Economic Feasibility of Installing PV on the Farmhouse

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The purpose of this paper is to explore the economic feasibility of having photovoltaic cells installed to help meet the energy needs of the farmhouse on the evergreen campus. The farmhouse is an older building that is the home to two caretakers year round and currently draws its power from the PSE grid. To estimate the economic feasibility we will be focusing on the overall solar radiance that is available here in the Pacific Northwest, what function the solar panels will serve, and what type of system is most appropriate. It is our belief that with further research it will be shown that, yes, solar panels are an advisable idea to install for evergreens farmhouse.

We first became interested in answering this question for different reasons. One of us was very interested in weather patterns and how their blocking of the sun effects the amount of solar energy can be collected while the other was curious about the amount of solar energy needed to supply the campus radio station, KAOS, with enough energy to run completely on solar energy. As we have become more knowledgeable on the subject we've come to realize all the different factors that are involved in our separate questions. After awhile we realized that by working together to answer a central question we could accomplish more than by working on our own. Then with the help of Zita and the facilities here at evergreen it came to light that the school was interested in the possibility of installing solar panels on two of its buildings, the library building and the farmhouse. This is where we first started running into problems.

When evergreen was first built the contract for the job of its creation fell to the lowest bidder. The problem is that this led to many cost cuts to get to that lowest bid, We also have a sub question that will help us better illuminate our main question for this project. One thing that kept on coming up during our research was what type of PV system would be most appropriate for the farmhouse. There are a couple of major types of solar arrays out there and each has their separate purpose. For us the choice was between a stand alone, grid tied, or grid tied with battery backup system, each with their own advantages and disadvantages. So our question concerning this issue is as follows:

Question 2: What type of system would be most logical to use for the farmhouse if we were to install solar panels to power the building?

Hyp 1: An on the grid energy plan would be the most logical system for the farmhouse in conjunction with photovoltaic cells.

Hyp 2: An off the grid energy plan would be the most logical system for the farmhouse in conjunction with photovoltaic cells and batteries.

Null Hyp: The installation of photovoltaic cells on the farmhouse is in no way a logical decision when it comes to the powering the building due to the costs involved in the installation, upkeep and the lack of energy provided by the cells.

The heart of this project is to determine whether or not it is economically feasible to install solar panels on the farmhouse. Answering this question inherently entails addressing a variety of smaller considerations. However, most of these considerations can be summed in the following two questions: what is the overall solar intensity at the higher places (2). Luckily, the solar pathfinder diagram is made to facilitate just these kinds of calculations. By adding the numbers that are under the tracing along any given month's sun path, one gets the percentage of the solar availability for that month. Thus, by comparing the percentages of solar availability for each month at both sites we can easily apply the data from the pyranometer to estimate the solar radiance at the farmhouse.

Alternatively, if we are unable to gain access to a solar pathfinder, we could use a transit, a basic surveying tool, to manually map the skyline. Doing this would involve physically looking at each part of the skyline and recording the height and distance away. Overall this approach would be much more time consuming and probably less accurate. Once we have a well-researched estimation of the available solar intensity at the farmhouse it is very straightforward to determine how much electricity a given solar panel could produce.

Also, since the solar pathfinder yields the percentage of solar availability we can use data from other sources to get additional estimations. For example, the National Renewable Energies Laboratory (NREL) has a large database of total solar radiance measurements at different locations. Applying the percentage of solar availability at the farmhouse to the estimated total solar availability from any of these databases will yield a good estimation of the overall available solar intensity at the farmhouse.

Through LAB Stores we can also get access to an actual solar radiance meter. Another way (and perhaps the most direct way) we could determine the solar radiance at the farmhouse is to set up an actual solar radiance meter at the farmhouse. However, this will only provide data for however long it remains set up. This is a huge problem because there really needs to be years of data to get a strong sense of the overall solar intensity.

Finally, the conversion from DC to AC entails a loss of about 10%. Overall that means only about 68% of the generated power will be available for use.

We've been in contact with PSE, Puget Sound Energy, the major energy provider in the area and they gave us some very helpful links to solar potential generators online that give you an estimate based on averages. The website that was recommended to us by the PSE employee that we were in contact with was www.findsolar.com. When you first enter the website you are asked a series of questions concerning your area such as what state and county you reside in. Once you've selected who your energy provider is and what type of system you are looking into you are presented with the information that in Thurston County our solar rating is about 3.827 KwH/Sq-m/day which they describe as good. Upon entering all of our data we were sorely disappointed with the information that we were given. The figure for the costs of building a solar array attempting to offset half of your energy consumption per month with a energy bill of $60.00 and energy costs of $.069 per KwH would be around $45,000.00 with a necessary roof space of about 500 sq ft. Out of curiosity we calculated what array for a similar building would cost if that building were in California and not Washington.

