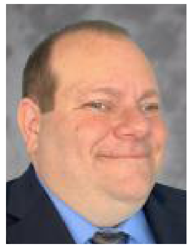
Factors Affecting Solar System Profitability for Southeastern Broiler Growers



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Acknowledgments

The authors are grateful for support of this work from the Alabama Agricultural Experiment Station and the Alabama Cooperative Extension System. The authors also thank Larry Bradford of Southern Solar Systems, Inc. for providing valuable solar industry insight.

Abstract

Using original data and a U.S. Department of Energy modeling program, we analyze how system size, photovoltaic power generation, and utility compensation affect solar system profitability on a representative southeastern U.S. commercial poultry farm. Results show that due to the poultry usage profile, when electricity buyback rates are low, system size and utility compensation are more important than solar availability in determining the profitability of a solar system for a commercial poultry grower. Also because of the usage profile, smaller systems may be more profitable regardless of solar availability. We also discuss the extent to which tax incentives and cost-share improve profitability.

INTRODUCTION

In many areas, commercial poultry growers face electric utility costs that increase faster than inflation and express interest in solar investments that will decrease this variable cost. Hardy, Clark, and White (1983) concluded that high investment costs of solar had hindered adoption and future technological improvements and cost decreases were required to make it a viable alternative for poultry. In the past decade, solar photovoltaic (PV) energy has been the beneficiary of substantial advances in technology while at the same time it has seen dramatic decreases in component cost; PV panels have decreased by as much as 85% over the past decade (NREL, 2021). Cost-share and tax credit subsidies are also available to some growers; however, our initial analysis calculates profitability without these subsidies because their application can vary among different growers. Concurrently, the poultry industry's customers are demanding more environmentally friendly production methods utilizing more renewable energy sources. As evidence of this, Tyson Foods, Inc. recently announced its commitment to carbon neutrality by 2050 (Gibbs, 2021). Utilizing solar on their contract poultry farms may help reach this goal. These factors have spurred an increased interest in solar power for commercial poultry farms, thus creating a need for farm managers to develop a greater understanding of solar use in poultry operations to best advise growers in this area.

We propose that system size, utility rates for incoming and outgoing power, and the usage profile compared to solar intermittency are three important drivers of a solar system's return on a specific broiler farm. However, other factors affect the profitability of a solar investment. A comprehensive evaluation should consider the opportunity cost of capital and discounting when evaluating future impacts. Intuitively, the costs of installing solar occur in the near term, while the benefits of using solar occur over the long term. The tax liabilities of the farm must also be considered because tax credit value is often included in the returns but may or may not be of benefit to a specific farm in the short term. How to properly handle tax credits long term is an accounting question each farm must address.

Although these and other factors affect the financial returns of solar for poultry, it is not clear which factors have the largest impact on profitability. For instance, is the availability of solar radiation more important than utility rates? Our analysis suggests the answer is "no." Indeed, our findings suggest that solar return depends considerably more on the utility company rate structure for distributed energy compensation versus retail purchase price (for reference, we call this the utility's "solar deal") than on the location's environmental/ weather characteristics. The overarching objective of this economic study is to help farm managers, extension personnel, industry decision makers, and others understand how recent changes in the solar market affect the economic viability of its use in poultry production. To do so, we look at how system size variation, the electrical usage profile of a representative commercial broiler farm, changes in solar generation potential, and the utility company distributed energy program affect the profitability of solar systems for poultry growers. This information may then be used to advise on any one farm whether to reject the use of solar, to size a system optimally in the near term, or to wait for a more favorable solar deal from the utility company.

BACKGROUND

A small number of prior studies examined the profitability of solar in the poultry industry. Cain and Van Dyne (1977) concluded that solar energy used for heat in broiler farms located in Maryland was unprofitable due to the high price of the technology. Further research in the 1980s and later in the early 2000s focused on the optimization of heating systems. Hardy, Clark, and White (1983) and Brown (2008) concluded that price was a limiting factor. Additional recent studies tended to focus on economic factors that could affect solar use in poultry. For instance, Simpson, Donald, and Campbell (2007) found that electricity costs are the second largest cost for broiler production. This substantial cost is a motivating factor for producers to use alternative electricity sources for their farms.

Existing solar systems on commercial poultry farms in the United States today are utility-grid connected and utilize some form of power purchase agreement (PPA), net billing, or net energy metering (NEM) program to produce enough profit to warrant the investment.[1] PPAs are contractual agreements between solar owners and utility companies in which the utility company agrees to purchase all electricity put onto their grid by the solar system for a set kWh price and are not the typical scenario for poultry farms today. Net billing allows for electricity to flow to and from the customer through a bidirectional meter and is a reconciliation between energy used and energy put onto the grid by the utility company at time of use. Under net billing programs, utility companies account for any excess generation above usage and decide what the compensation rate will be for the customer. NEM is similar, with the major difference being it allows for solar generation that exceeds usage to be counted, or "stored on the grid" for later use by the customer at a different time during the same billing cycle. NEM effectively values all or most solar generation at retail rates. Many states have NEM laws that mandate and regulate this type of agreement. For both NEM and net billing, a solar system should reduce the amount of power a grower would have to purchase from the utility company at retail rate by offsetting that power with solar energy used directly or redistributed back onto the utility grid.

The compensation rates for distributed energy generation in excess of usage can vary with every utility company. Sometimes the rates are mandated by state laws or public service commission regulations. Often utility companies only compensate for excess power above usage with a rate calculated to be their variable cost of production—referred to as an "avoided cost" rate—that reflects a wholesale rate. Avoided cost calculations vary with every utility company according to multiple factors, and the calculations are generally held as proprietary. For three major poultry producing states in the southeast United States, avoided cost rates vary from 20% to over 30% of published retail rates (Alabama Power, 2021; Mississippi Power, 2021; Entergy Arkansas, 2021). Because our study cannot vary every factor affecting avoided cost, for simplicity and consistency we assume the avoided cost is 30% of retail and apply it across all treatments. This is likely the most important assumption in our study, and growers who receive a higher avoided cost buyback rate will be more likely to find that solar installations are profitable.

