

MEMORANDUM

To: [REDACTED]
Cc: [REDACTED]
From: [REDACTED]
Date: September 24, 2013
Subject: The Feasibility of Solar Panels

OVERVIEW

Purpose

Per request, I have researched and analyzed solar panel options based on price, design, energy output, maintenance, warranty, and return on investment (ROI).¹ The objective was to discover a good looking, easy to maintain, solar electric system that costs less than \$12,000. You also desired it to produce 1,000 kWh, include a 25 year warranty, and provide 200% ROI over 25 years.¹ This document presents my findings and recommends a course of action.

Background

A solar cell is an instrument that converts energy from the sun into usable electrical power. This phenomenon occurs when semi conductive material inside a solar cell absorbs light energy.² As this material absorbs energy, electrons move to produce a flow. This electron flow generates a current, measured in watts, which can be harvested. Energy companies typically measure your energy usage over time. This is commonly denoted as kilowatt-hours (1000 watt-hours).

Summary

As we discussed, the most important requirements to consider were energy output, design, maintenance, warranty, price, and the ROI. Rocknoll Energy Systems is a local green energy company that was able to meet all your needs at the lowest cost. However, their ~\$21,000 price tag is above your current standard and therefore not feasible.³ My recommendation is to explore financing options as it may be another factor to consider depending on your desire. The following sections discuss and analyze each of the criteria we talked about.

ENERGY OUTPUT

Definition

Energy output is defined as the amount of power the solar panels provide. Solar panel output is affected by many different factors. Some of these factors are roof positioning and space, sunlight duration, and environmental obstruction. To reach your 1,000 kWh per month goal, all aspects of installation and use are analyzed.¹

Research

Producing 1,000 kWh through solar panels is a large task for a residential home. The first factor to consider is sunlight duration. Your area obtains on average 4.2 hours of usable sunlight daily.⁴ Luckily, the sunlight your roof receives is not blocked by any environmental obstructions, such as trees or houses. You are able to harness all 4.2 hours of sunlight, which decreases the overall solar electric system cost.

Rocknoll Energy Systems has stated that because of your high energy standard, you will likely need to use high efficiency 300 watt solar panels to acquire enough energy.³ The significance of this is that they may be a bit more expensive, but they will be more efficient and last longer. Therefore, the amount of solar panels you need to provide the required energy output is 26 (See Appendix A for calculations).

A typical 300 watt solar panel measures approximately 40 square-feet.⁵ This means approximately 1,040 square-feet of roof space is needed. However, to be able to meet your energy requirement, you will need to place the solar panels on your southern facing roof. Placing solar panels in any other direction greatly diminishes their energy output. Figure 1 demonstrates why positioning is important by illustrating the sun's location throughout the year.

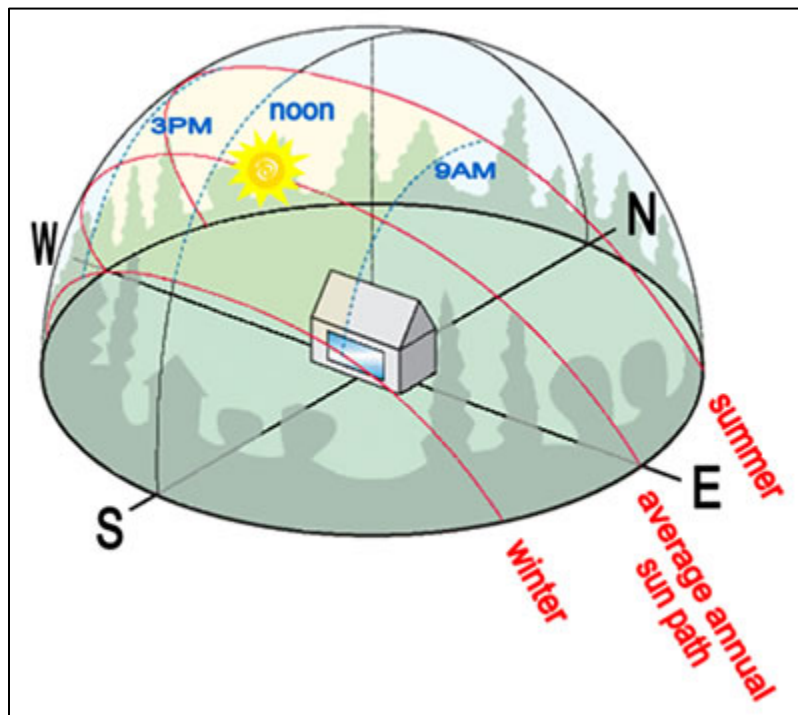


Figure 1: Sun Positioning Throughout a Year⁶

The sun shines from the south in the northern hemisphere, which is why it is important to consider location to obtain maximum efficiency. Additionally, roof space is not an issue as your southern roof is approximately 1,570 square- feet.¹ This is plenty of space to situate all 26 solar panels. It is feasible to generate 1,000 kWh per month of solar energy.

