

an analysis of solar
photovoltaic (PV)
performance and
benefits to a small,
rural community in
Illinois

GENESEO CASE STUDY

SOLAR PHOTOVOLTAICS

Illinois Clean Energy
community foundation

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EXECUTIVE SUMMARY

The City of Geneseo Municipal Electric Utility, located in Henry County about 150 miles west of Chicago, has demonstrated the benefits renewable energy can have for a rural community and its ratepayers. The Utility's Renewable Energy Facility, contains two Vensys 1.5 MW wind turbines and a 1.233 MW DC ground-mounted photovoltaic (PV) array. Geneseo Municipal Utility, operating within the Midcontinent Independent System Operator (MISO) transmission territory, serves 3,479 residential, 576 commercial, and 10 industrial customers. The 1.233 MW solar PV system was completed in August 2015 for a total project cost of \$2.5 million, equivalent to \$2.03 per watt, and provides enough renewable energy generation to fulfill the needs of 200 households. Geneseo pursued additional renewable energy capacity as a fiscally responsible use of ratepayers' money and the cost benefits for the utility. In the first year of operation, the PV system generated 1,601,724 kWh, outperforming the estimate of 1,547,582 kWh per year. Due to the success of the project, Geneseo Municipal Utility is planning to add an additional 300 to 500 kW of solar PV capacity in 2018-2019. The ultimate goal is to have 8 MW of renewable energy on-site to increase the utility's generation and essentially cover the baseload energy needs with renewable energy sources.

SOLAR PV PROJECT OVERVIEW

Owner:

Geneseo Electric Utility

Location:

4186 S. Oakwood
Geneseo, Illinois

Nameplate Capacity:

1.233 MW DC

Delivery Method:

Design-Bid-Build

Total Cost:

\$2,503,052.08

Funding:

\$1,000,000 ICECF grant
\$1,503,052.08 loan

Cost per Watt:

\$2.03

Project Team:

Geneseo Municipal Utility, J.F.
Edwards Construction Company

Project Contact:

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GENESEO MUNICIPAL UTILITY

The City of Geneseo is located in Henry County, Illinois, about 150 miles west of Chicago. The Geneseo Municipal Electric Utility department operates a 26-acre Renewable Energy Facility, of which 4 acres contain two Vensys 1.5 MW wind turbines and a 1.233 MW ground-mounted photovoltaic (PV) array. Its location, directly adjacent to Interstate 80 and Illinois Route 82, provides high visibility to the public. Geneseo's Renewable Energy Facility operates within the Midcontinent Independent System Operator (MISO) transmission territory but is also adjacent to the PJM Interconnection territory. The solar PV system, completed in August of 2015, is expected to provide renewable energy for 200 households in the Geneseo utility service area.

The electric utility serves 3,479 residential, 576 commercial, and 10 industrial customers, reaching nearly 7,000 residents. Geneseo's utility generation portfolio for 2016, outlined in Table 2, shows 12% of its energy coming from on-site renewable resources at the Renewable Energy Facility. Nearly all on-site utility generation comes from 3 MW wind turbines and 1.233 MW DC solar photovoltaic panels. Less than 1% comes from eight dual-fuel diesel generators with 30MW of total capacity intended for peak-load shaving and emergency power. Geneseo also owns 3.6 MW of generating capacity at the Muscatine coal plant in Iowa. The remainder of demand is fulfilled by purchasing on the day ahead MISO market.

GENESEO POWER MIX

Table 1: Geneseo Customer Mix and Electricity Demand

Sector	Number of Customers	Total Demand (MW)
Residential	3,479	27,000
Commercial	576	32,000
Industrial	10	2,000

Table 2: Geneseo Utility Power Mix

Energy Resources	2016 Power Mix
Solar	2%
Wind	10%
Coal	23%
Natural Gas/Diesel	<1%
MISO Market	64%
Total	100%

SOLAR PHOTOVOLTAIC PROJECT

The City of Geneseo undertook this project as the next step in their commitment to provide its citizens with cost-effective and environmentally responsible energy. The utility has taken steps towards increased sustainability by installing wind turbines and PV, converting street lights to LED and installing oxidation catalysts on its diesel generator. Geneseo's ultimate goals are to increase the utility's generation capacity and cover the baseload energy needs with renewable energy sources. The service area demand averages around 8 to 9 MW, which is the utility's future target for renewable capacity.

Surprisingly, the sustainability features of the project were not the main motivating factors driving the solar PV installation. The project was undertaken simply because the cost benefit of a utility scale solar project was the most fiscally responsible use of the ratepayers' money. The return on investment was enhanced with the help of a \$1 million grant from the Illinois Clean Energy Community Foundation (ICECF) and a 10-year loan at 2.2% interest for the remainder of the cost.

