ANALYSIS OF INTEGRATING SOLAR POWER AT CAL POLY'S ON-CAMPUS DAIRY OPERATION

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ABSTRACT

This study was performed to determine the feasibility of integrating a full offset solar power unit at Cal Poly's dairy operation. The dairy is relatively small, with four hundred cows and only two hundred mature milking cows. The dairy's average annual electricity use is approximately 330,000-kilowatt hours. Based on the size and annual electricity demand, REC Solar, a local solar power company, was able to determine that a 216-kilowatt system would be necessary to meet the electricity demands.

In order to develop an accurate study, governmental grants, rebates and incentives were researched. These forms of aid would provide financial support to the dairy in order to offset some of the initial start up cost associated with installing the solar power unit. An inflation rate and discount rate were also estimated to maintain accuracy. After all figures were analyzed, a thirty-year projection of cash flows was conducted using a Microsoft Excel spreadsheet. The net present value and internal rate of return were calculated to determine the feasibility of integrating the solar power unit. A sensitivity analysis was conducted using different discount rates in order to determine how much the net present value and internal rate of return would be affected by the change.

It is concluded that the original hypothesis was partially incorrect. The initial analysis did not present a positive net present value over the thirty-year period. However, integrating a full offset solar unit at the dairy would be an economically feasible option based on the favorable internal rate of return and possibility of Cal Poly receiving a lower discount rate.

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Chapter 1

INTRODUCTION

The rapid depletion of natural resources and the rising cost of energy are becoming increasingly important issues in today's society. The world's oil reserves are being consumed at an exponential rate, and coal deposits are becoming exhausted. Burning of fossil fuels releases carbon dioxide and other omissions that are thought to be harmful to the environment and the ozone layer. Environmental concerns regarding the use of these resources are widely known.

In response to these rising concerns, many industries and households have moved to alternative forms of energy. Solar panels have become a highly sought after means for creating alternative energy production. Solar panels are able to absorb light from the sun and convert it to energy that can be used for electricity.

Agriculture is an extensive and extremely important industry that relies on many natural resources to continue supplying consumer demands. Tractors to till the land, trucks to transport commodities and machines used to run processing equipment all run on oil. However, many of the more industrialized agricultural operations have taken the step toward alternative energy use.

Cal Poly is one of the leading agriculture universities in the nation, with a state-of-the-art dairy. However, the dairy still has room for improvement by integrating solar power to meet the energy demands. This study will determine what type of solar energy unit would best fit the needs of the on-campus dairy operation, and if the use and integration of this solar power unit would be economically feasible. In the end, this project will serve as a reference for those considering the integration of solar power into the on-campus dairy operation. It may also serve as a source that current or future dairy farmers can review, when they are faced with the same decision.

Problem Statement

Is it economically feasible to integrate a solar power system into Cal Poly's dairy operation, based on the operation's specific energy needs?

Hypothesis

Based on the climate in California and the high amount of sunlight during the year, as well as the size of the dairy operation, solar energy will be an economically feasible alternative energy option.

Within thirty years of initial startup, the necessary solar power system will provide a positive net present value, indicating a favorable decision to accept the solar power decision.

Objectives

1) To assess the overall energy needs and demands of the Cal Poly dairy operation through industry contacts.

2) To assess which solar energy unit would best fit the dairy operation's needs and determine the overall cost of such system.

3) To determine the economic feasibility of integrating the solar unit into the dairy operation.

Significance of the Study

California has been the nation's leading dairy producing state since 1993, when California bypassed Wisconsin in total milk production. In 2008, California produced 41.2 billion pounds of milk and is projected to increase that amount to more than fifty billion pounds by the year 2020 (California Milk Advisory Board, 2009). The dairy industry in California is so large and prosperous that in 2007, 1,950 dairy farms generated 61.4 billion dollars in economic activity and provided 435,000 full time jobs (California Milk Advisory Board, 2009).

The results of this study will provide individual dairy farms in California's industry with a resource to make an educated decision on whether to integrate solar energy units within their operations. With so many dairy farms in California all competing against each other, it is important to find a way to produce at a minimal cost in order to keep up with, or stay ahead of, the competition and rising costs. The integration of alternative forms of energy may provide a worthwhile means of cutting back on production costs, which will, in turn, help generate a successful dairy operation.

