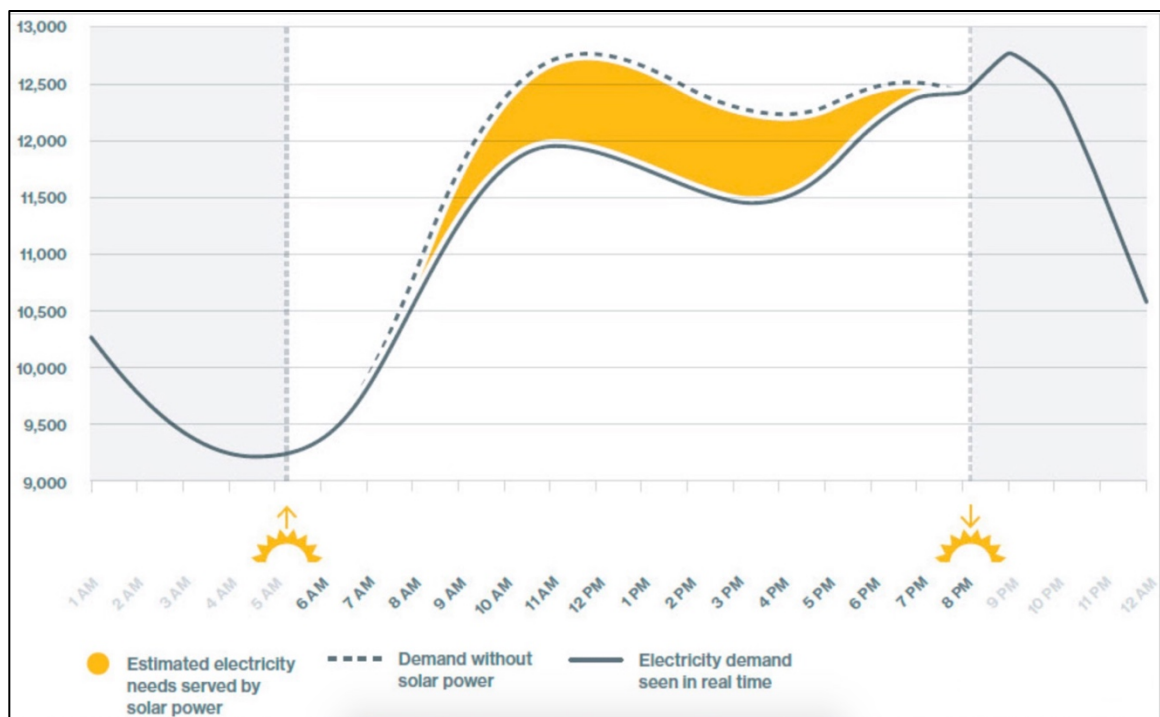
- *Increase the penetration of solar energy in Minnesota.*

This project increased the market penetration of solar energy in Minnesota by nearly one megawatt, which at the time of the original proposal accounted for roughly eight percent of Minnesota’s total solar integration. The four systems included in this project are projected to produce a combined average of 1,297,333 kWh/year over the next 15 years. Assuming a 0.5

percent efficiency loss per year, a conservative estimate of the energy production over a fifteen-year period is 19,508,000 kWh.

The success of this project and others led to IPS working with WGL Energy on an additional 27 megawatts of Community Solar Gardens across the state; all commissioned and producing power as of October, 2017. Also, publicity surrounding this project increased the public interest in this type of solar installation.

- *Establish a performance baseline for solar financing to quantify the true benefits of PV to the grid and to reduction in building demand during peak demand periods.*



Approximate daily (Mon-Fri) usage of all four buildings in Kiliwatts pre and post solar.

The Locus monitoring systems installed at the four sites allow both the site hosts and IPS to see hourly production data. This data will show how production lines up with peak demand hours and can be used to analyze how much building demand is reduced during those times. Over the coming months, both parties will be closely monitoring this data to discern the true benefits of PV to the grid. Having such detailed production data to work with will make it much easier to quantify the effect that these arrays have on the grid.

- *Promote Minnesota-based solar energy technologies*

Many local companies were involved with the completion of this project. Innovative Power Systems (IPS), an experienced energy installer based in St. Paul, acted as the general and electrical contractor on all parts of the project. Structural engineering was done by Erickson Roed, a firm whose offices are located along the Energy Innovation Corridor (EIC). The modules,

inverters, DC combiners, and AC disconnects used for all 4 of the locations were procured from Bloomington solar manufacturer, tenKsolar.

IPS worked with a renewable energy advocacy group to create a branding campaign and website focused on the project and its local components. In December 2015, IPS hosted a press event along the EIC that was attended by St. Paul Mayor Chris Coleman, Xcel Energy Regional VP Laura McCarten, IPS Solar CEO Ralph Jacobson, and several local reporters. The event was used to give project updates and explain the benefits of using Minnesota companies to design and build the system. Several local news outlets ran stories about the event which helped promote tenKsolar equipment and the other companies involved. Another ribbon-cutting press event is scheduled for October 2017 to celebrate the completion of the project.

After installation, the projects will continue to promote local solar energy technologies. TenkSolar's modules utilize a reflector system that gives the panels a unique look that catches the eye. These modules will be on full display at University Enterprise Labs, which is highly visible from Highway 280. Drone footage of all four sites has been provided for hosts to share along with online data monitoring portals. These tools will help the site hosts showcase their systems to clients and business partners.

3 Construction

The Project Innovation Green Line solar project is the largest installation in the 25-year history of Innovative Power Systems. To mitigate any unforeseen labor or bandwidth issues, IPS partnered with Oxbow Sunworks to carry out the module installation for all four sites and the complete electrical interconnection for 1000 University Avenue, 1919 University Avenue and 1000 Westgate Drive. In addition, Roseville based Muska Electric completed the AC interconnection portion of 2550 University Avenue to help expedite mechanical completion and allow Oxbow to focus on the remaining three sites. A collaborative effort from all three parties was integral to the successful completion of this project.

