COST-BENEFIT ANALYSIS OF

INSTALLING SOLAR PANELS ON THE SCHNOOR ALMOND RANCH

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ABSTRACT

This study was undertaken to determine if it would be cost-beneficial over a 30-year period to install solar panels to power the water pumps on the Schnoor almond ranch.

A cost-benefit analysis was performed to determine if the investment would be financially worthwhile. The analysis included calculating the net present values of the annual cash flows along with the calculation of the internal rate of return. If the net present value proves greater than zero and the internal rate of return proves greater than the discount rate, the investment will be cost-beneficial. State and federal rebates and incentives were also analyzed and factored into the annual cash flows as positive amounts, helping offset the initial cost of the solar panels.

Over a 30-year period, the financial benefits of installing solar panels on the almond ranch proved to outweigh the financial costs. This conclusion is based on the cost-benefit analysis that provides a net present value of over $360,000, an internal rate of return of 11.9%, as well as an investment resulting in positive cash flows after 11 years.

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CHAPTER 1

INTRODUCTION

Electricity has been around for centuries, evolving and changing more and more each day. Without electricity the world would be a very different place. The public relies on electricity to be readily available and to perform basic functions. Electricity use has increased every year since 1949 except for 1974 and 1992 (Berinstein, 2001). Not only has electricity usage been rapidly increasing, energy prices are rising and energy availability is diminishing (Foster *et al.*, 2010). With this continual growth in electricity use as well as an increasing price, new methods of producing electricity are constantly being developed. The turn to alternative energies to produce electricity dates all the way back to the 18th century but has gained momentum recently. Alternative or renewable energy comes from sources that replenish themselves, such as the sun, rivers, wind, and ocean waves and tides (Berinstein, 2001).

Solar powered systems are becoming more prevalent. Solar energy is one of the most important renewable energy sources that has been gaining increased attention in recent years (Khaligh *et al.*, 2010). Solar panels absorb the sunlight to create electricity. The government has decided to aid consumers choosing to invest in solar in hopes of supporting the "green" or sustainability movement. Solar energy is clean and free of emissions, which is great for the environment, as it does not produce pollutants or by-products harmful to nature (Khaligh *et al.*, 2010).

Agriculture is an industry that relies on natural resources to meet consumer demands. In order to meet these demands, a farm or ranch needs those natural resources unharmed and in abundance. Investing in solar energy will help improve air quality and slow the depletion of natural resources. Recognizing this reality, progressive agricultural operations have begun the switch to solar. A few almond ranches in California's Central Valley have seen the potential in solar and have opted to invest in solar powered systems.

The Schnoor almond ranch is doing well financially and producing great yields annually, but has yet to embrace the solar trend. This study will determine if it will be cost-beneficial for the ranch to install solar panels, thus becoming more sustainable. The type of panels needed to power the water pumps will be determined along with the incentives earned by the ranch for applying solar. It will prove as an analysis not only for the Schnoor ranch's potential investment, but any other farm or ranch in California considering the integration of solar energy.

Problem Statement

Will adding solar panels to power the electricity on the Schnoor almond ranch prove to be cost-beneficial?

Hypothesis

By adding solar panels to power the water pumps on the ranch, it will prove to be cost-beneficial over a certain amount of time because of incentives and elimination of monthly electricity costs through the use of a renewable energy source system.

Objectives

1) Determine the current cost of electricity for the almond ranch for one year.
2) Determine the number and size of solar panels that will best fit the needs of the water pumps on the almond ranch and the costs of installation and maintenance associated with such panels.
3) Determine incentives and rebates that will offset installation costs after installing solar panels.
4) Perform a cost-benefit analysis to organize the data into a table.
5) Determine the net benefit or detriment, the net present value and the internal rate of return for the new solar panels.

Significance of the Study

Almonds are the number one tree nut crop in California. California produces about 80 percent of the world's almonds and virtually 100 percent of the domestic supply. During the 2008–2009 crop year, approximately 6,000 growers located throughout the Central Valley of California produced 1.615 billion pounds of almonds on 680,000 bearing acres (Almond Board of California, 2010). Along with the sizeable acreage of almonds needing to be watered, the price of electricity in California has been on the rise, going from an average of 15.11 cents per kWh in 2009 to 15.30 cents per kWh in 2010. In order to cut back on electricity costs, solar energy can be implemented.

The results of this study will provide almond ranches in California with a resource to make an educated decision on whether to integrate solar energy systems on their ranches. With California producing an extensive amount of almonds, it is important to find a way to minimize costs. The integration of solar energy will cut down on electricity costs, which are a part of total production costs therefore proving to be a worthwhile investment.