Chapter2

REVIEW OF THE LITERATURE

California is the leading agricultural state in the nation and the dairy industry is the largest commodity produced in California. In 2007, the California dairy industry produced one- fifth of the nation's milk supply and one-fourth of the cheese (California Milk Advisory Board, 2009). This industry has a huge potential for integrating and leading the solar power movement.

Fossil fuels have been the staple for economic development and technological advances for hundreds of years. The Industrial Revolution set a benchmark in history due to the invention of various types of machines, such as the cotton gin and the steam engine. However, it was the discovery of natural resources that would be used as fuel that made this revolution possible. Two main sources of fossil fuels, coal and oil, proved to be the top forms of energy used (Baumol and Blackman, 2008).

Even today, coal and oil are used in abundance. The agriculture industry relies heavily on these natural resources for farming operations, economic growth, and industrial development. However, the rising costs for these fuels and the demands for alternative forms of energy have put increased pressure on the industry to integrate alternative forms of energy into their operations.

The demand for sustainable agriculture has led to research that analyzes the use and feasibility of alternative forms of energy in the agriculture setting. Sustainable agriculture operations can be viewed as an operation that fulfills a balance of goals over a period of time (Hansen, 1995). These goals generally express an enhancement or maintenance of the natural environment, provision of human needs, social welfare, and economic viability (Hansen, 1995). Agricultural use accounts for two-thirds of all water use worldwide (Horrigan, Lawrence and Walker, 2002). Unsustainable agriculture also accounts for many health problems because of the use of pesticides and is responsible for twenty percent of human generated greenhouse gas emissions. They conclude that the implementation of sustainable agriculture would solve many of these problems and would help agriculture prosper in an environmentally healthy way (Horrigan, Lawrence and Walker 2002). Integrating alternative forms of energy into agriculture appears to be an important factor in sustainability.

Geographical location is a key factor in determining which alternative form of energy is best to use for operations. Locations known for high amounts of rainfall throughout the year may not be best suited for solar energy due to extensive cloud cover. Places that experience a moderate climate and warm weather may be best suited to the use of solar energy. California is world renowned for high amounts of sunshine and a moderate climate, which makes it a great geographical location for solar energy use (California Solar Initiative- CSI, 2010.) The longitude and latitude of a specific location are ideal in determining the effectiveness of a solar power system due to varying angles of direct sunlight. Hoang and Hung (1998) analyzed the most efficient combinations of solar panels and borehole pumps for a well pump system in San Luis Obispo. This analytical research found that the highest flow rates occur at noon and the highest efficiency occurs in the late morning. It was also determined that more solar panels increased the flow rates of the well pump (Hoang and Hung, 1998). Shaffer (2005) also conducted a similar study, which involved an assessment of solar photovoltaic cells and windmills to power a well pump in Perfumo Canyon near the San Luis Obispo area. Her results determined given varying weather patterns, both systems would be suitable alternative energy options, but if only one were possible, a photovoltaic cell would be sufficient (Shaffer, 2005). Although there is a large push for sustainability in the United States, it is certainly not limited to just this region.

Industries all over the world are working on ways to develop sustainable agriculture. A feasibility study in Egypt was performed in order to determine if hybrid power systems were economically viable to sustain desert agriculture production in order to increase the country's total food production. Solar photovoltaic cells as well as windmill systems were analyzed to determine which would be the best viable option to produce enough electricity to sustain the operation. Information on weather patterns for the region as well as the efficiency rate for each alternative energy source was calculated. It was determined that a diesel fuel and wind combination would be the most economically viable option based on the geographical location and low operating cost (Dahl and Kamel 2005). This study determines that not all geographical locations are best suited for solar energy.

Elhadidy (2002) performed an evaluation that involved determining the effectiveness of wind, solar, and diesel power systems in the city of Dhahran, Saudi Arabia. Based on calculating weather factors for the region such as amount of sunlight, wind speed and wind direction, the results determined that a wind farm would be the most feasible option to supply the area with the needed energy to support demands (Elhadidy, 2002).