DESIGN

Definition

Design is defined as the appearance of the solar panels and its associated electrical equipment. You made it clear that large batteries or any other electric units on the ground are unacceptable.¹ Reasonably sized units hidden inside or attached to the side of the house is the desirable standard. “Large” is defined as an object with a volume greater than 64 ft³.

Research

Other than the actual panels, the only equipment required for a functional solar electric system is a charge controller and a power inverter.⁷ A charge controller is a small electronic box that is used to regulate the charge. A power inverter is another small piece of equipment that takes the electricity from your solar panel and converts it to power that can be utilized for your household.⁷ These pieces of equipment are about the size of a residential circuit breaker. A basic outline of what comprises a solar electric system is shown in Figure 2.

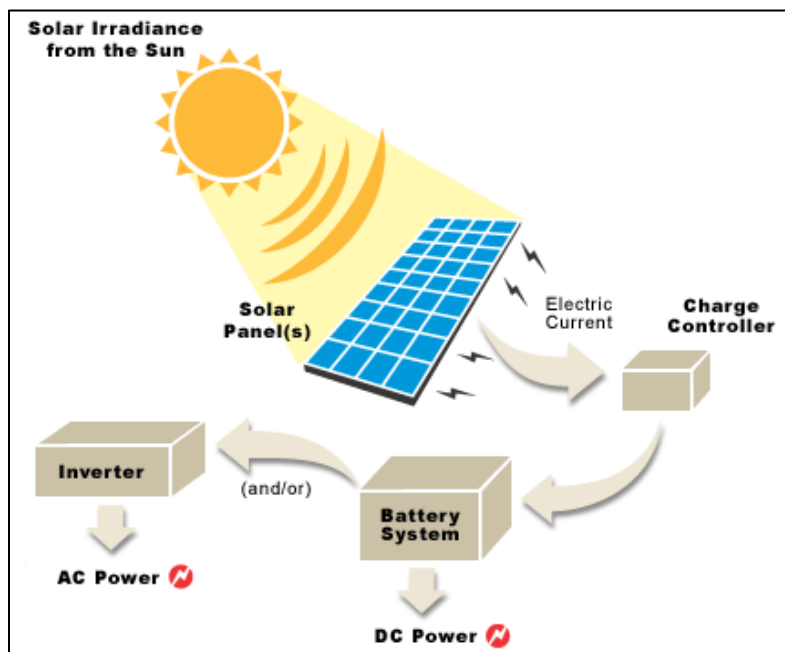


Figure 2: The Structure of a Solar Electric System⁸

Most of the time, the charge controller is built into the solar panels and the inverter can be hidden inside your house. The wiring between all the equipment can also be taken through the roof or down the side of your house. It all depends on personal preference. Figure 3 is an example of an average sized inverter.

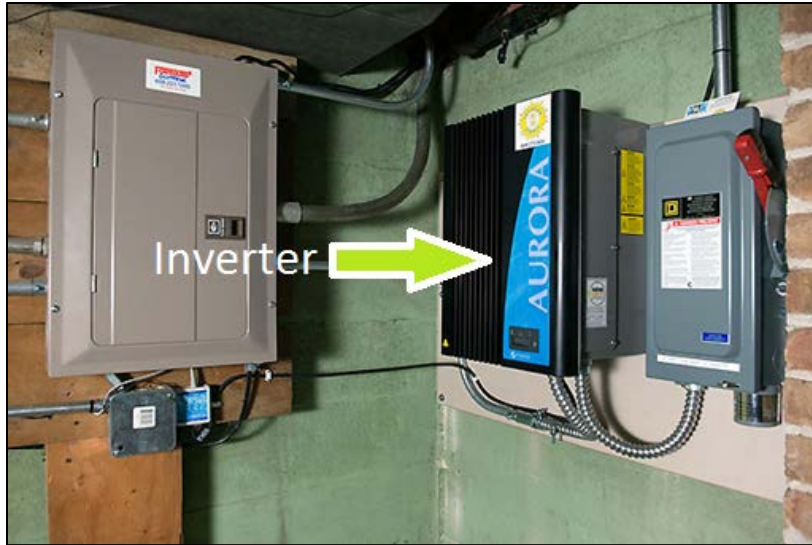


Figure 3: Inverter⁹

To review, the equipment needed to have a fully functioning solar power system is not large. Rocknoll Energy Systems stated that in most situations, they are able to find a non-obtrusive way to configure the electrical components.³