3.1 Sub-Contractors

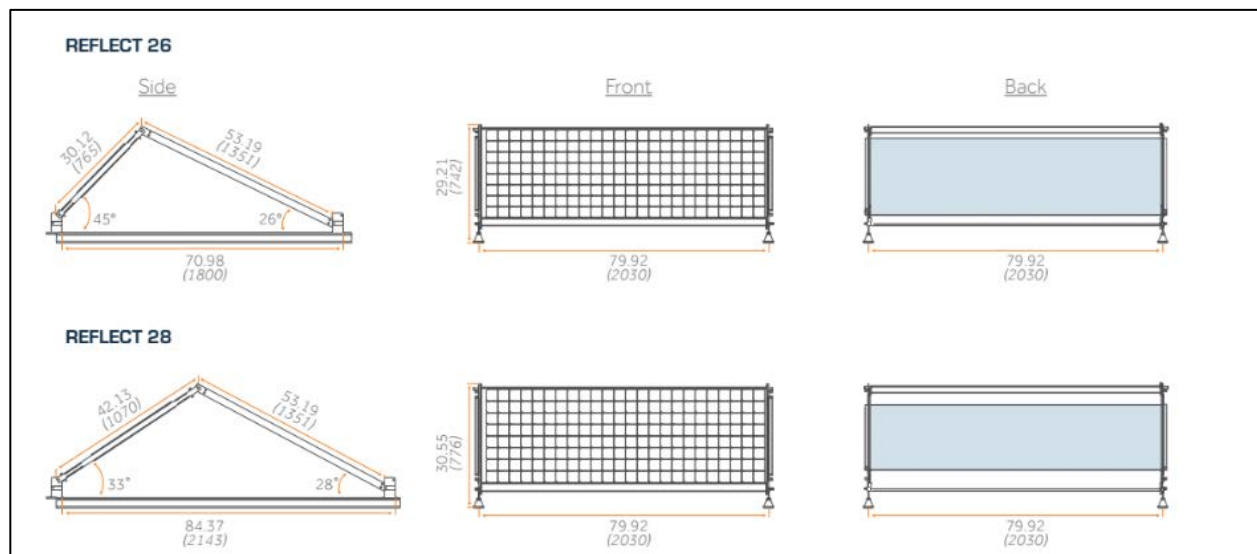
Oxbow Sunworks, formed by a former IPS installer, is a Stillwater, MN based electrical contractor that has amassed more installations of tenK equipment than any other MN installation company. IPS has worked extensively with Oxbow over the past three years and it was imperative to the success of the Project Innovation project that a company seasoned with the tenK system be involved to alleviate any issues with roof adaptation and system functionality.

3.2 Equipment

Bloomington, MN based tenKsolar was chosen for all four sites based on IPS's familiarity with the product and local connection. The tenK system is an integrated module/inverter/racking solution that is tailored to shade susceptible roofs; an issue at 1000 Westgate Drive and 1919 University Avenue, each with several roof stacks that may cause some shade-induced production loss with more traditional systems. The tenK system also has a strong track-record of performing as expected in cold climates without inverter failures or shut-downs at extreme low temperatures.

The heart of the tenK system is the 410W PV module, which is among the highest wattage modules on the market and comes standard with an integrated voltage regulator that eliminates module-to-module losses due to shading and degradation. The modules are connected in parallel strings (maintaining a constant low-voltage, but increasing ampacity) and terminated in Redundant Inverter Busses or RIB's. The RIB configurations contain 6, 12, 18 or 24 individual 700W micro-inverters which allows production of the system to continue even if one or more inverters fail. In total 2,358 tenK modules and 1,104 Lead Solar microinverters were used across the four sites.

The tenK racking is designed specifically for the tenK modules and provides a seamless installation between racking, module and inverter. The rack is a continuous aluminum rail running North to South and cushioned from the roof surface with poly-rubber pads spaced every 18-14". The pads provide a roof warranty compliant method of installing the system using only ballast (cement blocks) to hold the solar arrays on the roof and not make any permanent attachments. All four installations utilized no roof attachments and relied on structural engineering analysis by Meyer Borgman Johnson of Minneapolis to determine appropriate ballast weight and spacing to keep the system from becoming unstable in winds up to 115mph.



tenKsolar Reflect 26 & Reflect 28 Racking Systems

3.3 Challenges Faced

Each site had unique challenges during the construction phase. 1000 University Avenue is a standard commercial flat-roof with two 40' x 10' skylights protruding from the center. To maximize production, IPS utilized tenK flat-roof racking for the majority of the system and added tenK 'residential' racking onto the wooden frame of the skylights, resulting in 30% more production for the system throughout the year. This non-standard combining of commercial and residential racking technologies required additional electrical and structural engineering to verify no loss of maximum generation due to different module tilt angles as well as verification that the skylight frames were sufficient to hold the weight of the panels and resist uplift during high wind events. Once the design was fully signed-off by both the electrical and structural EOR's (Engineer of Record), Oxbow employed a mix of commercial and residential crew members to efficiently install both portions of the array.

1000 Westgate Drive (UEL) is a mixed-use commercial building that houses numerous laboratories and clean rooms. The result is a roof with numerous 4-6' vent stacks that provided a design, engineering and installation challenge in order to minimize shading and keep within the relatively light capacity of the roof to support additional weight. IPS worked with MBJ to create a design and construction plan that combined traditional ballasted arrays, ballasted arrays that required removal of portions of the existing river rock (a loose rock used to hold down rubber-membrane roofing) and reinforcing of roof trussing in areas where the removing of river rock was still not sufficient. IPS then coordinated with the building tenants and a St. Paul based certified welder to reinforce 10 trusses while Oxbow removed sufficient portions of river rock from the roof. The result is a patchwork of panels that utilize every potential square foot of the roof while maintaining all state required easements and setbacks and causing as little disruption in the tenants' operations as possible.