The advantage of holding avoided cost constant is that we can focus our analysis on varying system size, which we believe is an overlooked factor in solar installation decision making. Because solar power offsets purchased power at the retail price, solar customers are often urged to install a solar array sufficient to offset 100% of their total annual usage. This is done with the promise of electricity cost being reduced to solar system cost over the payback period, using the simplified payback equation:

> *PAYBACK* in years = *SYSTEM-COST* / (*PV-GENERATION* in kWH × *RETAIL-PRICE* in $/kWh – *O&M* in $/year)

where O&M is the operating and maintenance cost. Hay (2016, 19) argues that this simplistic model is insufficient to fully examine the profitability of a solar project because it "ignores several critical investment characteristics, including the time value of money, energy price escalation, variable rate electricity pricing, alternative investment options, and what happens after payback." Also, because a large percentage of broiler farms in the United States are in states that do not have solar-friendly NEM laws or regulations, many growers are only able to utilize a net billing scenario where they receive a combination of retail and avoided cost rates for their solar energy based on a time-of-use reconciliation between usage and generation without any excess generation rollover benefit. The resulting solar deal from their utility and additional factors unique to commercial broiler farms have great impact on the true return value of a solar investment on poultry.

METHODS

To evaluate the impact of solar availability, solar system size, and the utility's solar deal, we run simulation experiments using the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) System Advisory Model (SAM 2020.11.29). SAM is a computer-based modeling software with the power to calculate solar system performance by location and apply financial evaluation tools to a system model. SAM uses NREL-sourced location-specific solar radiation data for solar energy generation modeling. Users input their specific electricity usage data. SAM then applies a comprehensive set of financial evaluation criteria, including utility company power rates specific to location, utility distributed energy compensation program models, financial discounting, O&M, and PV panel degradation. A simulated solar return is estimated over a specified length of time using net present value (NPV) as the financial evaluation metric.[2]

We run a simulation with original experimental data within the SAM model. Specifically, we use hourly electrical usage from a modern broiler farm raising a 9# bird on a four-house farm in the southeastern United States. This region of the country is called the "broiler belt" of the country and is where a majority of U.S broiler production occurs. We vary our analysis looking at the effect of solar installation size as a percentage relative to power usage, utility company retail and avoided cost rates, and solar energy generation variance by location. Of these three factors, the solar customer is only able to vary the size of the installation according to the effects of the other two factors.

We use a 2x3x3 experimental design with the following treatments and levels:

- PV-GENERATION: High (High PV), Low (Low PV)
- SOLAR-DEAL: High SD ($0.13 retail/$0.039 avoided cost), Medium SD ($0.11/$0.033), Low SD ($0.09/$0.027)
- SYSTEM-SIZE: 100% annual usage offset, 50%, 30%

For variation in *PV-GENERATION*, we use two solar energy generation models representing different locations within the southeastern broiler belt, each being dense broiler production areas: one with higher solar resources (5.0–5.5 kWh/m2/day) and one with lower solar resources (4.50–5.0 kWh/m2/day) according to the NREL's 2018 U.S. Annual Solar DNI map (Roberts, 2021). *SYSTEM-SIZE* varies by modeling 100%, 50%, and 30% goals for percentage of usage offset by solar. Offset size of 100% represents a system parameter commonly recommended by the solar industry, while 50% and 30% represent lesser offset goals designed to examine the effect of downsizing the system. These three sizes represent systems targeted to offset 100%, 50%, and 30% of the total annual farm usage of our representative farm, or 172,403 kWh per year. A 120 kW (100%) solar system would be projected to generate approximately the same amount of power on an annual basis, with slight variability by location. To address probable price variation for economies of scale, we adjusted the price per installed kW of solar. We used the current industry average for commercial sized systems of $1.72/watt, according to NREL sources (Feldman et al., 2021), and then adjusted up by $0.10/watt cumulatively for each size decrease ($1.82/watt for 50%, $1.92/watt for 30%). For each of these six resulting models, we examine the effect of a high, medium, and low *SOLAR-DEAL* outlined below to calculate the final 25-year NPV.

The *SOLAR-DEAL* is the combination of the cost of purchased electricity and the value of solar generation that does not directly offset electricity usage. *SOLAR-*

DEAL is also impacted by the method the utility company uses to meter and compensate their customer for solar power put back onto the grid. Our simulations represent behind-the-meter installations *without* NEM. The SAM model simulates this most basic energy exchange through its "Net Billing" feature. This billing option reconciles solar generation to electrical usage hourly without rollover. Solar energy that offsets utility power usage is valued at retail/kWh rates. Any power needed above solar offset is purchased at retail rates. Excess generated solar above electricity usage is compensated by the utility company at avoided cost rates. Initial models were simulated using the U.S. Energy Information Administration's (EIA's) published national average for commercial electricity of $0.11 per kWh (EIA, 2021) and a 30% of retail avoided cost rate, or $0.033/kWh. Starting with the EIA average commercial rate listed above, we simulate a price range by adding $0.02/kWh and subtracting $0.02/kWh from the retail rate and calculate the avoided cost at 30% for each. We apply the three levels of *SOLAR-DEAL* to the same six simulation cases and generate the resulting NPV.

The following financial constants were applied to our model across all simulations:

- Interest on borrowed capital 5%, on a 15-year loan to match the standard poultry farm mortgage at the time the paper was drafted.
- The IRS's Modified Accelerated Cost Recovery System (MACRS) of depreciation, 5-year schedule, is used as a method to quickly capture depreciation dollars on IRS qualifying investments.
- Federal income tax = 21%, state 7%. This is used to calculate the value of tax deductions to cash flow.
- Yearly insurance rates are estimated at $7/$1000 or 0.70% of *SYSTEM-COST*.
- SAM default O&M cost of $19/kW/year with escalation.
- Monetary inflation rate, applied to costs = 1%.
- Discount rate of 6.08% over 25-year examination period is applied to calculate NPV. This rate was selected because it was in the 4% to 10% range Hay (2016) proposes for a higher-risk solar installation, in general, and the SAM model predicts this specific rate when one uses a 2% inflation and 4% nominal discount rate. We believe this final rate, which is in the lower range of Hay's high-risk category, accurately reflects the long-term stability of solar investments combined with the problematic mismatch of solar generation and poultry farm power usage.
- Utility rate escalation = 1%/year.
- PV panel degradation = industry average 0.5%/year.