Scientific approaches to determining the feasibility of sustainability in certain locations can also be conducted. Bastianoni et. al (2000) conducted a sustainability assessment of a farm in Italy by using an approach that only considered the farm's geographical location. This approach is named the "Emergy Analysis," which is an evaluation system based on science that is able to represent both the economic values as well as the environmental values of an area with a common measurement. This measurement uses a series of calculations involving solar energy to find an object's net worth in joules. After comparing all the aspects of the farm by their worth based on the "Emergy Analysis," it was concluded that the specific farm was more sustainable than others in the area (Bastianoni et. al, 2000). However, determining if solar energy is a viable option is not solely based on geographical location, but also the specific needs and uses the operation demands.

All agriculture operations, especially in the dairy industry, rely heavily on the use of water in order to provide nourishment for the livestock and maintain processing operations. In many instances, pumps are used in order to pump the necessary amount of water needed for production. Ervin and Polk (1996) conducted an analysis of wind powered and solar powered water pumps to determine which option would be best suited for powering a water pump located in the rangelands of the mid-west United States. Based on the start up and maintenance costs of each system, it was concluded that the costs were roughly the same and producers must choose the system that best suits their particular needs as a producer as well as geographic location (Ervin and Polk 1996).

The Mid-West was also the location of another study, which calculated the economic feasibility of a "Solar Energy Intensifier." This particular device, used in the study, is a portable system that has dual-sided collector modules and a parabolic reflector module. Sunlight gathered by the reflector modules is sent to a collector module that gathers and stores the energy. The study is based on two operations in the eastern South Dakota regions, where grain drying and livestock ventilation air and water heating take place. The specific energy requirements, along with weather patterns and conditions, were analyzed to determine the feasibility of the Solar Energy Intensifier. The benefits and output of the device were also analyzed in order to compare them to the farming operation's energy demands. The study concluded that the device would be feasible under some farming operations, but low energy cost savings and the high rate of return and payback periods may not be attractive enough to put the device into commercial production (Christianson, Dobbs and Zweden 1985).

Bartlett (2008) came to similar conclusions with her study of an analysis of the feasibility of solar, wind and hydroelectric power in ranching operations. After an interview with the ranch manager and an analysis of each energy source, it was determined that solar energy would be the better choice based on the geographical placement of the ranch and the particular economic situation of the ranch; however, after further analysis, it was concluded that the monthly savings generated by the use of the solar energy would not be enough to justify the high start up cost of the initial investment (Bartlett 2008). Although many studies have expressed the large start up cost and long-term break-even concern, initiatives and rebates are now being offered to business and households that decide to convert to solar power.

Currently, in the state of California, tax credits, rebates, and incentives are being offered to those moving toward solar power. The California Solar Initiative (CSI) is one example of a subsidy program that is offered. This initiative is part of the Go Solar California campaign and offers rebates to customers in California's utility territories such as Southern California Edison (SCE), Pacific Gas & Electric (PG&E), and San Diego Gas & Electric (SDG&E) (California Solar Initiative, 2010). These rebates aid producers because they are able to offset some of the initial start-up costs. Incentives like the CSI could prove to be beneficial for producers that are trying to move toward sustainable agriculture by integrating solar power into business operations.

Chapter 3

METHODOLOGY

Procedures for Data Collection

The first objective of this study was to assess the overall energy needs of Cal Poly's dairy operation. In order to acquire the necessary data, a formal interview with the dairy manager, Rich Silacci, was conducted because he oversees the entire dairy operation. Important data such as the types of mechanical systems used, length of daily operation, and amount of fuel and electricity used in a monthly period were beneficial in the analysis. By analyzing the dairy's accounting records, average monthly revenue, total monthly electricity use, and total monthly production were gathered in order to provide the necessary data.

In order to fulfill the second objective of assessing which solar energy unit would best fit the dairy operations needs and determining the overall cost of such as system, a formal interview with an appraisal manager at REC Solar took place. REC Solar is a leading manufacturer and installer of solar energy systems for both household and large-scale operations. They have a location in San Luis Obispo, as well as up and down the state of California and even in other states such as Colorado and Arizona. By providing the data collected from the dairy operation, it was possible for the appraisal manager to determine the size and type of solar unit necessary to cover the dairy's energy costs. The appraisal manager also provided the costs of such a system, from the initial start-up cost including the actual system as well as installation, to the efficiency rates of the system.