CHAPTER 2

REVIEW OF THE LITERATURE

Global Warming & Environmental Factors

Modern agriculture was founded on fossil fuels such as coal, oil and gas. Over the next century, the world will gradually begin to shift from burning fuels that are harmful to the environment to technologies that harness clean energy sources such as sun and wind. As the full effect and impact of environmental externalities such as global warming become apparent, society will demand cleaner energy technologies (Foster *et al.,* 2010). People are becoming more aware of global warming, carbon dioxide emissions, air pollution and other things degrading the environment. Resource-intensive agricultural practices are considered unsustainable for two reasons: much of the consumption is of nonrenewable resources, in particular, fossil fuels; and consumption of some renewable resources is occurring faster than the rate of regeneration (Horrigan *et al*., 2002). Since agriculture consumes a large amount of nonrenewable resources, specifically gas and petroleum, it would be beneficial to switch over to solar and reduce the amount used. Sun, unlike fossil fuels, will be around indefinitely thus making it economically viable.

If the current emission conditions continue, scholars and others have said that global warming will become much more prominent in the world and the climate will begin to change. Climate change will affect all economic sectors to some degree, but especially the agricultural sector (Xiong *et al*., 2007). Xiong et al (2007) completed a study mapping the crop yields across the country of China and their change due to climate change. They came to the conclusion that this decrease in temperature was attributed in large part to the acceleration in maturation due to temperature increase and a decrease in water availability, which will happen as global warming continues. Although this study was conducted in China, it relays a basic concern that will exist worldwide. Agriculture will be affected by the climate change that will occur because of global warming. It is clear that climate change would have an impact on China's food production (Xiong *et al*., 2007). If agriculture is negatively impacted throughout the world, it will hurt the economies of major agriculture producing countries, such as the United States and China.

Solar Energy

With issues of global warming looming over everyone's head, the world has begun to turn to alternative energies. Whether the energy is used to power the electricity at a family's home or to power pumps used to water almond orchards, renewable energy is becoming much more popular; one method of which is solar. Solar energy collection methods date all the way back to 1767, when Horace de Saussure, a Swiss scientist, built the world's first solar collector (Berinstein, 2001). From there the industry has grown and developed into something that is not uncommonly seen in today's society. Renewable energy, which had been technologically immature and financially expensive, became a serious force on the U.S. scene following the international oil embargo of 1973 (Berinstein, 2001). Solar energy bombarded the United States as a whole, but more specifically it started showing up in agricultural operations.

Solar energy is seen on ranches and farms as a way of powering water pumps either by supplying water to animals or to crops. Ervin and Polk (1996) did some analysis work on this subject and produced a report outlining the cost-effectiveness of both solar and wind powered watering systems. All issues surrounding the water systems, including life expectancy and initial costs, were taken into account when analyzing which was more cost-effective. It was ultimately concluded that the costs were very similar and that the decision was up to the producer, depending on where they felt the discount rate would go and also taking weather into consideration (Ervin and Polk, 1996).

There are a lot of factors that go into the decision of which solar panels to install and if solar is even the best option. One major factor is the sun. Considering the sun is what combines with the PV panels to produce the energy, an area rich in sunlight is highly desirable (Glasnovic and Margeta, 2009). Glasnovic and Margeta (2009) performed an analysis of photovoltaic pumps versus diesel pumps in the Croatia area, which is climatically different than the Central Valley, but concluded that photovoltaic pumps were more efficient than diesel pumps, even with the hotter climate. Issues other than the sun were also taken into account when doing the analysis, such as what kind of crop is being watered, how large the crop is, and the soil type (Glasnovic and Margeta, 2009). Although solar pumps are not the main focus, this study highlights the fact that solar power has already been proven to be more efficient in certain circumstances.

Although solar is more efficient, it is costly. According to Borenstein (2008), the high cost of power from solar panels has been a major deterrent to the technology's market penetration. The current direct cost of solar PV power is widely acknowledged to be much greater than fossil fuel generation or many other renewable energy sources. The initial cost of the solar panels may be expensive, but it is the only cost. After they are installed, there are no more electricity bills because the sun provides the power. Maintenance can be perceived as an added cost, but in reality all the panels need is dusting and/or washing.