The standard warranty period of PV panels is 25 years. This is considered the minimum usable life of PV panels, in which 80% or better production is guaranteed. Because the panels make up most of the total cost, cumulative NPV changes at the end of 25-year minimum life will be used for the final analysis.[3,4]

RESULTS

Results are presented in three stages. First, we explain how the hourly usage compares to the solar generation on three differently sized systems, focusing on the resulting mismatch of generation to usage. Second, we aggregate the hourly data to monthly trends across six treatments. Finally, in the third stage we present the NPV calculations for all our treatments.

The University of Arkansas (2019) found the average electricity usage for a modern commercial broiler barn to be 44 kWh per 1,000 pounds of broiler sold, though there is variation in electrical usage across farms, across bird sizes, and across years. Using the University of Arkansas' calculation method, our representative farm's usage was 50 kWh per 1,000 pounds of broiler sold for the sample year, only slightly higher than the average. Importantly, this usage is not constant over time, and neither is the solar production. The cycle of electrical usage mirrors the flock cycle on a broiler farm. The usage will also vary by the hour during a flock according to the weather's effect on the in-house environment. The solar availability varies daily with weather and cloud patterns as well as the normal seasonal variation.

One problematic factor in commercial poultry is the highly varying electrical usage profile that follows the flock cycle and the difficulty this creates with offsetting varying solar generation. To illustrate, Figure 1 shows daily generation of three different sizes of solar system compared to the daily electrical demand (herein "usage") of our representative farm. The purple area shows solar power generated from a 120 kW PV system, the yellow area a 60 kW PV system, and the blue area a 30 kW PV system. Every kWh of solar generation above the red power usage is either lost solar power or sold at reduced utility compensation rates. Solar produced that falls under the usage line returns retail value as a direct offset. Daily usage above the solar generation line must be purchased at retail in our net billing scenario. The value of solar for a farm is the result of the amount of solar used at retail offset value compared to solar lost or sold at a lower avoided cost value. From the simulations we see how changing the solar installation target size influences the NPV of a system. This relationship of *SYSTEM-SIZE* to NPV is complex since NPV does not consistently increase with the size.

In Figures 2A and 2B, we convert the hourly data to monthly and impose a usage line over solar generation for all three *SYSTEM-SIZE* models to illustrate more clearly how changing size alters how high and low valued solar affects NPV. Comparing Figure 2A and Figure 2B illustrates how little change is induced by the High and Low *PV-GENERATION* site scenarios.

Next, we analyze NPV by *SYSTEM-SIZE* variation and *PV-GENERATION*. We model 100% offset, 50% offset, and 30% offset goals to get the NPV results for each (Figure 3). The results suggest that *SYSTEM-SIZE* has a substantive effect on profitability. Simply installing a system sized for 100% annual usage yields a negative NPV for both high and low levels of *PV-GENERATION* (High PV, Low PV). Sizing to 30% shows the best NPV for Low PV, with the 50% size yielding the best NPV for High PV.

To complete the analysis, we then apply three levels of *SOLAR-DEAL* to the same six simulation cases and generate the resulting NPV in Figures 4A and 4B, with High SD = $0.13/kWh retail and $0.0039/kWh avoided cost rates, Medium SD = $0.11/$0.0033, and Low SD = $0.09/$0.0027. Figure 4A depicts this analysis applied to the High *PV-GENERATION* site, and Figure 4B for the Low *PV-GENERATION* site. We find the 50% offset sized system with the highest *SOLAR-DEAL* yields the best NPV for both sites. These results also show the extent to which NPV increases as *SOLAR-DEAL* increases for all sizes in this basic net billing model. Final NPV also varies with *PV-GENERATION*, but that variability is less than that caused by *SOLAR-DEAL*. These results should caution producers, extension personnel, and solar industry sales personnel who might be inclined to assume 100% sized systems are best.

Collectively, the results also show that the key factors for profitability of solar for commercial poultry in this basic net billing model are *SYSTEM-SIZE* and the available *SOLAR-DEAL*. These two far outweigh the *PV-GENERATION* at the levels we analyzed. Our analysis also shows that the *SOLAR-DEAL* available to growers is the most important factor to be considered. Within the constraints of these two factors, a system must then be sized to minimize the amount of solar kWh sold at low utility compensation rates and maximize kWh of retail value offset.

By assuming that solar returns retail value for all power generated, you will overestimate the profitability of solar for commercial poultry. We saw that matching solar installation size to total annual kWh usage increases excess solar sold at low avoided cost rates under the net billing scenario. Therefore, 100% offset should not always be the goal. In fact, smaller systems may yield better NPV even though they produce less solar. It is also apparent that higher utility rates yield better NPV on solar. It is imperative that every grower analyze their unique situation with their utility company power rates and the solar generation potential for their location to then size a system appropriately to best match their power usage profile.

DISCUSSION

As the United States comes under increasing pressure to incentivize and adopt more renewable energy, utility companies and public service commissions may feel pressure to increase solar energy compensation rates and improve NEM laws. In such cases, with solar continuing to experience technology advances and cost decreases, the opportunities to utilize solar to improve growers' bottom lines will increase, even in situations that are not currently viable due to the reasons discussed here. Otherwise, storing the mismatched solar for utilization at retail value may be another way for solar to be profitable on poultry farms in some locations. This storage can occur on the grid as NEM or on-site as battery system technology advances and cost decreases.

