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Solar Energy Implementation Case Study

Pork Chop Hill Farm LLC

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Background

Pork Chop Hill Farm LLC is a large pork producer located in Reading, Michigan. The farm was established in 1979 as a farrowing operation with 60 sows. Today, Pork Chop Hill sells approximately 38,000 head per year from their wean-to-finish operation, a large portion of which is contracted out to growers. They operate a large, automated feed system to supply to their on-site and contracted livestock. They also farm approximately 1,500 acres for cash crop and raise a small flock of sheep.

Tom and Margaret Schroeder, the farm owners at Pork Chop Hill have always been interested in solar energy. However, they initially pursued wind energy as a means to offset energy costs sustainably. After researching the potential of generating wind energy on their farm, they found that local ordinances and restrictions as well as a lack of strong wind in the area prevented the installation of a wind turbine in their area. Tom and Margaret still wanted to reduce their carbon footprint and demonstrate to their fellow farmers that renewable energy is a positive, cost-effective investment in the future of farming, so they focused their efforts on solar energy. They began researching solar energy, read magazine and journal articles on the topic for years, and finally met a representative from Harvest Energy Solutions at a local event. Harvest Energy presented information about solar energy, and the farm owners decided to proceed with a project.

Harvest Energy Solutions entered Pork Chop Hill's four electric meters into Consumer's Energy's EARP lottery to obtain funding for a solar energy project. The farm's residential application, including the house and an older hog barn, was chosen for the EARP program, which offered $0.24 per kWh produced with a solar energy system. Through this program, Tom and Margaret worked with Harvest Energy to install a 19.76 kW solar energy system on their farm. Commissioned on August 27, 2015, this system currently provides close to 100% of the electricity usage for their house and hog barn. Tom and Margaret were satisfied with the smooth installation, operation, and overall production of their system. This, coupled with higher hog prices and funding from Michigan State University's Farm Energy Program ($25,000), made a second solar energy project desirable and feasible. Climbing energy bills were also a large motivator to pursue an additional renewable energy project at the time.

Solar Energy System Implementation

The second solar energy project implemented at Pork Chop Hill Farms was a fixed, ground-mounted solar array with a vibrated I-beam structure including 2 sub-arrays of 150 250 W modules each, for a total of 75 kW. The system was installed by Harvest Energy Solutions, implementing SolarWorld panels and Fronius inverters. The solar field was positioned between their field and sheep pen, with an overall footprint of 9,065 square feet (37 by 245 feet). The system was designed to offset 90% of annual energy usage for the farm's machine shop, feed mill, and grain dryer system. A full specification sheet of the solar energy system as well as an aerial view of the system and surrounding property can be viewed in Attachment 1.

Tom and Margaret hired a grant writer from Iowa who helped them apply for a USDA REAP grant. However, since the results of the USDA REAP application wouldn't come in until after the system had been implemented, and this second system would be net metering, unlike the lottery of the first system, the financial investment was initially too large for the Schroeders to commit to a contract. Then, Aluel Go called from Michigan State University's Farm Energy Office with the opportunity for a $25,000 grant, providing the necessary incentive to move forward with the installation of the 75 kW solar energy system.

Harvest Energy Solutions managed the material requirements, coordination with the electrical contractor and utility, and the final installation of the system. Harvest Energy provided ideas for locations and orientations, but Tom and Margaret decided on the final location of the new arrays to best suit the needs of their operation. Starting on September 11, 2015 and lasting until September 22, 2015, the installation of the solar energy system went smoothly. The farm owners commented on the tidiness of the contractors, who cleaned up even small pieces of debris after the installation. Since this unit was larger than the first system, the installation process lasted considerably longer than the first 19.76 kW system—11 days compared to 4 days. The system was connected to the energy grid by a separate electrician and commissioned by the utility. For the first month, however, the farm owners noticed that they were not receiving any energy credits for net electricity produced. Consumers Energy came out to examine the system and found that it had been wired to the grid incorrectly. After a few adjustments, the system was running perfectly, with no maintenance or electrical issues to date. The solar panels were positioned between a field and the sheep pen, out of the way but still close to the operations it was designed to power, so the installation did not inhibit the farm's typical processes. A picture of the completed system can be seen in Figure 1.

Tom and Margaret were very happy with Harvest Energy Solutions, especially the contractor's quick responses to any of the farm owners' questions over the course of the project. They recommend researching contractors and selecting one that will assist with the entire process. They also state that their utility was good to work with, though Harvest Energy maintained a majority of the communication with Consumers Energy. Tom and

Margaret recommended keeping track of production values and credits, and to communicate more with the utility, especially the utility's solar energy department, to work through any questions or concerns throughout the process.

Figure 1 - The 75 kW solar energy system, positioned between a field and sheep pen.