Switching to solar can result in a multitude of benefits as well, two of the most important being money-saving and the decrease in environmental burdens (Diakoulaki et al., 2001). By using solar panels, it will cut electricity costs from outside sources completely because the sun combining with the PV panels to generate electricity will now power the pumps. This will lead to a major savings in electricity. Also, when converting to solar, emissions released into the environment decrease significantly depending on what was used prior to installation. The emissions taken into consideration are primarily conventional pollutants, i.e. sulfur dioxide, nitrogen oxides and suspended particulates. The most important effects of air pollutants on the human and natural environment are: the impact on public health, the impact on agriculture, the impact on buildings and historical monuments, and the impact on forests and ecosystems (Diakoulaki et al., 2001). These factors can affect the decision to switch to solar along with other benefits such as incentives and rebates.

Incentives & Rebates

One contributing factor to the beginning boom in solar were the federal tax incentives that started in the 1980s. These incentives gave people more reason to switch to renewable energies. From then on, the solar energy consumption steadily rose and continues to rise even today (Berinstein, 2001). Federal tax incentives for the use of solar began with the Energy Tax Act of 1978, which established a 15 percent tax credit for solar energy. Then in 2005, the Energy Policy Act was created, which established a new commercial and residential Investment Tax Credit (ITC) for fuel cells and solar energy systems that would apply through December 31, 2007. An 8-year extension was passed after that, so the ITC is now effective through December 31, 2016 (Solar Energy Industries Association, 2010). According to the California Solar Energy

Industries Association, for business solar energy systems the federal tax credit is 30 percent of the cost and is also eligible for accelerated depreciation based on a 5-year life (IRS, 2010).

Aside from federal tax incentives, there are also rebates given out that are specific to California. An example of one of the programs that provides rebates to those who use solar is The California Solar Initiative (CSI). This program is a key component of the Go Solar California campaign. It benefits consumers that are customers of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). The CSI general market program funds solar used on existing homes, existing or new commercial, agricultural, government and non-profit buildings (California Solar Initiative, 2010). The CSI Program pays solar consumers an incentive based on system performance. The incentives are either an upfront lump-sum payment based on expected performance, or a monthly payment based on actual performance over five years. The Performance Based Incentive (PBI) is paid on a fixed dollar per kilowatt-hour ($/kWh) of generation basis and is the required incentive type for systems greater than 30 kW in size, which is what would be needed to power water pumps on a farm or ranch. The rebates automatically decline in "steps" based on the volume of solar megawatts with confirmed project reservations within each utility service territory. Steps range from 1 to 10 and are based on the amount of MW of electricity that is produced in your area. PG&E, which provides the electricity to the Chowchilla area, is at step 8. This means that they will provide PBI payments at $0.05 per kWh (California Solar Initiative, 2010). Also, the government provides grants to farmers and ranchers, which can be found through the United States Department of Agriculture. The USDA provides specific grants for agriculture related fields that implement alternative energy. The Renewable Energy and Efficiency Grant Program is part of the Farm Bill and will help fund the purchase of renewable energy systems. The grant's typical funding is from $2,500 to $500,000 based on how competitive the application is and how much aide is needed (USDA Rural Development, 2010).

Cost-Benefit Analysis

An increasing investment seen in today's society is the switch to alternative energy. There are a few different energy conversion methods, but one of the largest is solar. This switch is seen because of harmful emissions produced by existing machinery used. Installing solar panels would be an example of a financial investment. Financial investments can look vastly different depending on the industry they are in. They can range from a large corporation looking to buy out a smaller company, to a small family ranch looking to purchase new equipment. Either way, they are not taken lightly and can impact the company or person drastically. In the case of a family ranch, specifically an almond orchard, many financials decisions are made daily, some of more importance than others. An example of an important financial decision is where to invest or what to invest in. Each decision needs to be thought through fully and analyzed completely, which can be done through a cost-benefit analysis. An example of a cost-benefit analysis is capital budgeting, or investment analysis. This process consists of four stages: 1) project definition and estimation of cash flows; 2) project analysis and selection; 3) project implementation; and 4) project review (Gitman and Forrester Jr., 1977). The purpose of a cost-benefit analysis is to examine both the costs and benefits in order to determine which outweighs the other. If the costs outweigh the benefits, the project will not be cost-beneficial, but if the benefits outweigh the costs, it would seem to be a profitable project.