2550 University Avenue (Court International) is the largest array and had the greatest roof-top installation challenges. The roof of Court International is divided into 10 'drainage basins', each approximately 80' square. These basins resemble large bowls with a drain at the bottom and a ridge 2' higher around the edge, resulting in significant pitch changes both East-West and North-South. To work around these undulations, IPS worked with MBJ to allow for the arrays to be broken into smaller sub-arrays that would leave space for the small ridges & valleys created by the different basins. Modifications had to be made to the racking in certain areas, but Oxbow worked closely with MBJ to have each alteration looked at and signed-off on prior to installation, leading to no issues from the EOR when the time came to give the final approval.

1919 University Avenue was straight-forward with regards to the solar installation, but needed upgrading of the existing building electrical gear, delaying the final interconnection by several months. NEC (National Electric Code) requires all electrical switchgear that gets modified from its original use to be recertified by a recognized testing laboratory. An analysis of the 1919 switchgear revealed that the installation of the solar system would trigger a recertification and that the gear would not pass. After many months of discussion between the electrical inspector, building owners and IPS, it was decided that the entire switchgear would be replaced. Due to the lead time of new switchgear and sensitivity of removing power from the building for enough time to accomplish the replacement, the work is not expected to be complete until early October of 2017. Once complete, we anticipate no more than 2 weeks to get the solar system commissioned and operational.

4 Benefits

Economic Benefits:

Chief among the economic benefits of this project was the ability of Oxbow Sunworks to commit to keeping a crew of 8-10 working throughout the Spring, Summer and Fall of 2016. Additionally, IPS hired one full-time Project Manager to oversee the design, engineering and construction of the systems and a Project Coordinator to assist with the various document submittals, deliverables and oversight. Both of these positions will stay on with IPS after this project has closed out. The ancillary benefits extended to the companies IPS and Oxbow used to design, engineer and install the systems. Landwehr Construction of St. Cloud, MN supplied logistics and crane services to all four sites. MBJ and EVS engineering (both located in the Twin Cities Metro area) contributed to the electrical or structural engineering required for design and permitting. Werner Electric of Hastings, MN supplied most (if not all) of the electrical

cabinetry, grounding transformers, conduit and wiring needed to connect into the existing building electrical systems.

According to a recent report from Clean Power Research¹ studying distributed solar projects and their impact on the grid, there are several tangible benefits for utilities. These benefits included:

Market Price Reduction – “By reducing demand during the high-priced hours, a cost savings is realized by all consumers.” The study found that those values varied by location, anywhere from \$35 to \$69 per megawatt hour.

Transmission & Distribution Deferral – The Clean Power Research study found that the average T&D benefits accounted for \$3 per megawatt hour. Solar allows utilities to defer additional investments in transmission and distribution infrastructure, the scale and location for the deferrals is highly variable however. At larger scale PV would have significant impacts on specific feeders where new loads are required, as would be the case with new electric-based mass transit.

Generation Capacity Value – According to the same study there is a moderate correlation between solar PV production and utility system load. The effective capacity ranged from 28% to 45%, and ranged in price from \$16 per MWh to \$26. According to the more recent Minnesota Value of Solar Methodology published in 2014 by the Minnesota Department of Commerce and Clean Power Research², avoided generation capacity had a levelized cost of \$48 per MWh.

Demand Reduction – Xcel has recently proposed a value of \$.07139 per kilowatt hour on solar production provided during the hours of 1pm to 7pm via their standby service tariff docket. With the majority of panels facing southwest these sites will produce roughly 48% of their power during this peak time (622,720 kWh per year). This equates to an estimated annual value for the project of \$44,456 in the first year.

Environmental Benefits:

During the first year of production, all four arrays will produce an estimated 1,298,000 kWh of clean energy; this equates to planting approximately 19,800 new trees. Using Xcel Energy’s emission calculator, this would offset 474 metric tons of carbon dioxide. According to the EPA’s equivalency calculator, offsetting this much carbon dioxide equates to taking 207 passenger vehicles off of the road for an entire year or preventing 1,056,886 pounds of coal being burned.

¹ The Value of Distributed Solar Electric Generation to New Jersey & Pennsylvania, Richard Perez, Benjamin Norris, Thomas Hoff, 2012. <http://mseia.net/site/wp-content/uploads/2012/05/MSEIA-Final-Benefits-of-Solar-Report-2012-11-01.pdf>

² Minnesota Value of Solar: Methodology, Benjamin Norris, Morgan Putnam, Thomas Hoff, Mike Rothman, Bill Grant, Matt Schuerger, Lise Trudeau, 2014. <http://mn.gov/commerce-stat/pdfs/vos-methodology.pdf>

³ Quote: Carol Olsen, Energy Research Center of the Netherlands. http://www.nytimes.com/2013/11/11/business/energy-environment/solar-power-begins-to-shine-as-environmental-benefits-pay-off.html?_r=0

Unlike natural gas and coal-fired facilities, solar energy doesn't require massive amounts of water for cooling. Specifically, PV electricity over its lifetime uses 86 to 89 percent less water than electricity produced with coal³. This means that these four arrays will conserve water and won't pollute local water resources like traditional power plants have done in the past.

Producing 1,298,000 kWh of clean energy will result in avoided environmental costs. These avoided costs are based on the federal social cost of carbon dioxide emissions as well as the Minnesota PUC-established costs for non – carbon dioxide emissions². Utilizing the MN Department of Commerce's rates it can be calculated that this project will avoid \$61,006 in environmental costs annually². This projects out to approximately \$1,830,180 over the life of the system.