Information regarding rebates and subsidies for moving to solar power were gathered through California's Go Solar website and through the United States Department of Energy Solar Energy Technologies Program website. The United States Department of Agriculture also has a renewable energy program called Renewable Energy for America, which provides incentives for the implementation of technologies such as solar, into agriculture related practices. These sources provided the data needed for analyzing both state and federal solar power initiatives, which will help off set some of the initial cost of purchasing a solar unit.

Procedures for Data Analysis

The information gathered from Rich Silacci, REC Solar and the different government rebates, grants and incentives were compiled into a Microsoft Excel spreadsheet. Analyzing information for the next thirty years gave a detailed description of cash flows in the future. A time period of thirty years was chosen in order to accurately display price changes over an extended period of time. Excel was a means of organizing this data into an orderly and easy to read format by using the rows as years of operation and columns for cash flows, such as the different governmental aid and the dollar amount saved from an avoided utility bill.

In order to determine the feasibility of integrating the solar power into the dairy operations, a net present value (NPV) and an internal rate of return (IRR) analysis were determined. To calculate these figures, inflation and a discount rate were taken into consideration to ensure accurate results. A positive NPV would indicate a favorable decision to implement the solar power and prove the hypothesis to be true. A negative NPV would indicate an unfavorable decision and, therefore, cause the hypothesis to be false.

Assumptions

This study assumes that the efficiency of the solar power system remains constant and is just as efficient later in its operating life as it is at the beginning. This study also assumes that the dairy farm's costs of operation, as well as revenue, remain roughly constant and are free from sudden positive or negative fluctuations. The inflation rate and discount rate used are also assumed to stay constant and avoid fluctuation.

Limitations

The results of this study will prove to be beneficial for all potential solar powered dairy operations, however, it will be most ideal for those operations located around the

Central Coast area of California due to similar weather and geography. It would not be meaningful to directly compare this study to an operation in a different location due to the change in environmental conditions, such as the amount of sunlight, as well as the change in solar power system costs.

Chapter 4

DEVELOPMENT OF THE STUDY

System Specifications

The first step in determining the size and type of solar unit that would best fit the dairy's needs was to gather as much vital information about energy usage at the dairy as possible. In order to gather such information, a phone interview with dairy herd manager Rich Silacci was conducted. Although Silacci was unable to provide any energy demand figures, a scope of the dairy operation was given, which is ideal for putting the size of the study into perspective.

Cal Poly's dairy consists of a herd of four hundred cows. Two hundred are mature, lactating cows, and the other two hundred are not yet to maturity. The mature cows are milked twice a day and produce roughly 1,400 gallons of milk a day. This dairy is considered a small to medium sized operation (Silacci, 2010).

In order to gather the dairy's energy demand, an interview with Mark Menard was conducted. Menard is Cal Poly's Energy Projects Manager and oversees all of the building's energy demands and usage on campus. A Microsoft Excel file was provided, which had the records of the dairy unit's energy usage in kilowatt-hours for every fifteen minutes for the past four years. With this information, the kilowatt-hour demand on a monthly and annual basis was calculated.

An interview with Seth Pearson determined which solar panel system would be best suited for the dairy operation. Seth Pearson is a Solar Information Specialist for REC Solar, which is a commercial solar panel system installation company with the headquarters located in San Luis Obispo, California. Based on the dairy's monthly and annual energy demand, a system of 216,000 watts, or 216 kilowatts, was suggested by Pearson in order to fully offset all demand. This system would consist of roughly 980, 220-watt panels and would require roughly 2,000 square feet of roof space (Pearson, 2010). The only maintenance required would be to keep the panels clean from debris and a ten-year full coverage warranty is included in the initial cost. The total cost of the system, as quoted by Pearson, would be $1,026,000. In order to determine if such a system would be feasible, it was essential to research any ways to offset some of the cost through outside means.