So if we were to leave all data the same from our first calculation except instead of Thurston County Washington we calculated for Los Angeles California we came up with a net cost of only $18,000. Furthermore it estimated that it would only take 1-8 years to break even on costs compared to the 45 years in Washington.

It needs to be stressed that the findsolar program is only for a quick general estimate, and that a carefully researched estimate is bound to differ. Overall, this general overview from solarfinder reinforces what our research has shown. PV has a very high

This high cost makes it hard to make a system economically feasible from the stand point of just trying to save money. The farmhouse is quite large, around 3000 square feet. It would take a very large and expensive PV system to meet the entire power needs of the building. This makes it very unpractical to propose meeting all the farmhouses needs with solar. Alternatively, we could examine a specific aspect of the farmhouses energy use and try to supply just that part with electricity. For example, we could design a system for the particular purpose of running the well pump off of solar electricity. But as the quick calculator and www.findsolar.com showed, something like this would still be much more feasible in a sunnier area like California. Still, it seems like designing a system to meet just a portion of the building's energy needs would be much more feasible than trying to supply the total energy needed.

In consideration of cost vs. benefits it is important to note that a PV system would serve many more purposes that just savings on the electrical bill. In particular, it would serve as an excellent tangible learning tool for Evergreen students. Classes that examine solar energy would be able to get hands on experience with a system on campus. This would be a rare learning tool and would definitely help justify the initial cost.

To sum, we believe that designing a small scale system aimed at meeting a particular portion of the farmhouses power needs and with the specific intention of being used as a hands on learning tool would make the system economically feasible.

Another important area that needs to be addressed and makes up our second major question is what kind of system would be most appropriate. For the most part there are three main types of systems; stand alone, grid tied, and grid tied with battery backup (4). Stand alone systems are not connected to the grid and rely extensively and batteries in order to supply power when the sun is not shining. Grid tied systems, on the other hand, importantly of all, a price tag cannot be put on an invaluable learning tool. Having an active photovoltaic system on campus would be a wonderful opportunity for students and classes examining solar or related areas to get hands on experience with a real world system. Overall, we believe that it will be apparent that installing solar panels would be a worthy investment.

This is an excellent resource provided by NREL. The National RENEWABLE Energy Laboratory is one of the main renewable energy research institutions in the US

7. www.findsolar.com.

This site gives a quick and easy sense of overall costs. After entering a little information it spits out projected total cost, possible tax exemptions, years to pay off etc. for a given form of solar energy.

However, this source may not be that reliable. I assume that the database the program works from can only have so much. It seems like the information pertaining to particular areas is not completely thorough. Again, this is good only for a very broad general feel for costs.

8. Steven V Szokolay. **Introduction to Architectural Science: The Basis of Sustainable Design.** Architectural Press 2004.

This book provides in a good description of how irradiance works and can be calculated and also has a lot of info about creating sun charts. Overall this would be very helpful in trying to calculate a theoretical solar intensity.

I think this book is very reliable. It is the primary textbook used in the Science of Sustainable Building program, which lends to its reliability.

9. **Solar Energy: An Infinite Source of Clean Energy**
George O. G. Löf
Annals of the American Academy of Political and Social Science, Vol. 410, The Energy Crisis: Reality or Myth. (Nov., 1973), pp. 52-64.
Stable URL: http://links.jstor.org/sici?sici=0002-7162%28197311%29410%3C52%3ASEAISO%3E2.0.CO%3B2-Y

This article looks broadly over the pros and cons of Solar Energy. Solar Energy is abundant. Enough to solar energy strikes the Earth to cover our energy needs over 700 times (as cited by the article). However, solar energy cannot be efficiently converted to mechanical or electrical energy. This is largely because of solar's low intensity. You need a large light collecting area to get the same amount of energy that could be attained through a small area using conventional ways. This article also examines a variety of possible solar energy uses. It is for this reason I have selected this article. As related to my research interest, this article examines all the possible applications of solar energy.

I would say this article is fairly reliable and large in scope. Being peer-reviewed also lends the article weight. It does not propose anything very quantitative and is mostly a qualitative analysis of solar energy. In this way, the article does not really cover anything controversal and thus adds to its reliability. However, the article is quite old