Social Benefits:

Socially, the Green Line portfolio impacts the community in a variety of ways. These 4 arrays will create "prosumers", consumers who produce their own energy. Gone are the days when electricity consumption was a one-way street. By distributing the production of energy, the community in which these projects are located will now have a more reliable source of power and be part of the solution and ownership of energy challenges they face every day. By building clean technologies, they now contribute to cleaner air, job creation, and become a pioneer in a fast growing industry. Each building and its tenants can now take credit for improving their community's health, both physically and economically.

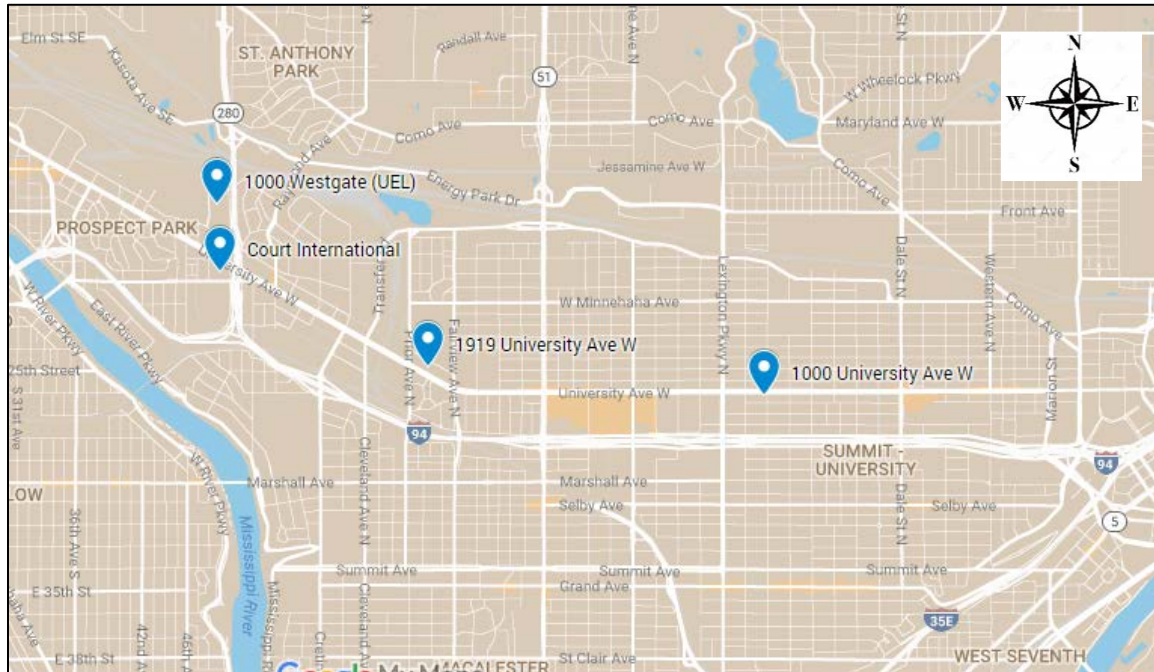
Improved air quality is a benefit from this project that the entire community will be able to enjoy over the long term. Anytime energy production from traditional fossil fuels is replaced by renewable energy harmful emissions will be reduced and air quality will be improved. From 2007 to 2015 solar and wind power deployment produced cumulative air quality benefits in the range of \$29.7 – 112.8 billion and prevented 3,000 to 12,700 premature mortalities⁴. Longer and healthier lives are among the most important social benefits any project can offer.

Studies have shown that solar energy sustains more jobs per unit of energy generated than conventional energy¹. Job creation has many social benefits including increased tax revenues, reduced unemployment, and an increase in general confidence conducive to business development¹. For example, studies done on solar production in New Jersey and Pennsylvania showed that each PV MWh represented a net new-job related tax collection increase for New Jersey equal to a levelized value of \$40/MWh, and a tax collection increase for Pennsylvania equal to \$39/MWh.¹

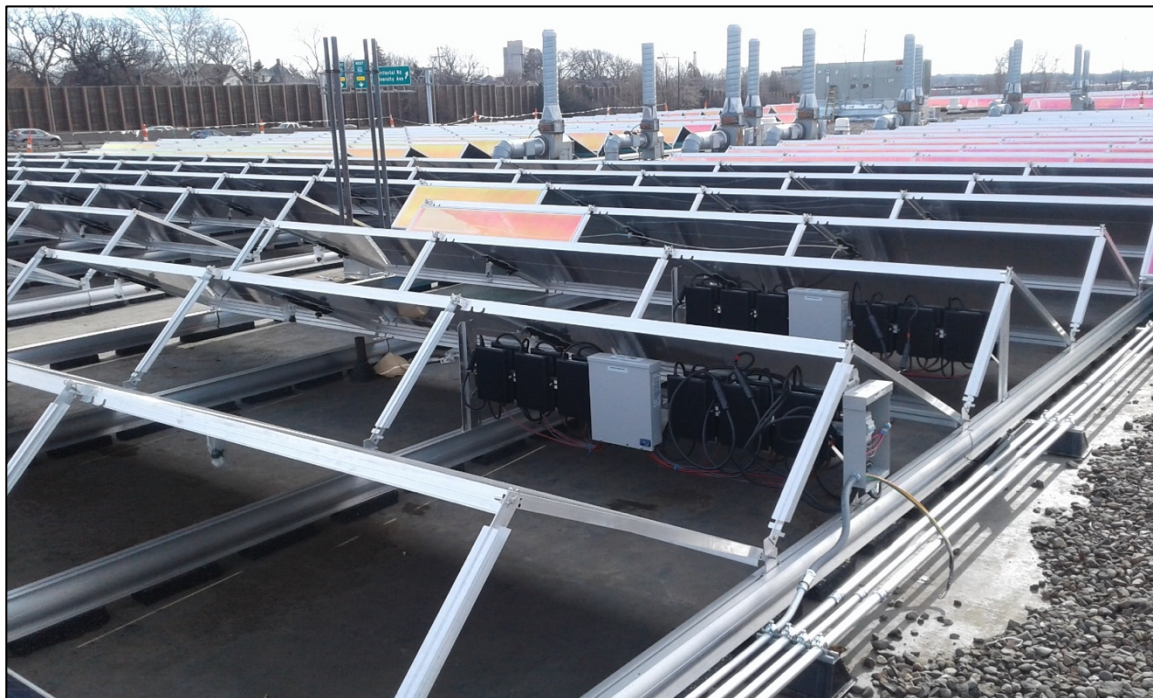
⁴The climate and air-quality benefits of wind and solar power in the United States, Dev Millstein, Ryan Wiser, Mark Bolinger & Galen Barbose, 2017.