Two institutional variables that were not included in our simulations are the federal tax incentives and cost-share opportunities available for solar. Both can improve the profitability of an investment due to reduction in system cost in the near term. System owners are eligible for a federal income tax credit (FITC) of 26% for systems installed from 2020 to 2022, and 22% for systems installed in 2023 (U.S. Department of Energy, 2021). The FITC expires starting in 2024 unless Congress renews it. There is no maximum amount that can be claimed, but there are qualifying limitations. Poultry growers may not have sufficient federal income tax liability to take full advantage of the credit in the near term. However, the credit can be rolled forward for a period based on IRS regulations. Growers should consult with a tax professional to examine the long-term implications of the FITC. As with any federal incentive program, the terms and limitations are subject to change with congressional action.

Currently, the most universally applicable cost-share opportunity is the USDA Rural Development's Rural Energy for America Program (REAP) Renewable Energy Systems & Energy Efficiency Improvement program (USDA Rural Development, 2021). The REAP grant program offers up to 25% of the initial installation cost of a solar system as a cost-share. However, this is a competitive grant program that is not guaranteed. The funding is limited, there are limited application times, and only rural small businesses and agricultural producers may apply. REAP grants require an energy audit be performed as part of the application. An experienced technical service provider should be hired to complete the audit and application. Renewable energy grants are capped at $500,000. The grant is typically a reimbursement. The current REAP program has a sunset clause and may or may not be renewed in the future. Renewed REAP or other grant programs may have different criteria altogether.

Both grants and tax credits can have great positive impact to cash flow and profitability of a solar system for poultry. However, they are not guaranteed or always applicable, and thus we did not include them in our analysis. Nonetheless, for comparison, if we apply both 26% FITC and 25% REAP grant to the least profitable simulation case (Low PV,100% sizing, low solar deal), the NPV goes from a $57,381 loss to a $23,949 gain. With incentives, the larger systems with the better solar deals yield the highest NPV (see Table 1 for additional comparisons). Thus, it is important to evaluate an individual farm's tax situation and pursue any grant availability when considering solar investment, which could be the difference between a losing proposition and a profitable one.

When appraising a poultry farm with an existing solar installation, the method should be similar to what has been outlined. The expected PV power generation based on size and location of the system must be compared to the annual usage of the farm. However, as has been exhibited, just comparing total usage to total PV generation will not yield an accurate estimate of profitability. The farm's usage pattern, PV generation pattern, and available solar deal must all be considered. Appraisers might also want to recognize that the solar deal is probably more likely to change in the medium to long term than the other forces driving the profitability of vertically integrated poultry farms. In areas with less than favorable solar deals, future changes in solar policies by state governing agencies or the utilities could greatly improve the profitability of an installed solar system. In areas with favorable solar deals, the possibility of the deal retrograding to less than favorable also exists. Therefore, an investigation into the drivers of state and local utility policy is warranted in these cases.

For these reasons, it is recommended that a reputable solar installer who understands the nature of poultry usage profiles as they compare to the location's PV generation potential and is familiar with the local utility and governmental policies be consulted to enhance the accuracy of an appraisal. Looking at the history of the system would also yield valuable information. Typically, this history will be available through the utility company. Unlike many farm capital improvements, a solar system should be expected to produce long after the system is paid for. In that light, a 15-year-old solar system that has been paid for is of great value to a farm for at least the coming 10 years, likely more, because all the electricity produced has only operations and maintenance costs associated with it.

CONCLUSION

Our results show that, due to the poultry usage profile's effect on excess solar generation, system size and utility compensation are more important than solar availability in determining the profitability of a solar system for a commercial poultry grower. In areas with relatively low wholesale buyback rates, we found that smaller systems may be more profitable regardless of solar availability and increasing system size does not equate to increasing profitability. It was also found that a solar deal with higher retail and avoided cost rates yields higher NPV regardless of system size or solar availability. However, a limitation of this study is that the assumptions in our simulations make it impossible to draw conclusions that apply to all possible poultry operations under all possible conditions and utilities. We believe the biggest limitation is assuming an avoided cost rate of 30% of retail across all rate structures. Avoided cost calculations are unique to every utility company. Some are published on utility company websites; others are not. Our 30% figure came from a canvas of utilities in the southeast United States but does not represent all utility avoided cost rates. The other primary assumption that limits this study is that the distributed power generation program used by utility companies varies with each of them, even when there are state laws that dictate parts of the program. However, our model was produced to resemble the situation of growers in states without NEM laws, or with very lenient laws, to present a "worst-case" scenario. It is in these areas that a grower may more often be victim to poor guidance on a solar investment. Therefore, poultry farm owners, managers, and farm consultants must analyze their operations closely when considering solar as a cost-saving opportunity.

When considering solar installation for electricity usage offset in a net billing application, several factors must be analyzed closely. Primarily, the farm's usage profile must be compared to solar availability to minimize excess solar generation. This analysis must be in consideration of the farm's utility power rates and should consider rate escalation and future value of returns reflected by appropriate discounting. If a solar installation does not prove profitable now, barring tax incentive or cost-share opportunities, changes in the utility company distributed power generation compensation program have the most positive effect on returns for poultry growers.