According to Prest and Turvey (1965) in their article for *The Economic Journal*, a cost-benefit analysis is a practical way of assessing the desirability of a project or investment. If a project does not look desirable on paper, it will not be an ideal investment. Identifying the costs and benefits that will be included in the analysis is the first task. Each cost and benefit is important in the analysis process. Diakoulaki et al. (2001) discussed the three ratios that need to be calculated at the end of the analysis in order to determine if the investment will be profitable: the net present value, which should be greater than zero, the internal rate of return, which should be greater than the initial discount rate, and the cost-benefit calculation, which should be a positive number. Prest and Turvey (1965) argue that the only meaningful way of measuring this cost saving is to ascertain the difference in the present value of total system operating costs in the two cases and deduct the capital cost of the alternatives. The net present value of the costs and benefits should first be calculated. Once the lifespan is determined, it is possible to calculate the NPV using a suitable discount rate (Diakoulaki et al., 2001). The NPV equals the total present values less the cash outlay required at i=0, or the initial investment in the solar panels (Myers, 1984). The internal rate of return (IRR) is the annualized rate of return that equates the present values of costs and benefits (Heckman et al., 2009). The cost-benefit calculation is determined by subtracting the benefits from the costs. Each of these calculations are used as methods of determining how profitable the project will be. Once these numbers are determined, it can be concluded whether to go forth with the project.

CHAPTER 3

METHODOLOGY

Procedures for Data Collection

In order to do a cost-benefit analysis of installing solar panels to power the water pumps on the Schnoor almond ranch, the current electricity bills will first need to be obtained. The bills will be obtained from the almond ranch owner and manager, Donald Schnoor, through an informal interview. The bills will provide data on how much electricity is currently being used. The monthly electricity bills from PG&E for the year 2010 will be analyzed. Using the monthly amounts of kWh of electricity, a total annual amount will be calculated. Once the total annual amount is determined it will be used as the base number for future avoided electricity costs with inflation accounted for and added on top. These calculations and resulting numbers will be obtained through the use of a Microsoft Excel worksheet.

Schnoor will not only provide the bills necessary for analysis, but also information such as what pumping machinery is currently used. He will provide the total amount of the current pumps used. The interview will be conducted on the Schnoor ranch in Chowchilla, CA. Background information about Schnoor will also be obtained to better understand his financial stability and current position in undertaking such a large investment. Questions relating to information about the almond industry and the agriculture in Chowchilla will also be asked. (See Appendix 1 for a full list of questions).

The next step will be to determine the make and model of the solar panels. This information will be obtained through an interview with a consultant from a specific solar company. Data will be gathered on different options including the size and number of panels that will best fit the needs of the almond ranch water pumps. Once the panels are selected, the costs of such panels will be determined. The solar company will provide information on the initial cost of the panels, installation costs and the anticipated life expectancy, which will be entered on a separate spreadsheet focusing on determining the net present value, the internal rate of return and the net benefit.

Incentives, such as rebates and subsidies, are given out to those who choose to switch to solar. California's Go Solar website, specifically the Go Solar California campaign area, will be used to find information on the specific California rebates. The performance based initiative rebate that will be given back to Schnoor is calculated per average annual kWh used. As mentioned before, it is a five-year rebate at $0.05 per kWh for the Chowchilla area. Federal tax incentives will be calculated as well using the IRS's Investment Tax Credit program information. The IRS will give a one-time tax credit of 30 percent of the total cost of the solar panels. Also, the USDA website will provide information on grants given to farmers and ranchers who invest in solar. These grants are to help finance the project and cut down on initial costs. The specific grant amount is determined after applying for it, which is normally from $2,500 to $500,000. Once all this information is collected, the analysis portion can be performed.

Procedures for Data Analysis (PFDA)

The information collected from Schnoor regarding the monthly electricity bills for the past year will be entered into a Microsoft Excel spreadsheet. This spreadsheet will analyze the monthly electricity costs incurred using the existing method of pumping. The monthly average kWh of electricity will then be determined from the monthly usage amounts. The average annual amount will then be calculated on the same spreadsheet. The calculated average annual amount of electricity currently used will eventually transfer over to the other spreadsheet focusing on the cash flows and be portrayed as a yearly cost no longer incurred after the installation of the solar panels. This will work against the initial installation and purchasing costs of the panels by being portrayed as a positive cash flow. This separate spreadsheet will then be developed displaying the cash flows, including the initial costs for the solar panels, the avoided electricity costs, as well as the financial rebates.

An informal interview with Schnoor will be conducted in Chowchilla, CA on his almond ranch. The background information provided from Schnoor's interview will help determine his current financial position and if he will be able to handle such a large investment. Installing solar panels is a costly project, so knowing whether or not he will be able to afford the initial cost on his own or need the help of a loan is important. Schnoor's information on the current pumping system will also be helpful. Determining whether all the pumps are electric or if some are gas powered will determine how effective installing solar panels will be. During the interview, Schnoor will also be able to provide information on the current almond industry and if any other farms in the area have invested in solar. Information on surrounding farms that have installed solar and have benefited from the investment will be yet another helpful resource in this analysis. It will give insight into how effective solar has been on farms or ranches.