<https://www.nature.com/articles/nenergy2017134>

5 Site Pictures



Location Map of All Four Sites



Reflector Panels Being Installed at 1000 Westgate Drive



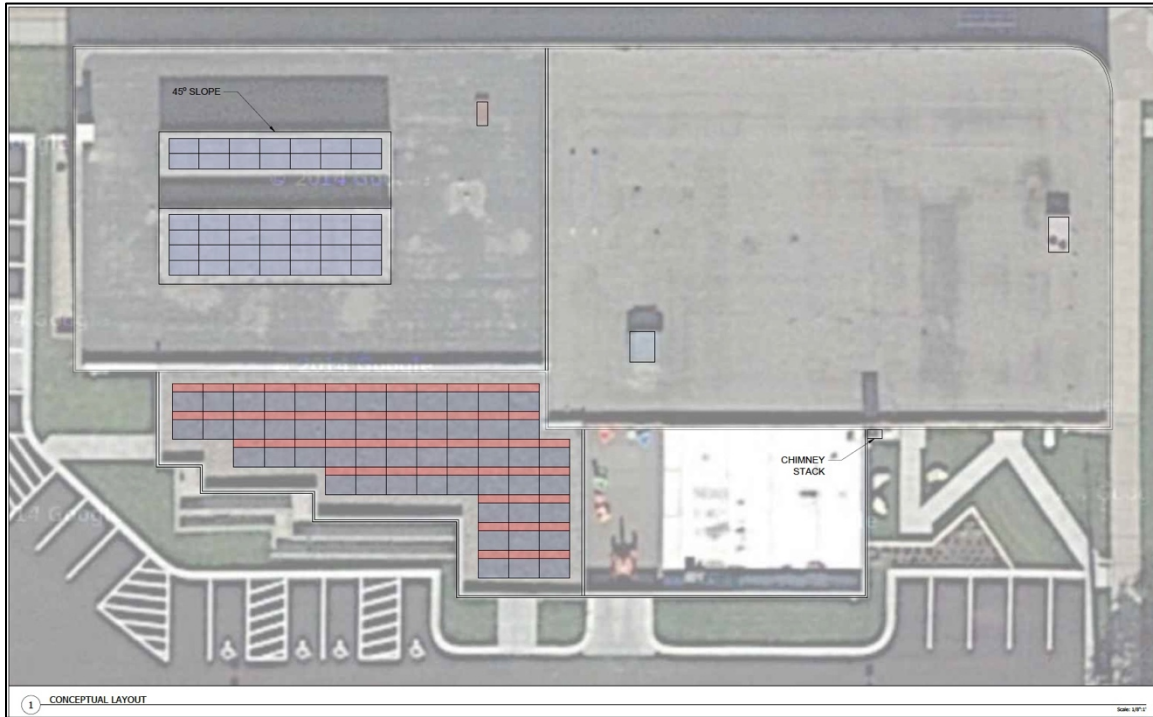
Switchgear Under Construction at 1000 Westgate Drive



Inverter Bus at 2550 University Avenue



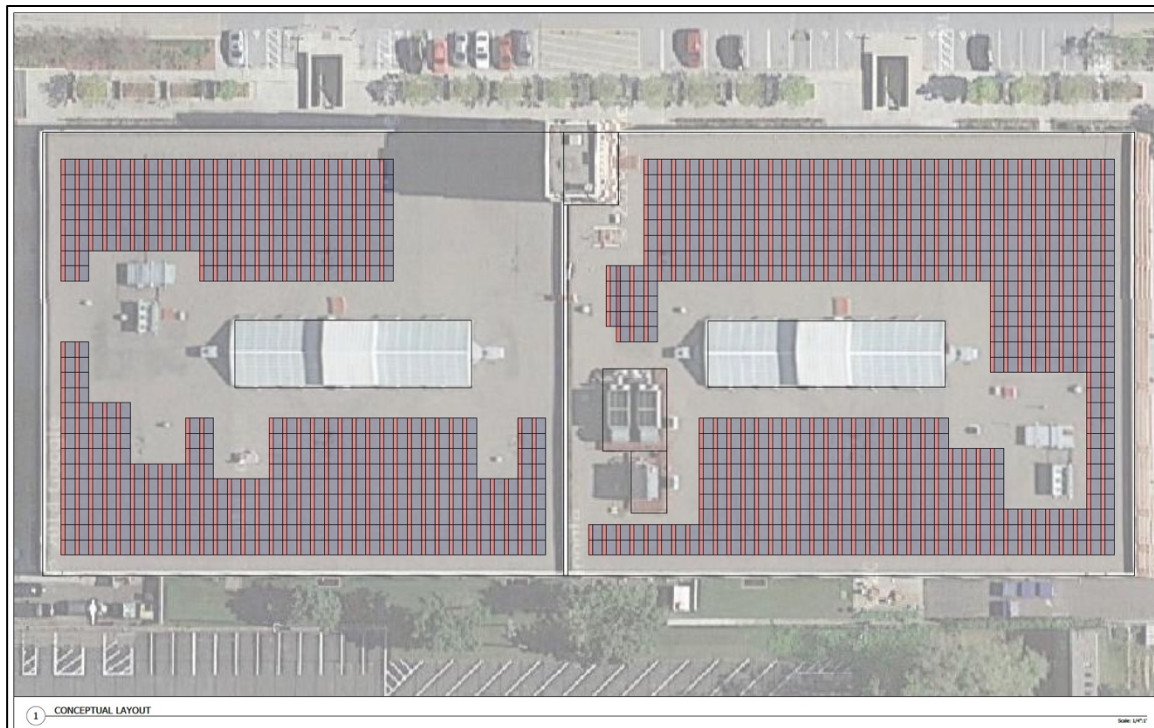
Accumulation Panel at 1000 University Avenue