FOOTNOTES

1. Aspects of the determination of profitability for solar in general as well as in agriculture (i.e., beyond poultry) are defined in NREL (2021), NREL SAM (2020), Hay (2016), DSIRE (2021), and others.
2. NPV is calculated by SAM in accordance with Short, Packey, and Holt (1995).
3. All simulation cases were modeled using SAM's "Distributed, Residential Owner" models to capture deductible interest on a mortgage loan.
4. NPV is a function of the following additional pertinent constants. All labeled "SAM" were left as the SAM default standard under the "PVWatts" modeling scenario.
    a. Monthly Utility Load: Hourly usage data from representative southeastern United States broiler farm
    b. Array type: standard, fixed mount
    c. Escalation: 1% rate escalation
    d. Inverter efficiency: SAM
    e. Total system losses: SAM
    f. Module: SAM
    g. Fixed cost by capacity: SAM
    h. Fixed cost per capacity escalation: SAM
    i. Variable cost by generation: SAM
    j. Variable cost by generation escalation: SAM
    k. Sales tax: Not included in simulations
    l. Tilt: SAM
    m. Disable demand charges: No utility company demand charges considered
    n. Metering option: Net billing, no rollover
    o. Fixed monthly charge by utility company: $20/month

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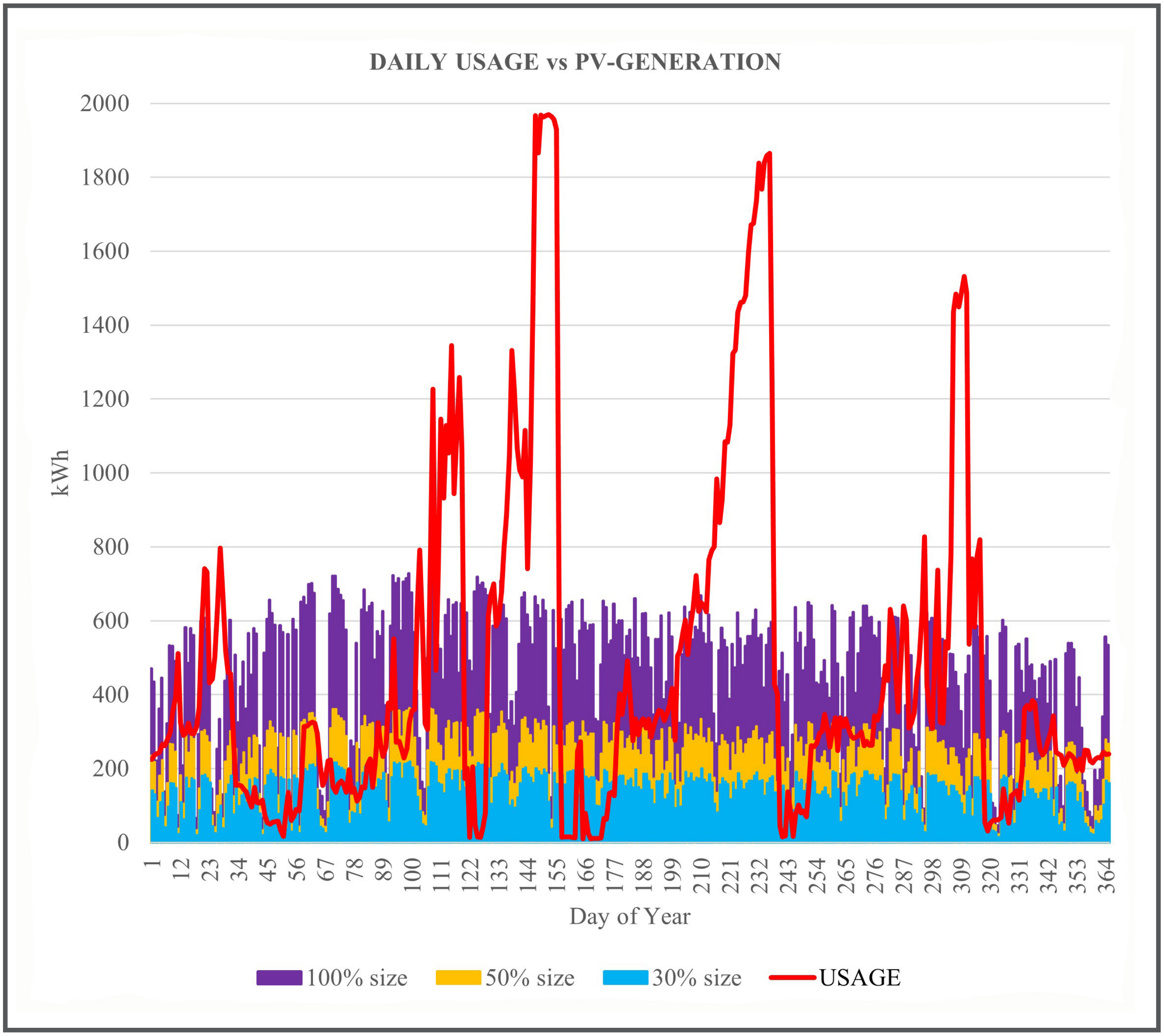

Figure 1. Daily electrical usage of representative farm vs. daily *PV-GENERATION* at a single location for *SYSTEM-SIZE* = {100%, 50%, 30%}