Grants, Rebates, Incentives

In order to determine the true cost of such a solar power system, further research had to be conducted on the various grant, incentive and rebate programs offered by both federal and state entities. These programs are designed to help alleviate some of the cost incurred of purchasing a solar powered unit and to make the switch to solar power more appealing to the consumer. The California Solar Initiative (CSI), Federal Tax Credits, Rural Energy for America Program and Renewable Energy Credits were the main programs researched. Although, due to the fact that the Cal Poly dairy is a non-profit, non-tax-paying entity, only the California Solar Initiative and Renewable Energy Credits apply. The other two programs are important policies to encourage private solar development, however.

California Solar Initiative

The California Solar Initiative (CSI) is part of the Go Solar California campaign and offers rebates to customers in the investor-owned utility areas, known as San Diego Gas & Electric, Pacific Gas & Electric, and Southern California Edison. The CSI was launched in January of 2007. Incentive levels are based on performance factors such as installation angle, tilt, and location (CSI Program Background, 2010). Current and existing homes, commercial businesses, agriculture properties, government operations and non-profit practices are all available to receive an incentive from the California Solar Initiative program.

The CSI currently has a $2.167 billion budget, which is to be distributed by 2016. The budget is divided into four categories, with the most funding going to the General Market Program. This program provides direct incentives to consumers for photovoltaic and non-photovoltaic systems, which is what the Cal Poly dairy falls under. The other three categories are Low-Income Programs, Research, Development, Deployment and Demonstration and San Diego Solar Water Heating Pilot Program. The goal of this budget is to reach the goal of creating 3,000 megawatts of new, solar-produced electricity by 2017 (CSI Program Background, 2010).

The CSI provides incentives based on the size of solar systems. Expected Performance-Based Buy-Down (EPBB) is designed for solar photovoltaic systems under 30 kilowatts, which is applicable to homeowners and small businesses. This category pays a one time up-front incentive that is based on installation factors (geography, tilt and shading), equipment ratings and expected performance. These payments are on a per watt basis. The other category is the Performance Based Incentive (PBI), which is for any system over 30 kilowatts. This program is based on actual kilowatt production and pays incentives once a month for five years on a dollar per kilowatt-hour basis. Both the EPBB and PBI are divided into ten payment ranges on a scale of one to ten. These ranges, also known as steps, are based on the volume of solar megawatts confirmed within each utility service company. The higher the step, the lower the incentive payoff is. The program is currently at step six, with a quoted photovoltaic system of over 30 kilowatts; therefore, an amount of $0.26 per kilowatt-hour would be received under the Performance Based Incentive program of the California Solar Initiative.

Federal Tax Credits

Although Cal Poly's dairy operation is unable to receive federal tax credits, it is still important to mention such means of price alleviation. Federal tax credits are generally more useful than a tax deduction because a tax credit reduces tax dollar-for-dollar, while a deduction is based on a percentage of the tax owed (Consumer Energy Tax Incentives, 2010). The availability of these tax incentives is due to the American Recovery and Reinvestment Act of 2009, which extended the life of many consumer tax incentives.

The Business Energy Investment Tax Credit is for any business with renewable energy use such as solar, wind, biomass, etc. This credit is 30% for solar, with no maximum level set. Eligible solar powered property includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a structure, or to provide solar process heat (Database of State Incentives for Renewables & Efficiency, 2010).

The Residential Renewable Energy Tax Credit is offered to residences that have solar-electric production. This is also a 30% tax credit and there is no maximum. The system must be larger than .5 kilowatts in order to be eligible for the credit. Excess credit may even be moved to the following year so that credits are not lost.

Rural Energy for America Program

The Rural Energy for America Program, or REAP, started in 2003 and is the basis of the Farm Bill's Energy Title under the United States Department of Agriculture. Since its beginning, REAP has helped thousands of small rural business owners, farmers and ranchers gain clean sources of energy while reducing energy waste. Like its predecessor, the Renewable Energy Systems and Energy Efficiency Improvements Program, REAP helps these business owners through the use of loan guarantees and grants for renewable energy systems, energy efficient upgrades and even energy audits. Congress has allocated $60 million for the fiscal year 2010 and $70 million for the two subsequent years thereafter, in order for REAP to fulfill its objective (Environmental Law and Policy Center, 2010).