1000 University Avenue Conceptual Layout



1000 University Avenue Completed Installation



2550 University Avenue Conceptual Layout



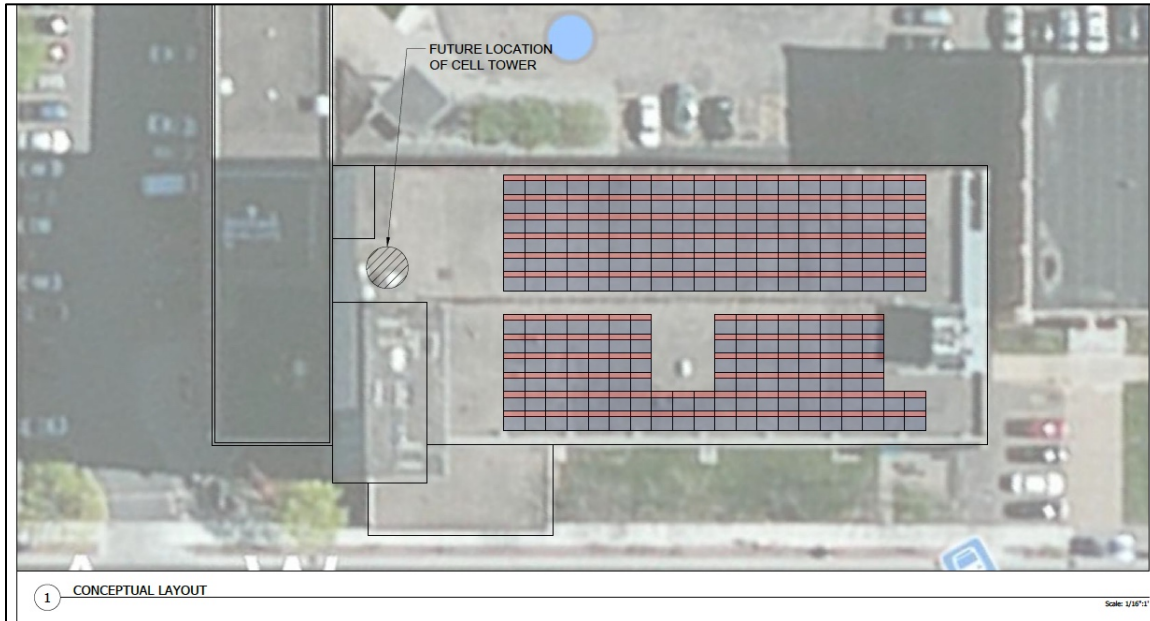
2550 University Avenue Completed Installation



1000 Westgate Drive Conceptual Layout



1000 Westgate Completed Installation



1919 University Avenue Single Line Diagram



1919 University Avenue Completed Installation

6 Lessons Learned

1. Clarify tie-in method, receive AHJ sign-off early in process

All solar projects need to be connected to the existing building electrical system (or directly into the utility grid) in a NEC and AHJ (Authority Having Jurisdiction) approved manner. The interpretation of the NEC by the AHJ can cause this connection to vary in different cities/counties/municipalities. With 1919 University, IPS assumed an interconnection that has been previously approved for tie-in to the Xcel grid but was not acceptable to the AHJ covering St. Paul. Moving forward, IPS will obtain consent of the AHJ before moving down the path of interconnection with the utility to ensure no significant delays during construction/inspections.

2. Bring on sufficient staff to cover projected busiest periods

Altogether, the Green Line project is the largest solar installation completed by IPS. At times during the interconnection application and design phases, IPS was not staffed sufficiently to respond to all requests and generate deliverables in a manner that kept the project moving as efficiently as possible. The result was 1-2 week delays in updated design documents, approvals on submittal packages and requests from site owners. Since kicking off the Green Line project, IPS has increased the Project Management department from one part-time PM to four full-time PM's and two full-time site supervisors and is well established to handle multiple projects of the same scale as the Green Line simultaneously.

3. Allow for enough time for interconnection application approvals

The Interconnection Application process began in early January 2016 and was not complete for all four sites until September 2016. The reasons for this included an increased workload for Xcel engineers due to the roll out of the Community Solar Garden program and delays on the side of IPS and our sub-contracted engineers in issuing updated drawings to address Xcel engineering concerns. Regardless, the assumed timeline of 40 business days proved to be overly optimistic and has since been updated for all similar projects.

4. Use standardized solar lease agreements.

When securing contracts with the four building owners along the EIC, unique lease agreements were created for each roof. This caused delays as alterations to the contracts were made. If more standardized leases had been used, it would have been easier to get the leases signed in a timely manner and there would have been fewer delays during the signing process.

7 Project Usefulness

Usefulness to Xcel Ratepayers and MN Citizens:

This report has highlighted several benefits from this project. One benefit is the offsetting of 967.27 kW of fossil fuel power generation which will benefit Xcel Energy by reducing the need for additional power generation infrastructure. 95% of all panels are Southwest oriented to capture peak production. In one year 1,297,333 kWh of clean energy will be produced. Utilizing Xcel Energy's emissions calculator method presented in their Energy and Carbon Emissions Reporting 2016 Summary, 1,297,333 kWh of energy will offset about 474 metric tons of carbon dioxide. This is equivalent to planting approximately 19,756 new trees. This project resulted in 8-10 crew jobs during 2016, two permanent, full time positions at IPS, and a substantial amount of business for its local partners.