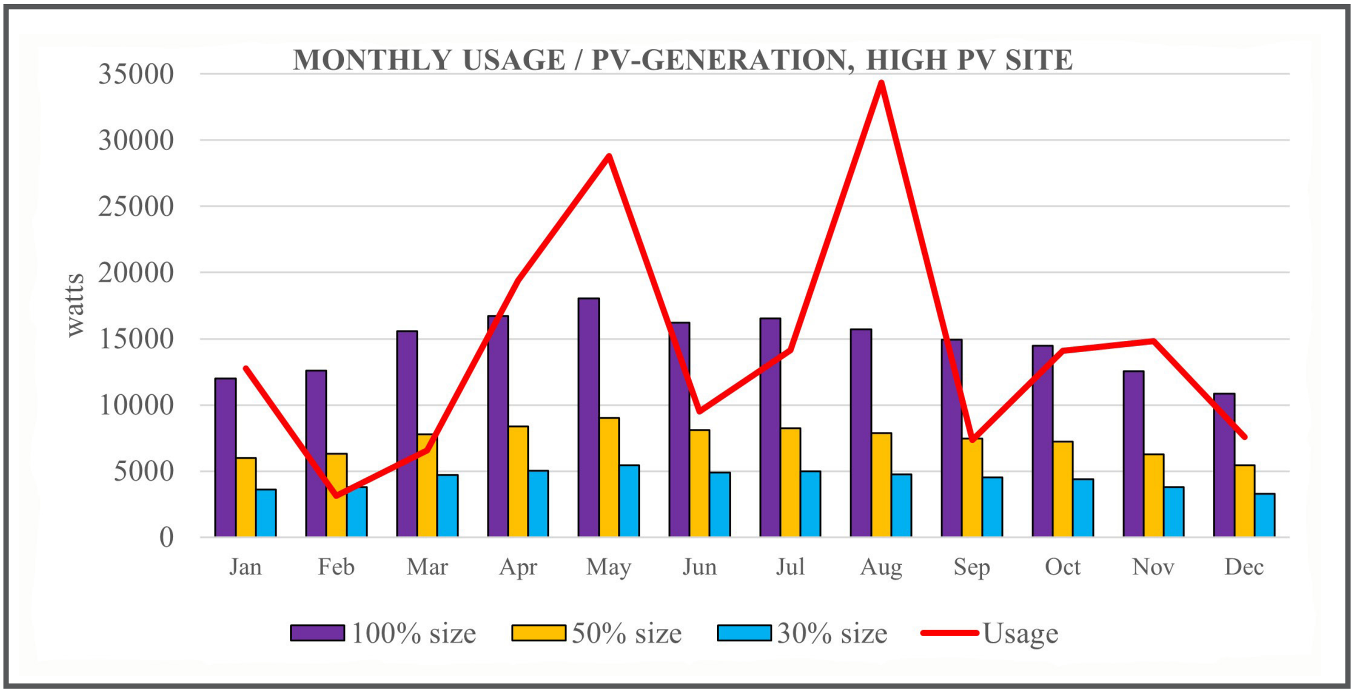

Figure 2A. Monthly *PV-GENERATION* at high PV site compared to monthly usage for *SYSTEM-SIZE* = {100%, 50%, 30%}

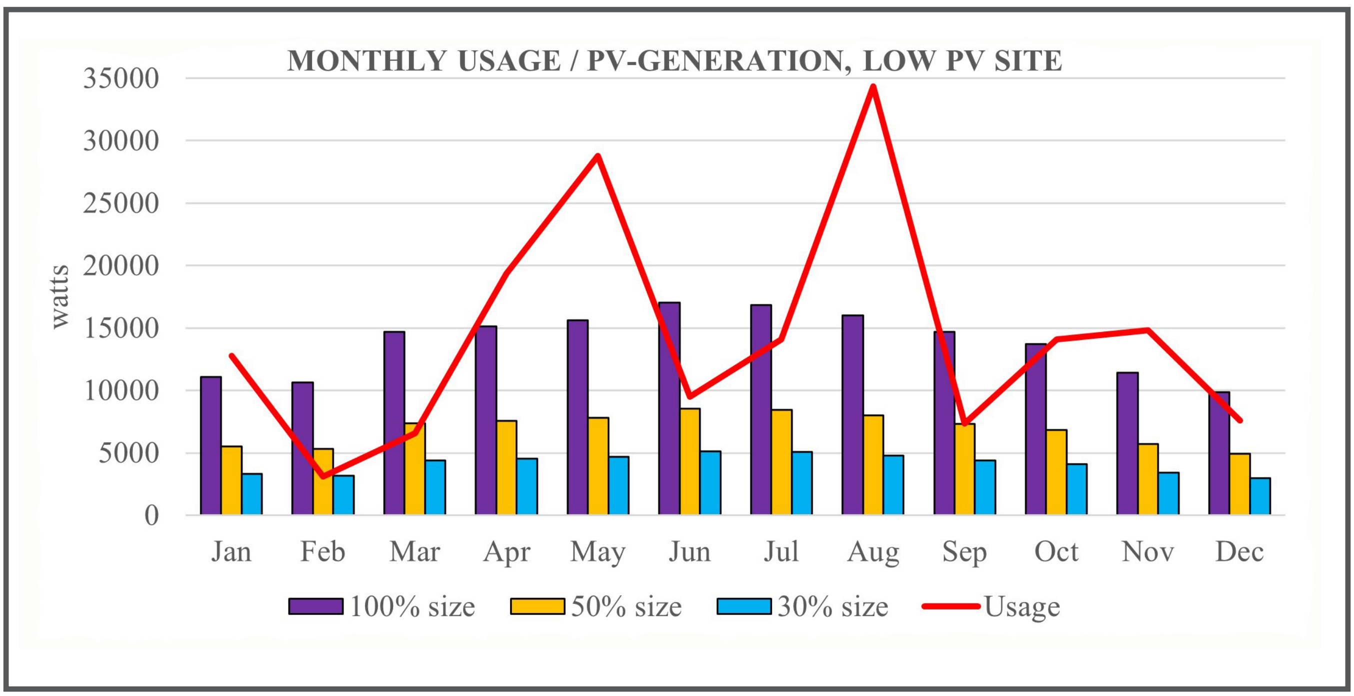

Figure 2B. Monthly *PV-GENERATION* at low PV site compared to monthly usage for *SYSTEM-SIZE* = {100%, 50%, 30%}