MAINTENANCE

Definition

Maintenance is defined as the process of preserving a working state. Maintenance must not annually require more than \$250 and ten hours of manual labor.¹

Research

There is little to no upkeep for a solar power system because there are no moving parts.¹⁰ They only need to be inspected and cleaned a few times a year.¹⁰ Cleaning your solar panels is as simple as using a garden hose to wash the face of the panels. In most situations, rainfall does the work for you. However, it is still recommended you inspect the panels to make sure they are clean. This is necessary because dirt/dust buildup can have a significant effect on solar panel efficiency. A visual inspection should be performed monthly. This inspection includes cleaning the panels with a garden hose if dirty. Inspection and cleaning will not take more than ten hours per year.

Another factor to consider for maintenance is the cost of replacing electrical equipment. Quality solar panels typically last 30-40 years.³ The only equipment needing replacement during this time period is the inverter. An inverter replacement will be required around the 15 year mark.¹¹ For this report, we assume solar panels last 30 years, the inverter only needs to be replaced once, and the cost of an inverter is \$6,825.¹¹ If we divide \$6,825 by 30 years, this comes out to ~\$230 a year. The cost and time of maintenance meets your standards.

WARRANTY

Definition

A warranty is a guarantee by a manufacturer to repair or replace an item that has failed within a stated period of time. For this report, all solar panels must come with at least a 25 year warranty.¹ The warranty must cover a defective product and storm damage.¹

Research

The industry standard for warranties on solar electric systems varies from company to company. The warranty also changes for each part of the solar electric system. Most solar panel manufacturers have a warranty for 20-25 years.¹³ This covers defective products and storm damage. All the large manufacturers also guarantee their equipment will remain at least 80% efficient for the warranty period.¹³ However, inverters usually have their own separate warranty. Depending on the type of inverter purchased, they are typically covered for five to ten years.¹¹

When we discussed warranties, you were very adamant that the warranty must cover storm damage. Although all leading manufacturers do include storm damage in their warranties, it is not something to worry about. Solar panels are built to last.¹⁴ They are made out of high-strength tempered glass. Tempered glass is four to five times stronger than standard glass.¹⁵ As stated by wiseGEEK, “this type of glass is designed to withstand a direct vertical impact of hail up to 1 inch in diameter, travelling at 50 miles per hour.”¹⁵ Even larger hail will not cause damage because solar panels are tilted at an angle to optimize their solar intake.¹⁵ This prevents hail from making direct vertical impacts.

Rocknoll Energy Systems provides a 25 year warranty on their solar panels, and a 15 year warranty on their inverter.³ These warranties meet your standard.

PRICE

Definition

For this analysis, the definition of price is the total amount of money it costs to purchase the entire solar power system. This includes installation costs and fees. For this report, the final amount must be no more than \$12,000.¹ The final amount will also take into account any tax credits that can be claimed at installation.

Research

The best price I was able to find was from a local energy company. Rocknoll Energy Systems estimated a \$21,000 price tag for the system that meets all your criteria.³ This price includes the Federal Tax Credit (30% of gross cost at installation).¹⁶ The energy system comes with a 25 year warranty on the solar panels, and a 15 year warranty on the inverter.³ This price includes installation costs and all paperwork needed to acquire the various tax credits. Rocknoll has also stated that their solar panels last 30-40 years.³

However, the proposed system does not meet the price criterion's standard; a recommendation is made at the end of this report.

RETURN ON INVESTMENT

Definition

In this report, return on investment (ROI) is the sum of all returns over the system life divided by the net cost (after all tax credits).¹¹ Return on investment is also defined as the amount of time it takes to recover the initial cost of purchasing a solar power system. The goal is to be able to recover the solar panel cost in less than ten years, and attain 200% ROI in 25 years.¹

Research

The current electric rate in your area averages at .117¢ per kWh.¹ Based on this number, it will take a little over five years to recoup your initial investment.¹¹ Conservatively, my calculations put your return on investment at approximately 350% in 25 years.¹¹ This signifies approximately \$80,000 in savings. Figure 4 illustrates the return on investment and your potential cash flow.