An interview will then be conducted with a representative from a specific solar company. The representative will provide information on the different types of solar panels and which one he feels will best fit the needs of the project. Once the panel type is chosen, the quantity of panels needed to power the water pumps will be determined. From the chosen panels, the representative will then be able to provide the pricing for the panels and the installation costs. These costs will be included on the same spreadsheet as the cash flows as an initial negative cash flow at year zero.

The subsidies and tax incentives are determined next. The tax incentive is based on the Investment Tax Credit program put out by the Federal government. They will provide a one-time credit of 30% of the cost of the investment. The total cost of investment will first need to be determined so the tax credit can be calculated. It will be included in the cash flow spreadsheet as a positive cash flow. The Go Solar California campaign puts out rebates that will be calculated for five years. Since the electricity is obtained through PG&E, it will be calculated using $0.05 times the average annual amount of kWh used. This credit will be included in the cash flow spreadsheet as a positive cash flow as well. If a grant is obtained from the USDA, this one-time amount will also be included in the spreadsheet. These rebates show how much money is given back to Schnoor on account of purchasing solar panels and using renewable energy. Each will be in a separate column as a positive cash flow. Once the cash flows are determined, a combined annual cash flow will be calculated.

The net present value can then be determined using the already calculated annual cash flows of the new solar pump. The total annual cash flows are determined beginning with the initial cost and adding back in the incentives yearly. The discount rate and the inflation rate will be determined. The discount rate will be determined by what the most current rate around that area is. The average annual inflation rate will be determined using the CPI index and estimating what it will be for the next 30 years. The NPV will be calculated taking into consideration inflation and the discount rate. The equation for $NPV = R_t/(1+i)^t$, where t is the time of the cash flow, i is the discount rate, and R_t is the net cash flow at time t. If the NPV proves positive, it is a good indicator that the investment will be financially favorable. If it turns out to be negative, the financial return of purchasing solar panels will likely be unfavorable. The internal rate of return will then be calculated. The equation for IRR is equated from the cash flows when the NPV equals zero. An Excel formula can be used to calculate both NPV and IRR accurately and efficiently.

The final spreadsheet will be created compiling all the data collected. It will reflect compiled average annual electricity usages that will be determined from the electricity bills. It will include the incentives and rebates determined from the Go Solar California Program, the IRS and the USDA. The discount rate and inflation rate will aid in determining the annual rebate amounts. It will also include the initial cost of the panels that will be determined from the solar company. The analysis will be done for a certain time period that will be based on the anticipated lifespan of the solar panels. The NPV and IRR will be calculated using the cumulative annual cash flows. If the NPV is positive, it will be a good investment. Another way to prove that the investment is a positive choice is if the IRR is at least greater than the discount rate (the higher, the better). Lastly, the cost-benefit calculation will be completed by subtracting the costs from the benefits. If this is a positive number, the investment will be cost-beneficial. These three calculations will be enough to conclude whether or not investing in solar panels to power the water pumps will be cost-beneficial.

Assumptions

It is assumed that the life expectancy of the solar panels determined by the solar company is in fact true and reliable. This will be a necessary data point in calculating the net present value and the internal rate of return, which is important to the decision. It is also assumed that the inflation rate and discount rate remain constant and are in fact good estimates. It is assumed that the weather conditions in Chowchilla, CA remain constant, as the information calculated is based on maximum sun exposure.

Limitations

The sun exposure is going to be different in other parts of the country, therefore this report and its conclusions are ideal for almond orchards in Chowchilla, CA. The rebates and incentives are also based on a ranch in California, so it would not be a beneficial study for someone looking to switch to solar outside of California or not for agriculture purposes. The installation and purchasing costs in this study are specific to one solar company although other solar companies may charge different amounts.

CHAPTER 4

DEVELOPMENT OF THE STUDY

Data Collection Problems

After consulting with Donald Schnoor about his electricity bills, PG&E was determined as the sole provider of electricity for the almond ranch. PG&E provides extensive information on solar incentives for businesses on their website. While researching the wealth of information and consulting with the REC Solar representative regarding the Performance Based Incentives (PBI), it was determined that the state of California no longer offers the rebate incentives for non-residential properties as of December 23, 2010. This is due to budgetary constraints and exceeding the allotted megawatts of 76.91 MW for non-residential customers. Although financially this is not ideal for the Schnoor ranch, it does show that more businesses are turning to solar. Therefore, the PBIs will not be included in the calculations.