Besides the electrical rewiring required to ensure successful net metering, the installation and implementation of Pork Chop Hill's 75 kW solar energy system was completed without major challenges. Tom and Margaret report that the installation was neat and efficient, and there have been no maintenance or electrical problems. They would recommend that other farmers seeking to implement this type of system keep up communication with their utility during the process to better understand the production and net metering policies and how these might change over time. They also recommend hiring an honest, stable contractor with good service and accessibility. They couldn't emphasize enough how valuable it was that Harvest Energy was always available to answer questions about any aspect of the process.

System Impacts

The Pork Chop Hill Farm solar energy system has been in operation since September 25, 2015, and since that time there have been no adjustments to the system by either the owners or Harvest Energy Solutions. The farm owners do wish they would have paid to have these new solar arrays positioned on stilts, since the current structure will not allow a lawn mower to access underneath the panels to maintain the grass. Due to this inconvenient arrangement they must now contend with, Tom and Margaret would recommend taking these factors into account when implementing solar energy systems in the future.

In terms of electricity production, the owners attest that the system operation is straightforward. Harvest Energy Solutions maintains an online server that is updated in real time and can be accessed at any time by the farm owners to monitor the operation and

electrical production of the system. The utility sends the owners a customized statement for the solar energy system on a monthly basis. Monthly data of actual and predicted electricity production is shown in Figure 2, and raw data is included in Attachment 2. Predicted values are based on Harvest Energy's solar electricity production averages of previous years. The system produced less over the winter months than predicted, though this is not presumed to have a major effect on the overall annual performance of the system since the majority of energy is produced in the summer months. This deviation may have resulted from the above-normal cloud cover in Michigan due to the strong effects of El Niño, experienced between December 2015 and May 2016. See Attachment 3 for additional data showing the impacts of El Niño on cloud cover.

Pork Chop Hill pays $0.13/kWh for electricity, and Consumers Energy allows the farm to bank every kWh produced back on the grid from their solar energy system for use on days when the system doesn't produce enough to meet the electrical needs of the operations it powers. Thus, the system generates savings from decreased energy consumption and, in some cases, excess energy production.

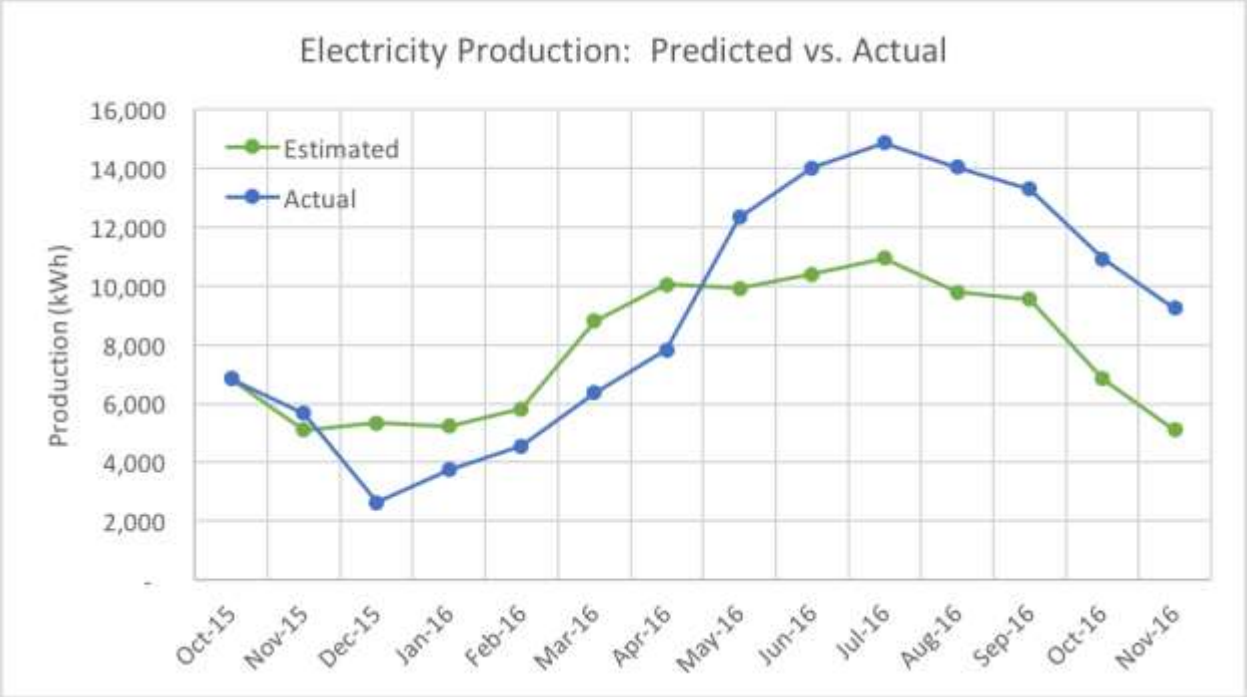

Figure 2 – Electricity produced by Pork Chop Hill's solar energy system since implementation compared to predicted values provided by Harvest Energy Solutions

In terms of regular operations, the second solar energy system does not inhibit the farmers' daily activities. While the arrays are out of the way, they are fairly visible and provide passerby with insights into the company's sustainability initiatives. Tom and Margaret mention that they've received a great deal of positive feedback from neighbors and the community, and many interested people come to look at their system.