Grants are awarded on a competitive basis and can be up to 25% of total eligible project costs. Grants are limited to $500,000 for renewable energy systems and $250,000 for energy efficiency improvements (REAP, 2010). Farmers, ranchers and rural business owners that gain over 50% of income through agriculture means and demonstrate financial need, are eligible to receive REAP grants. However, there is a high demand for these grants and an application must be submitted. If Cal Poly dairy had been able to receive a REAP grant, a grant for $256,500 may have been obtained, which is 25% of the total solar photovoltaic system investment.

Renewable Energy Credits

Renewable Energy Credits (REC) are certificates that represent the rights to renewable energy generation and may be bought and sold separately from actual energy purchases. For every kilowatt-hour of electricity a renewable generator generates, it also generates a one-kilowatt hour renewable energy credit. The generator can sell both commodities together as renewable electricity or sell the electricity as generic electricity to one buyer and the RECs to other buyers (Frequently Asked Questions- Renewable

Energy Credits, 2010). Essentially, RECs are a legal right to claim that the electricity being used is renewable and to claim the environmental benefits it produces.

Carbon footprints are highly noted problem with the issue of global warming. Carbon footprints is a term used for the amount of CO_2 that is expelled into the atmosphere due to the burning of fossil fuels and other non-renewable means of energy production. However, if a business were to purchase an equal amount of RECs to that of the amount purchased from an energy provider, that business is able to classify itself as a renewable-powered company because the amount of energy associated with the RECs offsets that of the energy purchased from the supplier.

There are many companies all over that United States that purchase these Renewable Energy Credits from entities that run off of full renewable energy. MMA Renewable Ventures is a California-based company that presents the best price for RECs in the state at $0.033 per kilowatt (Renewable Energy Certificates (RECs), 2010). The Cal Poly dairy could sell RECs at this price, which would help reduce the impact of the initial cost.

Net Metering

Net metering does not classify as a grant, rebate or incentive; however, it is a practice that can play a large role in adoption of renewable energy systems. Net metering is a way of "selling" or banking energy back to the utility company. When a solar photovoltaic system, windmill, or other energy-producing device produces more electricity than what is consumed, the utility meter will spin backwards, which banks electricity for the customer until the time when it is needed. This offset means that customers receive full retail prices for the excess electricity they generate (Net Metering Policies, 2010). Net metering would be a very helpful means of saving on electricity costs for consumers with renewable energy systems. The solar photovoltaic system for this study is capable of fully offsetting all electricity demand; therefore, all the electricity that would have been used will be banked back to the utility company. In turn, the utility company will pay full retail value of $0.11 per kilowatt-hour for this electricity.

Analysis of Investment

To determine the feasibility of integrating the solar photovoltaic system into the dairy operation, a net present value and internal rate of return analysis for the next thirty years was conducted. In order to organize and visually represent this analysis, a Microsoft Excel spreadsheet was used. Rows were designated for the number of years in the study, and columns were used for different cash flows. The Performance Based Incentive, Renewable Energy Credits, and avoided utility bill were the main three means of determining if such a system would be worth purchasing.

Due to the fact that the study projected thirty years of data, an inflation rate had to be applied. The United States Department of Energy provides projected per annum inflation rates for both low and high economic times. In order to calculate the inflation rate for this study, an average of the two was taken, which provided an annual inflation rate of 2.21%.

To determine the average annual electricity savings, the amount of kilowatt-hours used for the past year was calculated. This figure was then multiplied by $0.11, which is the cost per kilowatt-hour of electricity paid by Cal Poly, to determine the total amount of savings that would incur if the solar powered system were to be integrated. These savings were discounted and inflation was applied in order to determine the projected value of savings into the future.

Determining a discount rate is often hard to do. There are many speculations and ideas about correct discount rates and often times they fluctuate. Enormous uncertainty and controversy exists about choosing an appropriate rate of return for discounting distant-future events (Gollier et. al, 2010). The discount rate relies heavily on other rates such as the inflation rate and risk rates, which are also constantly fluctuating, making it increasingly difficult to determine a set figure. Due to such uncertainty, a rate of 8% was chosen for this study based on an energy lender price survey by Macquarie Tristone (Energy Lender Price Survey Q4 2009, 2009).