Planning for the project began in July 2014 when the initial grant application was submitted to ICECF. The initial design called for a 1 MW system. Over time the prices for systems larger than 1 MW became more cost-effective so the design was increased to 1.233 MW. Construction began April 1, 2015 with completion by August even though the installation of the posts alone took two weeks. With attentive project management on the part of the contractor and Geneseo, the project was finished ahead of schedule by fourteen days despite weather delays.

In addition to providing generation and peak demand reduction, the solar PV and wind projects offer hands on learning opportunities for developing practices for renewable energy under the assumption that these technologies will continue to grow in the coming years. Geneseo will gain insight into peak shaving, financial planning, system engineering, and learn about how to handle safety issues, potential strains on the distribution system, and voltage swings associated with expanding grid-tied renewable energy systems.

Pre-Design

While planning this project, employees of the Geneseo municipal utility did extensive research on their own including visiting other large solar PV installation in Rochelle, Illinois and Kalona, Iowa. By the time Geneseo selected a contractor, J.F. Edwards Construction Company (JFECC), the utility knew what equipment they wanted and on what aspects of the project they needed assistance.

The city council and mayor at the time, Linda Vanderleest, were in support of the project from the beginning so obtaining municipal support was not difficult. The utility released information about the project through the local paper and received nothing but positive responses. To date, the utility has maintained community support for the project and faced little challenge with execution. They anticipate the same support for future renewable energy endeavors.

Design

The permitting process during the design phase was fairly simple for Geneseo because they already had a conditional use permit for the on-site wind turbines. The Illinois Department of Natural Resources EcoCat report revealed no species of concern in the area that would hinder the PV installation. However, unexpectedly,

Geneseo did have to obtain a Phase 1 Archeology and Historical Permit from Illinois EPA for disturbing more than one acre of land. This required a last minute archeological investigation on the site which delayed installation by about a week.

Construction

Geneseo performed an environmental study of the area prior to installation and built a new road to make the area more accessible. The city also provided the metering cabinet, the transformer, distribution interconnection, fencing, and the fiber optic connection, which helped reduce costs. Any work that could be handled in-house was completed by city employees who were involved throughout the duration of the project.

J.F. Edwards Construction Company (JFECC) oversaw the PV installation as a turn-key project. Due to the topography of the terrain, it was more economical to install the panels on the rolling landscape versus leveling the ground and installing them flat. The city saved about \$250,000 for the city by leaving the natural terrain.

The construction process faced some issues due to weather since there were 11 rain days and 24.57 inches of rainfall during the installation. JFECC purchased a pile driver with a laser level and GPS capabilities to make the installation of the posts quicker and to overcome the obstacle of the rolling terrain.



Operations and Maintenance

Annual operation and maintenance activities were estimated to cost about \$5,000 per year. Over the last year of operation, the City of Geneseo spent \$6,295 on one-time cost maintenance, mainly to install a new waterway for drainage and landscaping. The utility is working on landscaping that will minimize the need for mowing to keep maintenance costs low. To date, three inverters and two panels needed to be replaced but these items were under warranty. These replacements were received within 3 or 4 days and had little impact on generation. Geneseo plans to purchase and store spare parts to mitigate these kinds of disturbances.

Post-Installation Evaluation

The PV system has monitoring software to track the daily production. This information is being used to evaluate the cost-effectiveness of the installation and track the return on investment. The utility utilizes the monitoring software, which issues email alerts, to quickly identify any maintenance issues that need to be addressed and reduce the amount of down time.