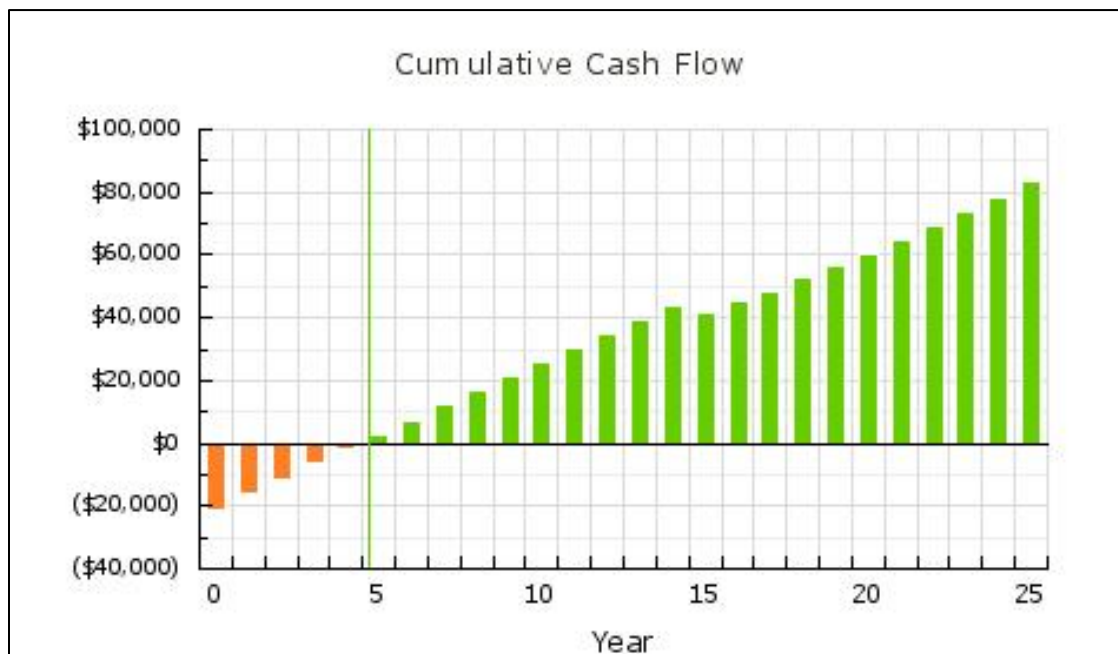


Figure 4: Cumulative Cash Flow¹¹

The first red bar on the left in Figure 4 signifies that when you pay for the solar electric system, your cumulative cash flow starts at -\$21,000. Each year as you save money through electric savings and tax credits, the bar increases. The big green line represents the breakeven point; this is the point where the money you have saved with the solar panels has paid off your initial investment. Appendix B contains the detailed calculations that

make up Figure 4. These statistics show it is feasible to expect a great return on your investment.

CONCLUSION AND RECOMMENDATION

In conclusion, according to your criteria, it is not feasible to purchase solar panels at this time. The initial cost of the solar panels is the only standard that was not able to be met. Solar panels require minimal maintenance and can be placed to eradicate any design issues. Furthermore, your roof has plenty of space and the available warranties should be able to address any of your concerns. Even though this report shows it is not currently feasible to purchase solar panels, I would look into financing options because you can save a lot of money with solar power. Throughout my research, I learned about many places dedicated to financing green energy with interest rates as low as 0%.¹⁷ If you are prepared to put \$12,000 on a down payment for a solar energy system, then my recommendation is to call Rocknoll Energy Systems and acquire more information about their financing options.

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APPENDIX A – Solar Panel Requirement

The calculations to determine how many solar panels you will need are shown below:

1. The average amount of sunlight received in your area per day is 4.2 hours:⁴
 - $300 \text{ watts} * 4.2 \text{ hours} = 1260 \text{ Wh (watt * hour)}$
 - Therefore, a 300 watt solar panel provides on average 1260 Wh every day.
2. The average amount of days in a month is 30.42:
 - $1260 \text{ Wh} * 30.42 = 38329.2 \text{ Wh}$
 - Therefore, a 300 watt panel provides 38329.2 Wh every month
3. The amount of energy needed per month is 1,000 kWh:¹
 - $38329.2 \text{ Wh} * \frac{1 \text{ kWh}}{1000 \text{ Wh}} = 38.3292 \text{ kWh}$
 - $38.3292 \text{ kWh} * \# \text{ of solar panels needed} = 1,000 \text{ kWh}$
 - $\# \text{ of solar panels needed} = \frac{1000 \text{ kWh}}{38.3292 \text{ kWh}} \approx 26 \text{ Solar Panels}$
 - Therefore, the amount of solar panels you need to provide the desired energy output is 26.