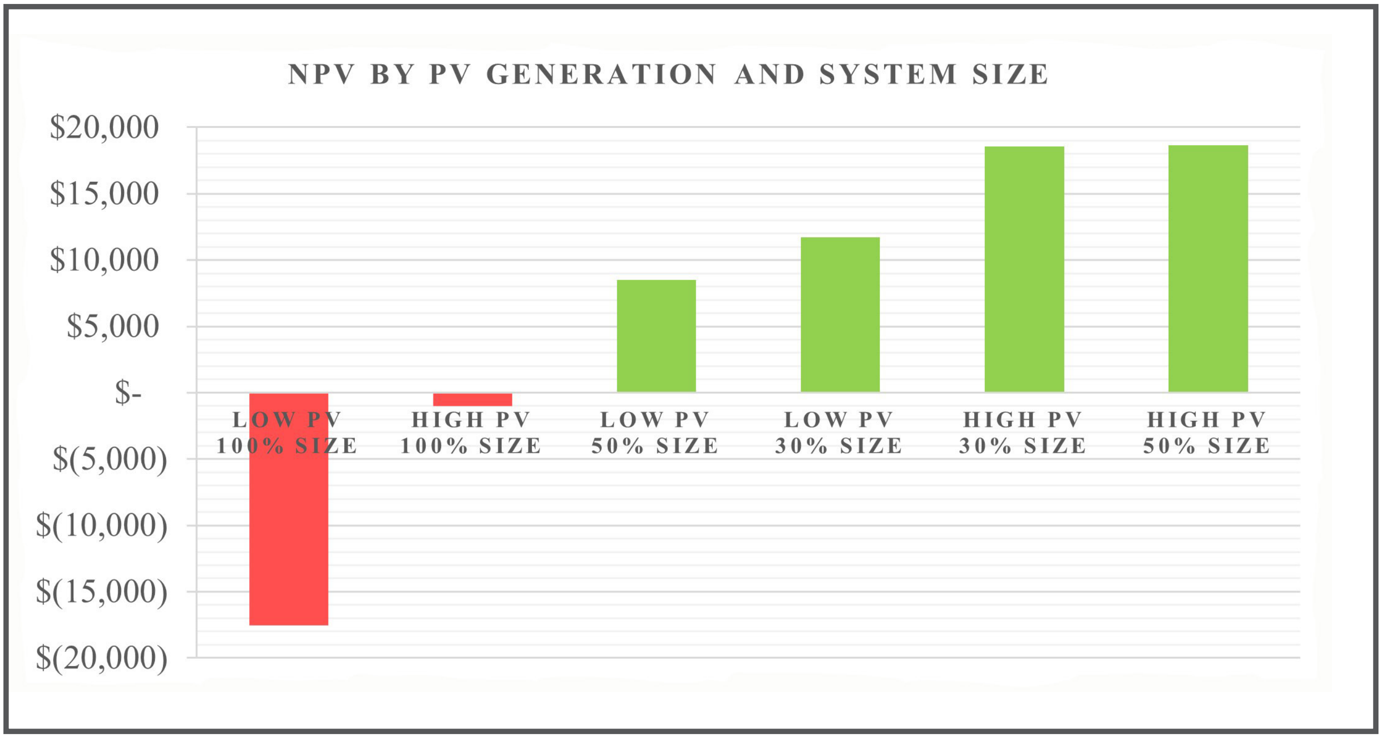

Figure 3. Effect of *SYSTEM-SIZE* and *PV-GENERATION* on NPV. *Note: SYSTEM-SIZE = {100%, 50% and 30%} PV-GENERATION = {High and Low} PV Availability.*