According to Harvest Energy Solutions, the total cost for the solar energy system was predicted to be $240,450, and there were no major additional costs associated with implementing the system. With the $25,000 grant from the Michigan Farm Energy Program, and assuming a 30% federal tax credit, the payback period was calculated to be 3.9 years. Since implementation, there have been no major costs or issues to cause the actual payback period to deviate from this value.

Conclusions

Overall, the owners at Pork Chop Hill Farms are very satisfied with their solar energy systems. They recommend that farmers look into solar energy to see if the payback will allow the implementation of these types of systems. Both Tom and Margaret Schroeder emphasize that the initial investment can be a significant barrier, so any financial assistance is instrumental in making the decision. The owners noticed that information regarding renewable energy programs and financial opportunities, such as through the NRCS and USDA, were somewhat lacking during their project implementation. Considering the financial barriers common to renewable energy projects, they believe that it would greatly benefit farmers to have financial opportunities and programs more widely publicized. They are grateful for the funding they received that made this project possible, and are hopeful that incentives will continue to be available for those seeking to implement renewable energy systems in the future.

Since the implementation of this second solar energy system, Pork Chop Hill has installed a third, 30.24 kW system to supply 70% of the energy required for their remaining hog barns. This third system was pursued soon after the second because the farm owners became aware of potential policy changes both for the state of Michigan and Consumer's Energy that may decrease the price paid per kWh generated by solar energy systems back onto the grid. Pork Chop Hill Farms has also conducted a company-wide energy audit recently, and while the farm's current level of efficiency didn't require many additional changes, the owners state that the process was smooth and fairly helpful.

Acknowledgment

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Disclaimer

Attachment 1

Photovoltaic System Specification Sheet Thomas Schroeder – Grain Bins and Shop	
Latitude	41.8340°N
Longitude	84.7912°W
Array Azimuth	180° True South
System Type	Fixed Array – 2 high Vibrated I-beams
System Footprint	37’ x 245’ or 9065 sq. ft
Array Orientation	Portrait
Tilt (Degrees)	35° from Horizontal
System Size (DC)	75.00 kW
System Losses	14.49%
Inverter Efficiency	96.00%
Racking System	Harvest Energy Solutions
Module Type	SolarWorld 250W
Inverter	Fronius Symo 12.0-3
Number of Sub-Arrays	2
Number of Modules per Sub-Array	150
Total Number of Modules	300
Number of Modules per String	15
Phase	240VAC 3-Phase
Sub-Array Current (AC)	210.00 Amps
Maximum Possible Total System Current	262.50 Amps

Below is an aerial view of property with the original schematic of the solar arrays and electrical connections. This shows Pork Chop Hill's second solar energy project located between the field and sheep pen.

Attachment 2

Monthly production data for Pork Chop Hill's solar energy system since implementation on September 25, 2015.

Month	Estimated Production (kWh)	Actual Production (kWh)
Oct-15	6,847	6,847
Nov-15	5,097	5,671
Dec-15	5,336	2,637
Jan-16	5,223	3,745
Feb-16	5,826	4,561
Mar-16	8,814	6,357
Apr-16	10,048	7,830
May-16	9,919	12,353
Jun-16	10,395	14,032
July-16	10,946	14,882
Aug-16	9,784	14,040
Sept-16	9,542	13,295
Oct-16	6,847	10,924
Nov-16	5,097	9,240

Attachment 3

The loss of solar energy production observed from December 2015 through April 2016 may be due to the effects of El Niño, which caused an increase in cloud cover compared to typical years, as seen by the 30% increase in partly cloudy days and the 86% decrease in fair days compared to historical averages. This is shown in the table below.

Month	No. of Fair Days		No. Partly Cloudy Days		No. Cloudy Days	
	Actual[1]	Avg.[2]	Actual[1]	Avg.[2]	Actual[1]	Avg.[2]
Dec-15	0	3	7	6	24	23
Jan-16	1	4	8	7	22	20
Feb-16	1	5	14	7	14	16
Mar-16	1	6	12	7	18	18
Apr-16	7	6	5	8	18	16
May-16	3	7	14	10	14	14
Jun-16	6	8	15	11	9	11
July-16	1	9	21	12	9	10
Aug-16	2	9	20	11	9	11
Sept-16	7	8	12	10	11	12
Oct-16	5	8	17	9	9	14
Nov-16	8	4	9	7	13	19
Dec-16	1	3	4	6	26	23
Avg. Difference	-86%		30%		-5.6%	

[1]National Weather Service Climate. (2016). *Detroit/Pontiac Observed Weather Reports.* Retrieved January 19, 2017, from http://w2.weather.gov/climate/index.php?wfo=dtx

[2]Current Results (2016). *Average Sunshine in Michigan*. Retrieved January 19, 2017 from http://www.currentresults.com/Weather/Michigan/average-sunshine-december.php.