Analysis

To begin the analysis, an interview with Donald Schnoor took place in Chowchilla, CA on the almond ranch and the PG&E electricity bills were obtained. The bills cover four different account numbers that encompass 16 meters all together. The monthly bills were totaled for each account number and then combined to reach a gross monthly amount for the ranch. The monthly amounts were summed to determine the amount spent on electricity for one year: $48,823.49. The PG&E electricity bills not only included the amount of money spent on the energy, but also the amount of electricity used in kilowatt-hours (kWh). Each month was recorded to come up with a total yearly amount of kWh used. This information can be seen in Table 1.

Table 1. 2010 PG&E Electricity Bill Totals & kWh Totals

MONTH	TOTAL PAID	TOTAL kWh
Jan-10	$568.62	251
Feb-10	$600.20	248
Mar-10	$210.87	188
Apr-10	$540.46	990
May-10	$2,130.66	9,664
Jun-10	$3,244.29	16,672
Jul-10	$5,925.33	30,231
Aug-10	$8,384.42	45,320
Sep-10	$7,345.63	43,564
Oct-10	$11,923.90	71,149
Nov-10	$5,253.51	24,363
Dec-10	$2,695.60	6,414
ANNUAL	$48,823.49	249,054

After analyzing a year's worth of electricity bills and extracting the important financial information, REC Solar, a local solar company, was contacted. REC Solar was started in San Luis Obispo in 1997 and now has thirteen offices throughout the United States. Seth Pearson, a Solar Information Specialist at REC Solar, was the main contact person for the project. An interview was conducted with him and he was able to recommend information about the purchase of the solar panels. Based on Pearson's recommendations, the almond ranch would require a 137 kWh system. This was calculated based on his knowledge of modules and watts usage. In order to produce enough energy to power the electricity throughout the ranch, 595 modules will need to be installed. Since the ranch is inconsistent in it's electricity usage month to month, Pearson recommended purchasing a system at 230 watts, or 230,000 kWh, because the panels will produce excess energy in the winter months. 595 modules at 230 watts equals the quoted system size of 137 kWh. Pearson then estimated the ranch's energy price at $4.50/watt. After calculations, Pearson quoted $615,825 for the solar panels, which includes installation costs as well as a 20-year warranty.

Although the Performance Based Incentives given out through the California Solar Initiative have run out, the federal government is still offering a one-time tax credit of 30 percent of system cost. Since the calculated cost of the system is $615,825, the one-time tax credit will be $184,747.50. The USDA's grant offer would be between $2,500 and $500,000. However, since this grant has to be applied for and is based on each farm or ranch individually, it will not be used in the calculations because it would be an assumption. Whatever the amount is, will only benefit Schnoor and help offset initial costs.

In order to perform the cost-benefit calculations, a spreadsheet was set up displaying the financial information from the Schnoor almond ranch. The net present value and internal rate of return were calculated using the cumulative cash flows for the 30 years. 30 years was the chosen time frame because it is the estimated life of the solar panels. Once the time frame was set, a table was created to show the system cost, the federal tax credit, the future avoided electricity costs, the annual cash flows, the NPV of the annual cash flows, and the cumulative NPV. The system cost is a one-time cost in the present year or year zero. The federal tax credit is also a one-time credit that will come at the end of the first year, but displayed as 1/1/2012. The future avoided electricity costs were calculated using the 2010 electricity cost. However, using that number every year for 30 years would be unrealistic and thus the inflation rate is accounted for starting in year one. The inflation rate was determined using the Electricity Supply, Disposition, Prices, and Emissions table from the U.S. Department of Energy's website. They produce data tables each year showing current and future predicted energy prices. Referring to Table 2, the commercial energy price inflation percentage, 1.5%, was used as the inflation rate in the analysis table.

Table 2. Electricity Prices & Annual Growth

		Reference Case						Annual Growth 2009-2035 (percent)
Supply, Disposition, and Prices	2008	2009	2015	2020	2025	2030	2035	
End-Use Prices								
(nominal cents per kilowatthour)								
Residential	11.2	11.5	11.9	13.0	14.1	15.5	17.3	1.6%
Commercial	**10.3**	**10.1**	**10.1**	**11.0**	**12.1**	**13.2**	**14.7**	**1.5%**
Industrial	6.8	6.8	6.7	7.4	8.1	9.0	10.2	1.6%
Transportation	11.7	11.9	11.3	11.5	12.9	14.8	17.2	1.4%
All sectors Average	9.7	9.8	9.8	10.7	11.8	13.0	14.7	1.6%
Source: Energy Info Source: Energy Information Administration, U.S. Federal Government, 2010. Electricity Supply, Disposition, Prices, and Emissions. U.S. Department of Energy. Annual Energy Outlook 2011, January.								