PRODUCT SPECIFICATIONS

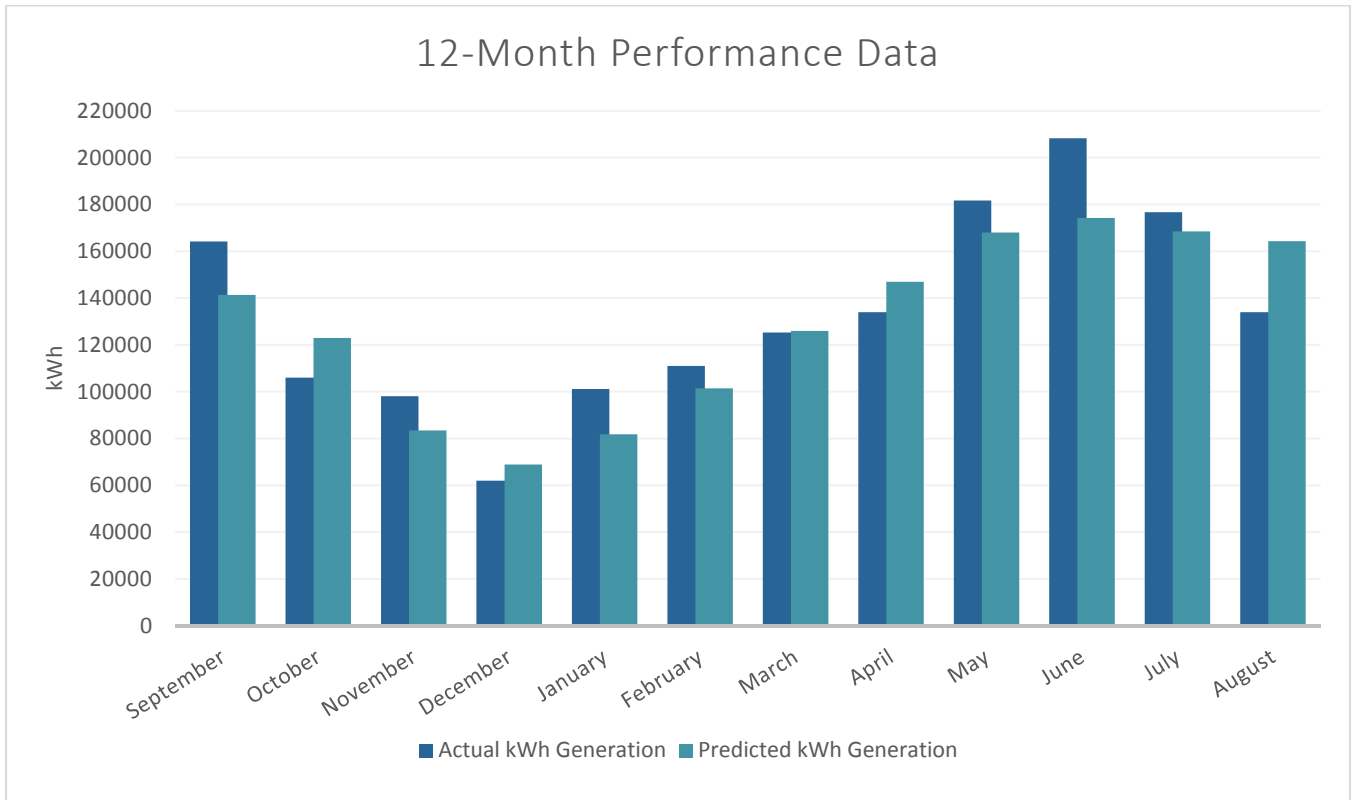
The City of Geneseo installed 1233 kW DC of crystalline PV panels from Universal Solar. The WXS290P-US panels have a nameplate capacity of 290W each with 4248 of them installed across the landscape. Geneseo installed 40 inverters, some 20kW and some 24kW from SMA. The PV racks are installed so the PV panels face due south and have a fixed tilt angle of 30 degrees.

The modules come with a 10-year warranty, the inverters with a 5-year warranty and the installation with a 1-year warranty.

Product Specifications

Solar Panels	
Manufacturer	Universal Solar
Make/Model	WXS290P-US
Individual Capacity	290 kW
Number	4248
Total Capacity	1233 kW DC
Warranty	10 years
Angle	due south
Tilt	30 degrees
Inverters	
Manufacturer	SMA
Individual Capacity	20 and 24 kW
Number	4 and 36
Total Capacity	944 kW AC
Warranty	5 years
Racking System	
Manufacturer	Legrand
Make/Model	FAS Racking
Monitoring System	
Manufacturer	SMA
Make/Model	Cluster Controller

ENERGY GENERATION ANALYSIS



The estimate given in the bid for the system, when increased to reflect a larger system size than originally designed, claimed annual production would be about 1,547,582 kWh per year. The actual generation numbers from the Geneseo PV system are outproducing this estimate with 1,601,724 kWh generated between September 2015 and August 2016. The real-time generation data can be found [here](#).

The Illinois Clean Energy Community Foundation requires the City of Geneseo to retire the renewable energy credits (RECs) from the PV system. Over the last year, the utility has realized significant financial impacts during the summer when the PV system offset peak purchases, the time when electricity prices are the highest. Prices on the MISO market can reach up to \$500 per MWh, with demand charges of \$50 per MW per month. In the summer months, these peak demand charges can reach \$30,000 to \$60,000 per month. The PV system offsets some of the peak demand to reduce these monthly charges thereby saving substantial amounts of money.

PROJECT RESULTS

The City of Geneseo predicted an internal rate of return for the initial project, which was only a 1 MW system, of 8% with a payback of 11.8 years. In the first year, the solar PV system is estimated to have brought in about \$170,000 in revenue based on current electricity rates. This suggests that the actual payback will be closer to 9 or 10 years.

With the \$1 million grant from ICECF, Geneseo is estimating the electricity generation cost is about 3.5 cents per kWh. Without ICECF support, the costs would be about 5.7 cents per kWh which is still well below market price.

Due to the success of this project, Geneseo Municipal Utility is planning to add an additional 300 to 500kW of solar PV to the existing area in 2018-2019. The ultimate goal in the future is to fill the remaining space in the Renewable Energy Facility with PV, an additional 3 to 3.5 MW, to reach the goal of 8 MW of renewable energy.

