Solar Energy Implementation Case Study

Black Star Farms

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Background

Black Star Farms is a large local fruit and wine producer and processor located in Suttons Bay, Michigan. The farm was founded in December of 1997 as an equestrian boarding facility with a winery tasting room housed within the owners' mansion. At the time of its founding, only a small amount of grapes were grown on the property. Between 1998 and 2000, a new tasting room was built, followed by a bed and breakfast. After the construction was finished, farm manager Don Coe brought in 40 acres of land for fruit (apples, pears, and cherries) and grain production. Black Star Farms currently produces their own proteins for their farm-to-table restaurant and bed and breakfast, raising livestock for beef, ham, poultry, and eggs. The winery itself is a co-op owned by five different partners, together with over 300 acres of grapes, putting out 30,000 – 35,000 cases of wine every year. In addition to keeping up their equestrian boarding facilities, the farm also maintains a qualified forest management program (QFMP) and agro tourism through their petting zoo.

Black Star Farms has long been interested in alternative forms of energy and initially considered geothermal and wind energy. When major hurdles presented themselves in the pursuit of these forms of energy, the next best option was solar. Former farm manager Don Coe especially pushed for solar energy initiatives in 2010 and 2011; but the project did not become feasible until the past two years, due to a lack of available grants. After funding became available, including carbon credits for producing solar energy, Black Star Farms began writing a proposal for a solar energy project in conjunction with Harvest Energy Solutions. Management at Black Star Farms also discussed the availability of funding with their utility company, Cherryland Electric Cooperative. While the grant deadline was just barely missed for 2014, the managers reapplied in 2015 and received funding from USDA REAP ($47,000), the Michigan Farm Energy Program ($20,000), and Cherryland. Black Star Farms also received a loan from GreenStone Farm Credit Services to fund their solar energy initiative. The funding, in combination with the federal investment tax credit, tax savings, and energy savings, allowed this project to become financially possible. Looking back, the managers emphasize that any renewable energy initiative would have been economically unfeasible without incentives.

Solar Energy System Implementation

The solar energy project implemented at Black Star Farms was a fixed, ground-mounted solar array with a vibrated I-beam structure including an array of 204 260 W modules, for a total of 54.08 kW. The system was installed by Harvest Energy Solutions, implementing Canadian Solar panels and SolarEdge inverters. The solar field, consisting of three physical structures, was positioned next to the on-site petting zoo, with an overall footprint of 7,232 square feet (64 by 113 feet). The system was designed to offset 90% of annual energy usage for the nearby wine tasting room. 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.

Writing and coordinating the grant took approximately one month, and after the funding was received from the USDA, MSU, and Cherryland Electric, Black Star Farms moved forward with the solar energy project. Harvest Energy Solutions managed the material requirements, coordination with the electrical contractor and utility, and the final installation of the system. They additionally provided ideas for locations and orientations, however, the original plan to position the solar arrays on the barn roof could not be implemented due to structural incompatibility. Thus, a ground-mounted system was pursued instead. The electrical panel at the winery also needed to be upgraded and configured to receive solar energy before the system could be implemented. The installation began in mid-October and required seven working days. Cherryland Electric came to commission the system, and the solar panels were operational by November 1, 2015. The solar panels were positioned by the petting zoo (Figure 1), out of the way but still visible, so the installation did not inhibit the farm's typical processes. The managers comment that the process was very seamless. Though Black Star Farms lacked experience in the installation of solar energy systems, they devoted ample time to comparing different contractors and systems to determine the best fit for their farm. The managers state that their utility, Cherryland Electric, was very helpful throughout the process in terms of availability and willingness to answer questions and generate solutions. Black Star Farms also appreciated the funding provided by GreenStone, who they stated was an excellent agricultural lender, especially in terms of sustainable energy.

Figure 1 - Photograph of the solar arrays positioned by the petting zoo and livestock area

Though the planning and implementation of the solar energy system were well organized and executed, one major challenge stemmed from a lack of communication between Harvest Energy Solutions and their utility, Cherryland Electric. This miscommunication caused a deviation in the expected payback of the system. Due to a change in Cherryland's policy after the initial construction of the project, the benefits from the net metering through the farm's utility were lower than Harvest Energy predicted. As a result, the economic payback for the project, while still positive, was less favorable than originally expected. Thus, the farm managers recommend that project leads confirm the details of the net metering system, and any expected changes, with their electric company to confirm compatibility with the contractor's plans and ensure the project's economic feasibility. Since every utility and county approaches these systems differently, it is important to involve them in the project proposal. Also, the Black Star Farms managers recommend that those looking into solar energy take time in selecting the best contractor by checking references and referrals, as well as successes and pitfalls of the companies. This will ensure that the system implementation proceeds smoothly and efficiently, as was experienced in this project.