Once the future avoided electricity costs are determined taking into account the inflation rate, the annual cash flow is calculated. For years 2-30, it is only the future avoided electricity costs, but for year one it also includes the federal tax credit. The NPV of the annual cash flows is calculated each year using a discount rate. The discount rate is an estimate based on the bank interest rate. The current average 30-year loan rate is approximately 5.5%, which for this study will be rounded to 6% and used as the discount rate. The NPV calculation takes into account the 6% discount rate, the year, and the annual cash flow. Finally, the cumulative NPV column is calculated. This is combining the NPVs to come up with the final NPV of year 30. This is information has been combined and Table 3 has been created.

Table 3. Cost-Benefit Analysis of Cash Flows - 30 years @ 6% Discount Rate

Year	Year	System Cost	Federal Tax Credit	Avoided Electricity Cost	Annual Cash Flow	NPV of Annual Cash Flow	Cumulative NPV
0	2011	($615,825.00)	$0.00	$0.00	($615,825.00)	($615,825.00)	($615,825.00)
1	2012	$0.00	$184,747.50	$49,555.84	$234,303.34	$221,040.89	($394,784.11)
2	2013	$0.00	$0.00	$50,299.18	$50,299.18	$44,766.09	($350,018.02)
3	2014	$0.00	$0.00	$51,053.67	$51,053.67	$42,865.64	($307,152.38)
4	2015	$0.00	$0.00	$51,819.47	$51,819.47	$41,045.88	($266,106.50)
5	2016	$0.00	$0.00	$52,596.76	$52,596.76	$39,303.36	($226,803.14)
6	2017	$0.00	$0.00	$53,385.72	$53,385.72	$37,634.82	($189,168.31)
7	2018	$0.00	$0.00	$54,186.50	$54,186.50	$36,037.12	($153,131.20)
8	2019	$0.00	$0.00	$54,999.30	$54,999.30	$34,507.24	($118,623.95)
9	2020	$0.00	$0.00	$55,824.29	$55,824.29	$33,042.31	($85,581.64)
10	2021	$0.00	$0.00	$56,661.65	$56,661.65	$31,639.57	($53,942.07)
11	2022	$0.00	$0.00	$57,511.58	$57,511.58	$30,296.38	($23,645.69)
12	2023	$0.00	$0.00	$58,374.25	$58,374.25	$29,010.21	$5,364.52
13	2024	$0.00	$0.00	$59,249.87	$59,249.87	$27,778.65	$33,143.17
14	2025	$0.00	$0.00	$60,138.61	$60,138.61	$26,599.37	$59,742.54
15	2026	$0.00	$0.00	$61,040.69	$61,040.69	$25,470.15	$85,212.69
16	2027	$0.00	$0.00	$61,956.30	$61,956.30	$24,388.87	$109,601.56
17	2028	$0.00	$0.00	$62,885.65	$62,885.65	$23,353.49	$132,955.05
18	2029	$0.00	$0.00	$63,828.93	$63,828.93	$22,362.07	$155,317.12
19	2030	$0.00	$0.00	$64,786.37	$64,786.37	$21,412.74	$176,729.86
20	2031	$0.00	$0.00	$65,758.16	$65,758.16	$20,503.71	$197,233.56
21	2032	$0.00	$0.00	$66,744.53	$66,744.53	$19,633.27	$216,866.83
22	2033	$0.00	$0.00	$67,745.70	$67,745.70	$18,799.78	$235,666.60
23	2034	$0.00	$0.00	$68,761.89	$68,761.89	$18,001.67	$253,668.28
24	2035	$0.00	$0.00	$69,793.32	$69,793.32	$17,237.45	$270,905.73
25	2036	$0.00	$0.00	$70,840.22	$70,840.22	$16,505.67	$287,411.40
26	2037	$0.00	$0.00	$71,902.82	$71,902.82	$15,804.96	$303,216.36
27	2038	$0.00	$0.00	$72,981.36	$72,981.36	$15,134.00	$318,350.36
28	2039	$0.00	$0.00	$74,076.08	$74,076.08	$14,491.51	$332,841.87
29	2040	$0.00	$0.00	$75,187.22	$75,187.22	$13,876.31	$346,718.18
30	2041	$0.00	$0.00	$76,315.03	$76,315.03	$13,287.22	$360,005.40
TOTALS		($615,825.00)	$184,747.50	$1,860,260.98		$360,005.40	