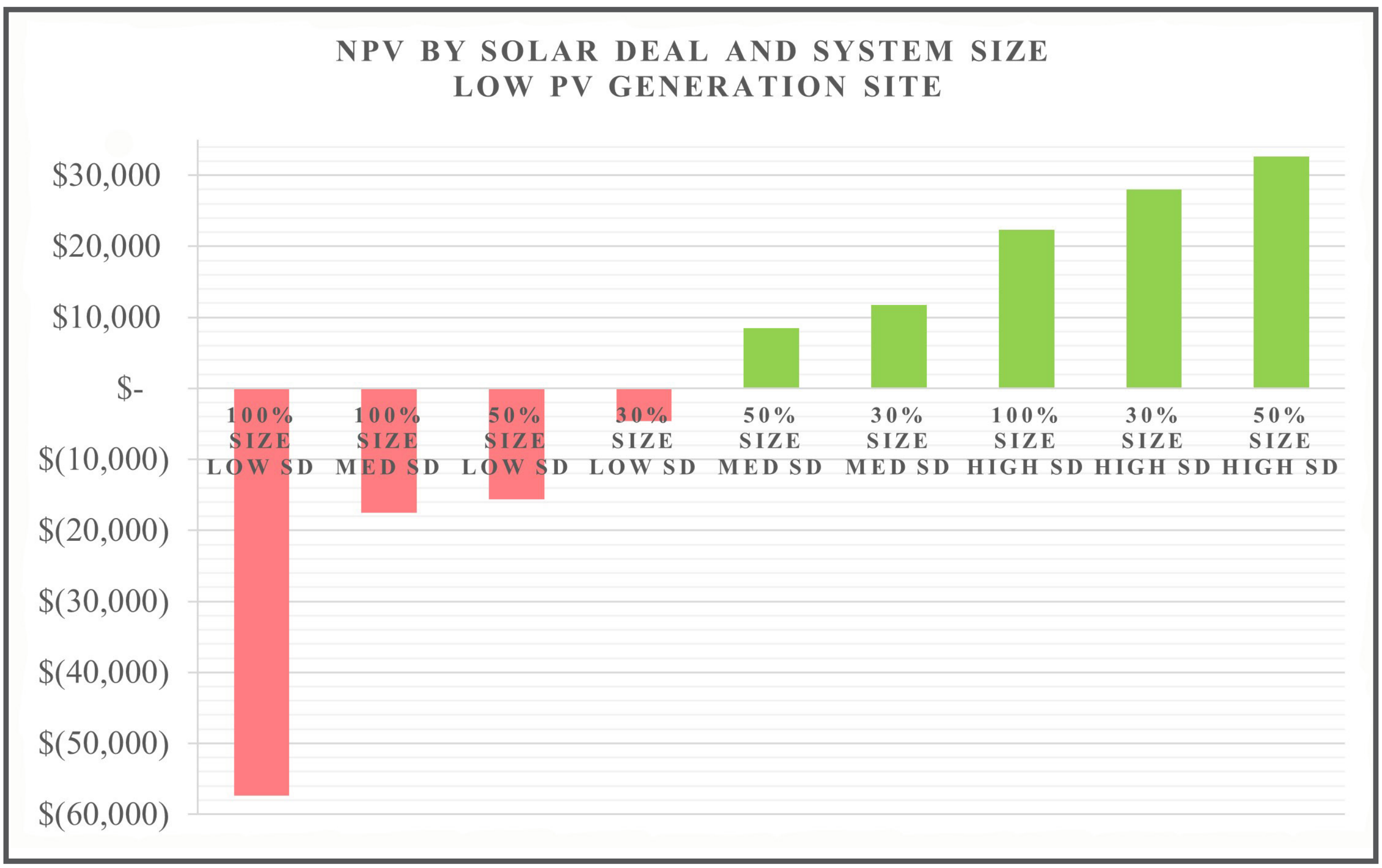

Figure 4A. Effect of *SYSTEM-SIZE* and *SOLAR-DEAL* on NPV for low *PV-GENERATION* site. *Note: SYSTEM-SIZE* = {100%, 50%, 30%} *SOLAR-DEAL*'s retail and avoided costs = {High SD = $0.13 and $0.039, Med SD = $0.11 and $0.033, Low SD = $0.09 and $0.0027}.

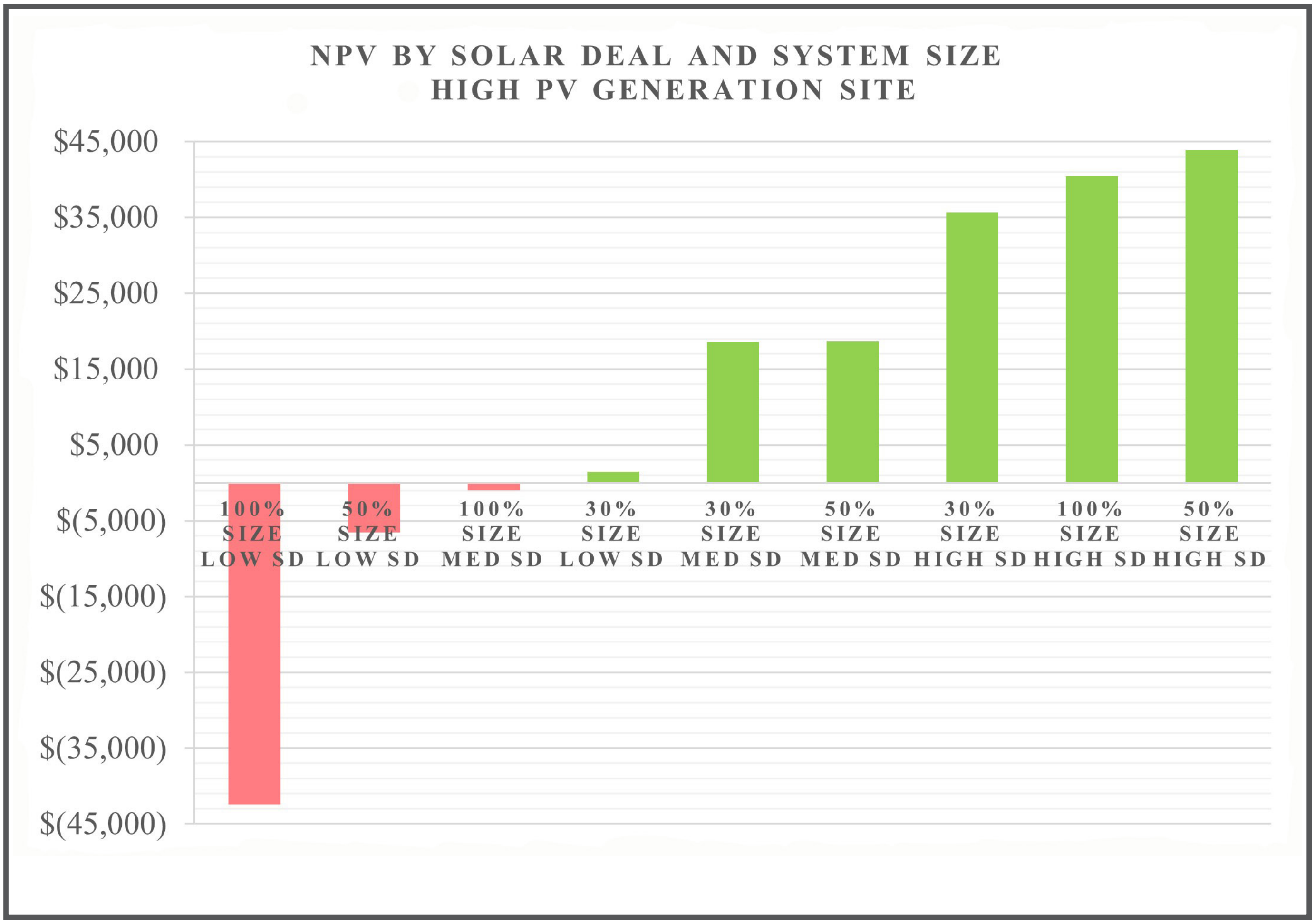

Figure 4B. Effect of *SYSTEM-SIZE* and *SOLAR-DEAL* on NPV for high *PV-GENERATION* site. *Note: SYSTEM-SIZE* = {100%, 50%, 30%} usage offset target, *SOLAR-DEAL*'s retail and avoided costs = {High SD = $0.13 and $0.039, Med SD = $0.11 and $0.033, Low SD = $0.09 and $0.0027}.

Table 1. Resulting NPV of Formerly Non-Profitable Models After Adding REAP Grant and REAP + FITC Incentives

System Model	NPV, No Incentive	NPV with REAP	NPV with REAP + FITC
Low PV, 100%, Med SD	($17,519)	$13,223	$63,812
Low PV, 100%, Low SD	($57,381)	($26,639)	$23,949
Low PV, 30%, Low SD	($4,577)	$5,718	$22,569
Low PV, 50%, Low SD	($15,591)	$674	$27,438
High PV, 100%, Med SD	($1,015)	$28,702	$77,604
High PV, 100%, Low SD	($42,443)	($12,726)	$36,176
High PV, 50%, Low SD	($6,531)	$34,382	$60,254