After all values were determined, they were input into the Excel spreadsheet in order to determine the net present value and internal rate of return. Once applied, the net present value came out to be ($1,457,390) with an internal rate of return at 5.55%. However, twenty years of positive cash flow resulted from this analysis. It is also important to note that a return of 5.55% is relatively favorable considering the high discount rate.

Cal Poly is a public entity and therefore, is not held to the same loan and business standards as a private entity. It is actually possible for Cal Poly to receive a lower discount rate than the one used in the initial analysis. A sensitivity analysis was conducted using a 6% and 3% discount rate to see how much of an impact the rate had on the net present value and internal rate of return. After applying a 6% discount rate, the net present value came out to be ($475,257) with a 5.37% internal rate of return. A discount rate of 3% produced a net present value of $2,314,618 with an internal rate of return of 5.08%. It is determined that a discount rate below the internal rate of return yields a positive net present value because the return on investment exceeds that of the loan interest set by the discount rate. Positive cash flows are exceeding negative cash flows, which results in positive overall value. Although the internal rate of return dropped with the decreased discount rate, it still remained at a favorable level.

The results of this analysis conclude that the original hypothesis was partially incorrect. The net present value over a thirty-year period, using an 8% discount rate, was not positive. However, a 5.55% internal rate of return was determined, which is favorable. The sensitivity analysis also revealed that if Cal Poly could receive a lower discount rate, an increased net present value would result, while maintaining a relatively good internal rate of return. Due to the favorable internal rate of return and the possibility of Cal Poly receiving a lower discount rate, integrating the solar unit would be economically feasible. The following three pages display the analysis spreadsheets for 8%, 6% and 3% discount rates.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Rising energy costs and concern for the environment are becoming increasingly dominant in today's society. Due to these instances, the demand for renewable energy options is widely prevalent. The agriculture industry is heavily dependent on energy to maintain production so that consumer demand is filled. The agriculture industry would be at a large advantage to implement a renewable energy system, such as a solar photovoltaic system, into production operations. Many federal grants and incentives are available to those who adopt such a system.

The purpose of this study was to determine if implementing a full offset solar photovoltaic power system into Cal Poly's dairy operation would be economically feasible. Dairy herd manager, Rich Silacci, provided information about the dairy operation and size, and Mark Menard, the Energy Projects Manager at Cal Poly, provided the dairy's electricity demand in kilowatt-hours for the past four years. Once the average annual electricity demand was calculated, Seth Pearson of REC Solar determined the appropriate solar system that would fulfill the dairy's energy demands.

In order to determine if such a system would be feasible, federal and state rebates, grants and incentives had to be researched. These solar incentives, grants and rebates would help offset some of the initial cost of implementing the system. Renewable Energy Credits (REC) were also researched, due to the fact that the photovoltaic system would be full-offset, allowing the option of selling REC's. After all aid and costs were determined, the information was implemented into a Microsoft Excel spreadsheet to analyze the investment for a projection of thirty years.

Conclusions

A complete thirty-year projected analysis has proved the original hypothesis to be partially incorrect. Integrating a solar photovoltaic system at the dairy with an 8% discount rate would not result in a positive net present value over a thirty-year period. However, it is important to mention that a 5.55% internal rate of return was determined and positive cash flows resulted ten years after initial installment.

The initial analysis revealed a net present value of ($1,457,390). However, these figures were determined using a relatively high discount rate that exceeded the internal rate of return. It is possible that Cal Poly could receive a lower discount rate because it is a public entity and is not held to the same business and loan standards as that of a private operation. Due to this possibility, a sensitivity analysis was conducted using a 6% and 3% discount rate. A 6% discount rate revealed a decreased negative net present value, where as a 3% discount rate produced a net present value of $2,314,618. Both discount rates maintained a favorable internal rate of return slightly higher than 5%. Therefore, due to the possibility of Cal Poly receiving a lower discount rate and the favorable internal rate of return, integrating a solar power unit proves to be an economically feasible option.

Recommendations

It is recommended that Cal Poly invest in a solar photovoltaic unit for the on-campus dairy, due to the favorable internal rate of return and possibility of receiving a low discount rate.

An avenue of possible further study is to analyze the feasibility of a partial offset system and determine if the results are comparative to this study.

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