Usefulness to MN Solar Community:

Minnesota-based solar technologies were given positive press from this project. This will increase interest in local solar manufacturers in the future. The online tracking portals for the four arrays included in this project are available for public viewing. The data from these portals can be used to study the effect these systems have on grid demand, how their production matches up with peak demand times, and what the true value of PV is.

IPS worked with building owners at all sites to assess current demand charges (per Xcel) and map this using building monitoring software. The goal is to pinpoint 15 minute peaks and valleys of building demand and compare this to the supplemental PV metering installed at each array. While this is in process and data is being gathered at 2550 University and 1000 University, the data is not yet available for UEL or 1919 University. We anticipate having all four sites available for online reporting in the coming months. Once we have data going back 2-3 years, this comparison can help quantify the actual impact of urban solar PV on commercial electrical demand- a key financial component of large-scale PV that has been more guess-work than fact-based, data-driven calculations.

IPS created a structured development process with timelines and milestones that encapsulate all aspects of solar development in Minnesota. The development process is replicable and will serve as a model for other solar developers to use for future Minnesota solar projects. Structuring large-scale development in this manner allows for companies the size of IPS to cash-flow larger projects in a way that mirrors when module/inverter/racking & electrical contracting vendors would expect down-payment and progress payments. The process allows for varying lengths between milestones depending on the size and location (urban commercial rooftop vs rural ground mount), but the milestones begin from contract signing and continue as follows:

1. Notice to Proceed
2. 50% Design review
3. 90% Design review
4. Ordering of Modules, Inverter and Racking (separate milestones)
5. Mobilization of labor and materials to site
6. Delivery of Modules, Inverters and Racking (separate milestones)
7. Mechanical Completion (all mechanical and electrical connections complete)
8. Substantial Completion (all mechanical and electrical permits closed and system energized)
9. Final Completion (system producing power and all punch-list items closed out)

8 Performance and Analysis Plan

All four systems have been outfitted with Locus 360 revenue-grade solar production monitoring meters. These meters collect inverter and system-level production data at utility-grade precision and transmit via an internal cell card to an aggregation website currently available to Xcel and interested industry groups via individual log-ins provided below. In addition to 5-minute system production data, the Locus meters collect site-specific readings including Voltage/Amperage per phase, solar irradiance, solar cell temperature and ambient air temperature. Taken together, the cell temp/irradiance measurements allow for remote diagnosis of the solar system 'health' when compared to overall system production.

To fulfill the performance/demand analysis goal, IPS is working with the non-profit Windustry organization to establish a single website that will pull in the data from all four installations via a real-time API and compare to building demand measurements to show the correlation of building energy usage to solar production. The building demand data will be collected via existing energy monitoring equipment and updated quarterly to allow for free viewable and downloadable analysis to any interested parties. Once live, IPS will pass along the website to Xcel as well as providing to educational and industry groups to use for continued analysis of solar as a form of energy demand reduction. The long-term goal of providing this information is to allow for open and easy access to concrete data on solar production vs. commercial building demand in an effort to shape the next generation of renewable energy policy as well as pinpoint marketing/sales efforts.

Production data for this project can be viewed online at the following web address:

<https://solarnoc.datareadings.com/>

The four sites have separate logins:

1000 University Avenue

username: 1000universityprojectinnovation@innovativepowersystems.com

password: welcome

1000 Westgate Drive

username: 1000westgateprojectinnovation@innovativepowersystems.com

password: welcome

1919 University Avenue

username: 1919universityprojectinnovation@innovativepowersystems.com

password: welcome

2550 University Avenue

username: 2550projectinnovation@innovativepowersystems.com

password: welcome

As detailed in the IE Report, the four systems included in this project are expected to produce 1,297,333 kWh of energy annually. As previously mentioned, this production will offset 522 metric tons of carbon dioxide annually.

Actual production for the month of August among the three active systems was at 91.4% of their projected capacity.

9 Budget

Innovative Power Systems, Inc. Budget (EP4-11)

Original Budget	Year One			Year Two			Total Project		
Budget Item	RDF Share	Cost Sharing	Total Cost	RDF Share	Cost Sharing	Total Cost	RDF Share	Cost Sharing	Total Cost
Direct Costs									
Salaries & Wages	\$84,751	\$42,799	\$127,550	\$219,344	\$110,769	\$330,113	\$304,095	\$153,568	\$457,663
Fringe Benefits	\$17,028	\$8,599	\$25,627	\$31,086	\$15,698	\$46,784	\$48,114	\$24,297	\$72,411
Equipment	\$9,900	\$5,000	\$14,900	\$19,800	\$9,999	\$29,799	\$29,700	\$14,999	\$44,699
Consultants/Subs	\$42,240	\$21,331	\$63,571	\$6,613	\$3,340	\$9,953	\$48,853	\$24,671	\$73,524
Supplies	\$10,336	\$5,235	\$15,601	\$14,520	\$7,333	\$21,853	\$24,886	\$12,568	\$37,454
Construction Materials	\$64,977	\$32,813	\$97,790	\$1,211,183	\$522,324	\$1,733,507	\$1,276,160	\$555,137	\$1,831,297
Facilities	\$8,399	\$4,242	\$12,641	\$8,585	\$4,335	\$12,920	\$16,984	\$8,577	\$25,561
Travel	\$4,290	\$2,166	\$6,456	\$8,250	\$4,166	\$12,416	\$12,540	\$6,332	\$18,872
Publicity, Printing Duplicating	\$10,890	\$5,499	\$16,389	\$16,500	\$8,333	\$24,833	\$27,390	\$13,832	\$41,222
Workshops			\$0			\$0	\$0	\$0	\$0
Other Direct Costs	\$41,028	\$20,719	\$61,747			\$0	\$41,028	\$20,719	\$61,747
TOTAL DIRECT COSTS	\$293,868	\$148,403	\$442,272	\$1,535,881	\$686,297	\$2,222,178	\$1,829,750	\$834,700	\$2,664,450
Indirect Costs									
Administration	\$6,750	\$4,500	\$11,250	\$13,500	\$9,000	\$22,500	\$20,250	\$13,500	\$33,750
Indirect Facility Costs			\$0			\$0	\$0	\$0	\$0
Indirect Rate (0%)			\$0			\$0	\$0	\$0	\$0
TOTAL INDIRECT COSTS	\$6,750	\$4,500	\$11,250	\$13,500	\$9,000	\$22,500	\$20,250	\$13,500	\$33,750
TOTAL COSTS	\$300,618	\$152,903	\$453,522	\$1,549,381	\$695,297	\$2,244,678	\$1,850,000	\$848,200	\$2,698,200