Appendix B – Cash Flow Calculations

These are the calculations that are represented by Figure 4.

Year of Operation:	at Install	1	2	3	4	5		
Gross Cost(\$30,030)								
PUC of Ohio - Solar Renewable Energy Credits (\$ 262.50/MWh assume 6% deflation per year)	\$0	\$2,960	\$2,782	\$2,615	\$2,458	\$2,310		
Federal Tax Credit (30% of Gross Cost at Installation)	\$9,009	\$0	\$0	\$0	\$0	\$0		
Utility Savings	\$0	\$2,010	\$2,086	\$2,165	\$2,247	\$2,332		
ANNUAL CASH FLOW	\$-21,021	\$4,970	\$4,868	\$4,780	\$4,705	\$4,642		
Cumulative Cash Flow	\$-21,021	\$-16,051	\$-11,183	\$-6,403	\$-1,698	\$2,944		
						Breakeven		
Year of Operation:	6	7	8	9	10	11		
Gross Cost								
PUC of Ohio - Solar Renewable Energy Credits (\$ 262.50/MWh assume 6% deflation per year)	\$2,171	\$2,041	\$1,918	\$1,803	\$1,695	\$1,593		
Federal Tax Credit (30% of Gross Cost at Installation)	\$0	\$0	\$0	\$0	\$0	\$0		
Utility Savings	\$2,420	\$2,512	\$2,606	\$2,705	\$2,807	\$2,913		
ANNUAL CASH FLOW	\$4,591	\$4,553	\$4,524	\$4,508	\$4,502	\$4,506		
Cumulative Cash Flow	\$7,535	\$12,088	\$16,612	\$21,120	\$25,622	\$30,128		
Year of Operation:	12	13	14	15	16	17		
				(\$6,825)				
Gross Cost				Inverter Replaced				
PUC of Ohio - Solar Renewable Energy Credits (\$ 262.50/MWh assume 6% deflation per year)	\$1,497	\$1,407	\$1,322	\$1,243	\$0	\$0		
Federal Tax Credit (30% of Gross Cost at Installation)	\$0	\$0	\$0	\$0	\$0	\$0		
Utility Savings	\$3,023	\$3,138	\$3,256	\$3,379	\$3,507	\$3,640		
ANNUAL CASH FLOW	\$4,520	\$4,545	\$4,578	\$-2,203	\$3,507	\$3,640		
Cumulative Cash Flow	\$34,648	\$39,193	\$43,771	\$41,568	\$45,075	\$48,715		
Year of Operation:	18	19	20	21	22	23	24	25
Gross Cost								
PUC of Ohio - Solar Renewable Energy Credits (\$ 262.50/MWh assume 6% deflation per year)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Federal Tax Credit (30% of Gross Cost at Installation)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Utility Savings	\$3,777	\$3,920	\$4,068	\$4,222	\$4,382	\$4,547	\$4,719	\$4,898
ANNUAL CASH FLOW	\$3,777	\$3,920	\$4,068	\$4,222	\$4,382	\$4,547	\$4,719	\$4,898
Cumulative Cash Flow	\$52,492	\$56,412	\$60,480	\$64,702	\$69,084	\$73,631	\$78,350	\$83,248

Figure 5: Data for Cumulative Cash Flow Graph¹¹

Figure 5 description:

- The year of operation is each year that the solar panels are functioning.
- Gross Cost is any amount of spending. The only two expenses are at installation and year 15.
- The green area represents all the money you are saving each year from various credits and utility savings.
 - o PUC of Ohio is an energy credit that gives you money for producing green energy.¹⁸

- o The Federal Tax Credit gives you 30% of the gross cost of the solar electric system back at installation.¹⁶
 - o Utility Savings represents the money you are saving by generating power with your solar panels.
- The annual cash flow is how much money lost/gained in that year only. This is found by adding all the numbers in the green area and subtracting by the gross cost for that year.
- The cumulative cash flow is the total amount of money you have lost/gained.

Figure 5 assumptions:

- Your solar panels stay at least 90% efficient for 25 years.¹¹
- The utility inflation rate is going to be 3.78% every year.¹¹