System Impacts

The Black Star Farms solar energy system has been in operation since November 1, 2015. Since its implementation, the system has not experienced any issues nor have any adjustments been made by either farm management or Harvest Energy Solutions. The managers attest that the system operation is incredibly straightforward. Harvest Energy Solutions maintains an online server that is updated in real time and can be accessed at any time by farm managers to monitor the operation and electrical production of the system. The utility sends the managers 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, which started in December 2015 and lasted through May 2016. See **Error! Reference source not found.** for additional data showing the impacts of El Niño on cloud cover. This deviation may also have resulted in part from light snow accumulation on the solar arrays, though the managers state that they cleaned off the arrays on occasions of significant snow accumulation. In the case of minimal accumulation, it was observed that snow melted off the panels soon after the sun came out.

Black Star Farms pays $0.06/kWh for electricity, and Cherryland Electric pays them $0.02/kWh they put back on the grid from their solar energy system. The system generates savings from decreased energy consumption and, in some cases, excess energy production.

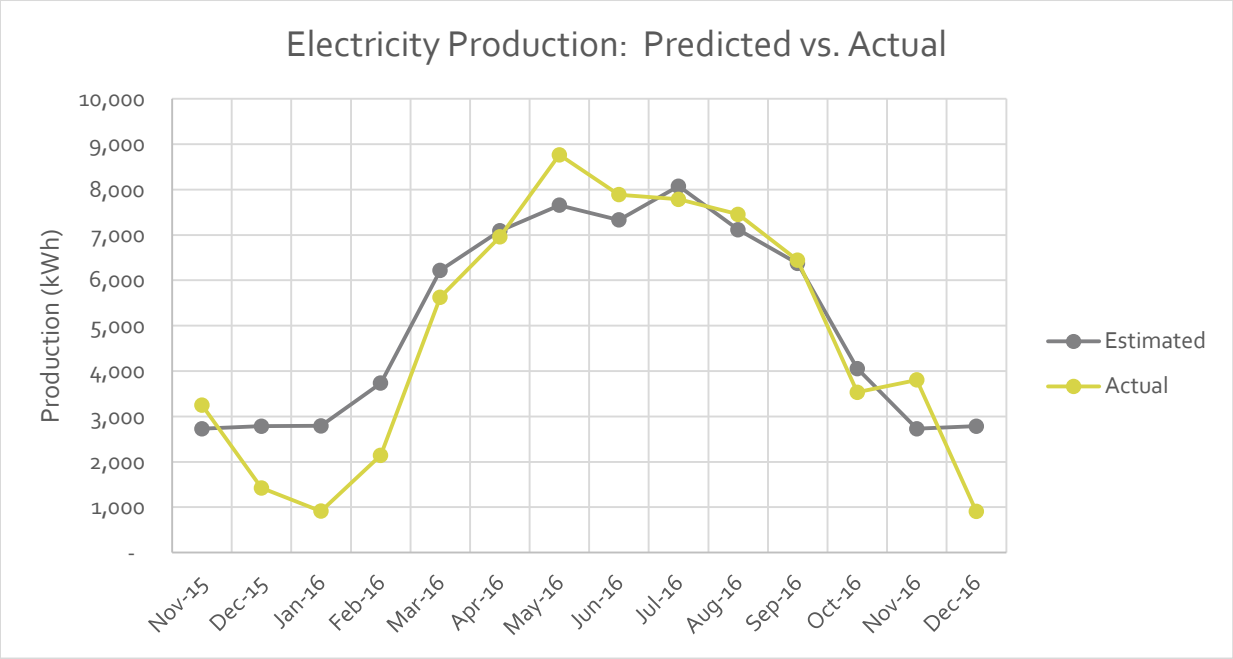

Figure 2 - Electricity produced by the Black Star Farms' solar energy system since implementation compared to predicted values provided by Harvest Energy Solutions.

In terms of regular operations, the solar array does not inhibit the farmers' daily activities. The system's position by the petting zoo, where the protein animals are raised, is out of the way, but still visible to customers who wish to see it. While the system provides insights into the company's sustainability initiatives, the managers did not want the industrial installation to distract from the main focus of certain aspects of their business, such as the wine tasting room. While the managers emphasize that they implemented this renewable energy project for the environmental and economic benefits, they have noticed an additional benefit in the form of positive feedback from customers.