ACTUAL	Year One			Year Two			Total Project		
Budget Item	RDF Share	Cost Sharing	Total Cost	RDF Share	Cost Sharing	Total Cost	RDF Share	Cost Sharing	Total Cost
Direct Costs									
Salaries & Wages	\$84,751	\$65,250	\$150,001	\$44,000	\$22,008	\$66,008	\$128,751	\$87,258	\$216,009
Fringe Benefits	\$17,028	\$10,950	\$27,978	\$8,600	\$4,500	\$13,100	\$25,628	\$15,450	\$41,078
Equipment	\$9,900	\$6,485	\$16,385	\$2,750	\$1,350	\$4,100	\$12,650	\$7,835	\$20,485
Consultants/Subs	\$650,000	\$334,900	\$984,900	\$46,000	\$23,000	\$69,000	\$696,000	\$357,900	\$1,053,900
Supplies	\$10,336	\$15,105	\$25,441	\$4,879	\$2,400	\$7,279	\$15,215	\$17,505	\$32,720
Construction Materials	\$985,000	\$470,000	\$1,455,000	-\$60,000	\$30,142	-\$90,142	\$925,000	\$439,858	\$1,364,858
Facilities	\$8,399	\$9,455	\$17,854	\$8,585	\$6,500	\$15,085	\$16,984	\$15,955	\$32,939
Travel	\$0	\$605	\$605	\$600	\$300	\$900	\$600	\$905	\$1,505
Publicity, Printing Duplicating	\$1,300	\$700	\$2,000	\$0	\$0	\$0	\$1,300	\$700	\$2,000
Workshops			\$0			\$0	\$0	\$0	\$0
Other Direct Costs	\$41,028	\$13,500	\$54,528	\$2,150	\$1,200	\$3,350	\$43,178	\$14,700	\$57,878
TOTAL DIRECT COSTS	\$1,807,742	\$926,950	\$2,734,692	\$57,564	\$31,116	\$88,680	\$1,865,306	\$958,066	\$2,823,372
Indirect Costs									
Administration	\$6,750	\$4,500	\$11,250	\$6,750	\$4,500	\$11,250	\$13,500	\$9,000	\$22,500
Indirect Facility Costs	\$37,000	\$22,000	\$59,000	\$92,750	\$43,540	\$136,290	\$129,750	\$65,540	\$195,290
Indirect Rate (0%)			\$0			\$0	\$0	\$0	\$0
TOTAL INDIRECT COSTS	\$43,750	\$26,500	\$70,250	\$99,500	\$48,040	\$147,540	\$143,250	\$74,540	\$217,790
TOTAL COSTS	\$1,851,492	\$953,450	\$2,804,942	\$157,064	\$79,156	\$236,220	\$2,008,556	\$1,032,606	\$3,041,162

Out-sourcing the installation of the modules and AC electrical resulted in a significant shift in the project budget. IPS had originally planned to undertake most of the installation in-house, but the booming Community Solar Garden market resulted in shortages of qualified installers and the need to bring in larger companies with more robust pools of labor. This shift resulted in an under-realization of Salaries/Wages & Fringe Benefits of \$271,000.

The decrease in Salaries/Wages & Fringe Benefits was offset by an increase of \$980,000 in Consulting and Sub-contracting. The reasons for this increase are twofold; requirements of the system owner, WGL Energy, and the difficulty of obtaining labor in the sudden booming Minnesota solar industry. WGL

Energy was/is the owner of the four systems and associated PPA's with Xcel. As such, they imparted a series of engineering and installation requirements that were not included in the original budgetary estimates. These requirements resulted in more robust and well-vetted installations, but at an appropriately robust increase to the budget. The shortage of compliant installation labor throughout the region also contributed to higher sub-contracting costs by forcing IPS to pull in multiple companies during winter months to complete the installations within the agreed upon window required by WGL Energy.

The volatility of solar panel pricing worked to IPS's favor in a savings of \$376,000 in solar panels/inverters/racking. There was a refund of \$90,000 realized in 2017 from the panel manufacturer, TenK Solar, which increased this savings to \$466,000 total.

Indirect Costs of \$195,000 were incurred due to interest on a loan with the Port Authority of St. Paul (\$101,000) and damages assessed by WGL Energy for energizing the systems later than contractually agreed (\$94,000).

10 Conclusion

This project was successful in meeting the specific project goals and objectives. The success of the private financing based development process will serve as an example to be used for future Minnesota commercial solar projects. Production data gathered from the four systems installed will help establish the true benefits of PV to the grid and its effect on building demand. The construction process put Minnesota-based solar energy technologies, like tenKsolar modules, in the spotlight. Promotional efforts during construction and continued efforts afterwards have showcased these local companies and products in a positive light. These efforts, along with the installation itself, have helped increase the penetration of solar energy in Minnesota and will continue to do so. This project will function as an example of how commercial solar can prosper in the great state of Minnesota.