Table Notes

Annual Inflation	1.50%
Base Annual Electricity Bill	$48,823.49

Analysis Calculations

NPV =	$360,005.40
IRR =	11.91%

Discount Rate	6.00%		Payback =	Year 12

The net present value and the internal rate of return were determined once all the information was compiled in the spreadsheet. At the discount rate of 6%, the NPV for 30 years is $360,005.40 and the IRR is 11.91%. The NPV and IRR turned out to be favorable. The NPV is a great deal above zero, which is good and the IRR is not only positive but also above the 6% discount rate, which is great. Overall this means that the financial benefits outweigh the costs. The cumulative NPVs also look favorable. After eleven years, the system will begin operating as a positive cash flow and no longer be a burden to the ranch's financials.

Interpretation of Results

The results of the cost-benefit analysis turned out to be positive and thus proving the hypothesis correct. Over the time period of 30 years, the initial cost of installing the solar panels was only a small cost and eventually beneficial to the ranch's electricity expenditure. The NPV, being a great deal larger than zero, and the IRR, being much larger than the discount rate, indicate that the project is financially favorable. Since the cost-benefit analysis proved financially favorable, installing solar panels would be a favorable investment on the Schnoor almond ranch.

CHAPTER 5

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The switch to alternative energy sources to power electricity has become much more common in today's society, especially through solar energy. The installation of solar panels is advertised throughout California and other states with the use of incentive programs, both state and federal. These incentive rebates and grants are set up to help people afford to switch to solar and thus help improve the environment. California offers a performance based initiative, the federal government offers a tax-credit and the USDA offers a grant to farmers/ranchers applying solar.

The purpose of this project was to determine if applying solar to the Schnoor almond ranch was going to prove cost-beneficial or detrimental. Through the analysis of the ranch's electricity expenditure, a spreadsheet was set up to determine the net present value (NPV) and internal rate of return (IRR), which are major indicators of whether or not a project is beneficial. The NPV was calculated using the annual cash flows which took into account avoided electricity costs, the system cost, and any incentives. Unfortunately, the California state incentives have recently run out and did not contribute to the cash flows as originally expected. Also, the USDA grant would contribute to the benefits, but will not be applied in this situation because of the uncertainty of the amount. Although Schnoor will only reap the benefits of a one-time tax credit and no state or USDA benefits, the overall investment proved positive. The total cost of the solar panels is $615,825.00 and by year 12 the ranch will return to operating with a positive cash flow. Also, the NPV is $360,005.40, and the IRR is 11.91%. Both calculations show the investment is financially positive and that switching to solar will be cost-beneficial.

Conclusion

In 2010, Schnoor spent $48,823.49 on electricity to power the water pumps on his almond ranch. Schnoor became interested in applying solar to the almond ranch to reduce costs and thus a cost-benefit analysis was performed. Installing solar panels to the Schnoor almond ranch to power the water pumps proved cost-beneficial through calculations and analysis of current expenditure versus avoided expenditure. NPV and IRR calculations were performed to better understand the investment. Since the NPV, estimated at $360,005.40, is greater than zero, it will be a financially beneficial investment. Since the IRR, estimated at 11.91%, is greater than the discount rate of 6%, this again shows the investment is beneficial.

Through the analysis of the spreadsheet, after year 11, the cumulative NPV becomes positive. This shows that after 11 years, the solar panel system will begin operating as a positive cash flow and no longer a financial burden. Based on the 30-year estimated lifespan of the solar panels, there will be more years benefitting from the solar panel installation than years paying it. After fully analyzing all the results, the investment is definitely cost-beneficial. Each calculation proves positive and although the initial cost is a large amount, over 30 years, it will more than pay for itself.

Recommendations

Based on the results of this study, through the NPV and IRR calculations, it is recommended that Schnoor invest in solar panels to power the water pumps on the almond ranch.

After 11 years, the solar panel system will begin to operate as a positive cash flow and Schnoor will begin benefitting from the avoided electricity costs.

It is recommended to those considering expanding on this project that more research should be done on power purchase agreements. This is where a company will fully finance the system for your facility and charge you for the electricity generated at a discounted price.

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APPENDIX I

INTERVIEW QUESTIONS

1. Mr. Schnoor, how long have you been in the farming business?

2. Have you always farmed almonds?

3. How many water pumps are currently pumping water to your orchards?

4. How are the pumps currently powered?

5. Have you ever worked with solar energy?

6. Do you know of any farms or ranches around the area that have installed solar panels?

7. If proved cost-beneficial, do you have the financial means to install the solar panels?

8. How big of a part does electricity play in total costs for the ranch?