The solar energy system cost breakdown is shown in Table 1. The total cost of the Harvest Energy system was $201,443, but with additional costs for the grant application, service upgrades, and permits, the total cost amounted to $219,701. Black Star Farms received a total of $92,145 in external funding: $47,762 from a USDA REAP grant, $25,000 from the Michigan Farm Energy Program, $14,469 in Cherryland Electric Capital Credits, and $4,914 in rebates from Cherryland. The project was financed with an initial company contribution and a 7-year loan from GreenStone. Overall, the project payback period was calculated to be 9 years. This deviated substantially from the initial estimated payback period of 2.5 years due to the aforementioned changes in the utility's net metering policy, which reduced the crediting rate for solar-produced electricity. Again, the farm managers recommend that project leads stay in constant communication with the utilities and contractors to make sure all parties are aware of policies and potential changes and how these will impact the project.

Table 1 – Cost breakdown for the purchase and installation of Black Star Farms' solar energy system.

Component	Cost
Solar energy system components and installation ($3.79/W from Harvest Energy Solutions)	$201,443
Grant writer to assist with USDA grant	$2,388
Electrical service upgrade at winery	$13,570
Permits – county and township	$2,300
Total:	$219,701

Conclusions (Key Points)

Overall, the managers at Black Star Farms are very satisfied with their solar energy system. They recommend that everyone, not just farmers, look into solar as a renewable energy source, and that those that are interested research all the details of the system and contractors to find a system the best suits their needs. Michael Lahti, Chief Financial Officer and Director of Operations at Black Star Farms, emphasizes that the biggest challenge for implementing a solar energy system is ensuring a positive return on investment. He stated that, "If I build a system that doesn't pay for itself and doesn't have longevity, then I'm building waste… We would not have built this system without incentives; it just would not have been feasible." Funding from the USDA, Michigan Farm Energy Program, and Cherryland Electric allowed this project to be cash flow positive. Michael and others at

Black Star Farms are very grateful for the funding that made this project possible, and are hopeful that incentives will continue to be available for those seeking to implement renewable energy systems.

Managers at Black Star Farms had planned to implement another 53 kW solar energy system elsewhere on their farm, but since tax rebates disappeared and net metering agreements changed, the project was no longer financially viable. Black Star Farms has conducted a company-wide energy audit within the past two years and has implemented many energy and cost-saving initiatives since then, such as converting luminaires to LEDs and installing high-efficiency boilers in their winery. The managers highly recommend that other farmers conduct an energy audit to start reaping the benefits of improved energy efficiency as well as discuss the feasibility of renewable energy systems.

Acknowledgment

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Disclaimer

Attachment 1

Photovoltaic System Specification Sheet Black Star Farms – Tasting Room	
Latitude	44.5326°N
Longitude	85.6357°W
Array Azimuth	180° True South
System Type	Fixed Array – 2 high Vibrated I-beams
System Footprint	64’ x 113’ or 7232 sq. ft
Array Orientation	Portrait
Tilt (Degrees)	34° from Horizontal
System Size (DC)	53.04 kW
System Losses	14.49%
Inverter Efficiency	96.00%
Racking System	Harvest Energy Solutions
Module Type	Canadian Solar 260W
Power Optimizer	SolarEdge P300
Inverter	SolarEdge 7600A
Number of Sub-Arrays	1
Number of Modules per Sub-Array	204
Total Number of Modules	204
Phase	240 VAC 3-Phase
Sub-Array Current (AC)	192.00 Amps
Maximum Possible Total System Current	240.00 Amps

Below is an aerial view of Black Star Farm's solar energy system, located adjacent to the petting zoo, as well as the surrounding property.

Attachment 2

Monthly production data for Black Star Farms' solar energy system since implementation on November 1, 2015.

Month	Estimated Production (kWh)	Actual Production (kWh)
November, 2015	2,727	3,249
December, 2015	2,784	1,423
January, 2016	2,793	914
February, 2016	3,735	2,145
March, 2016	6,218	5,628
April, 2016	7,091	6,956
May, 2016	7,653	8,765
June, 2016	7,331	7,888
July, 2016	8,072	7,785
August, 2016	7,113	7,453
September, 2016	6,372	6,441
October, 2016	4,054	3,532
November, 2016	2,727	3,804
December, 2016	2,784	905

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.