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Senior Design in Power Engineering
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Project 1 Proposal

Design and Implementation of a New Solar Panel Array on a Passive Solar Tracking Mount for Whittemore Hall Solar Array

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Executive Summary

In a world where energy consumption is on the rise along with the depletion of the world's natural resources, it has become the world's number one priority in finding alternate sources of energy for the future. The most abundant resource most common to everyone, no matter of location, is the sun. So a shift towards solar power can have major benefits to everyone worldwide. Today's automotive fuel costs and the cost for power to buildings are constantly increasing due the demand and lack of resources. If consumers can garner their own power from sunlight to supply buildings and automobiles, consumers everywhere could save a lot of money. This would also help secluded regions where it is difficult to send power to.

The purpose of this project is to upgrade the current solar array on top of Whittemore for ongoing investigation and research into solar energy. Although for educational purposes, the ongoing investigation will prove the usefulness of solar arrays in powering buildings while decreasing power consumption and cost from power companies.

Solar panels are very efficient and easy to maintain and can supply a great deal of power. An average solar panel can last a user up to twenty years if properly maintained. With new ways of mounting panels that follow the sun, the efficiency of the panel can be greatly increased. Solar panels can be used by anyone, for large or small scale applications, where the power can either be stored or directly tied into the power grid of a building.

Problem Statement

Over the past couple of years, there have been several improvements made to the Whittemore solar array including the cleaning, refurbishing, and removal of solar panels. All of the solar panels on top of Whittemore are beginning to show their age, and in the very near future, may become completely unusable.

Our solution to the aging solar panels is to install a modern solar array mounted on a passive solar tracking mount[1]. This passive solar tracking mount will allow for both expansions to other types of solar panels as well as a higher efficiency of delivered power than the currently installed stationary solar arrays.

The new passive solar tracking mount will be directly attached to the existing framework on top of Whittemore Hall for a secure framework to hold a new array of solar panels. After the passive solar tracking mount is installed, the solar panels will rest on each side of the passive tracking mount, creating a new solar array. After each panel's terminals are tied into one another, the array's wiring will then be ran through the conduit down through the roof and to the Voltage Rack in the 7th floor laboratory. The voltage rack will read the input voltages and current and send the information to the data logger and [1]the new DC inverter. The grid tie-in DC

[1] See Appendix A for a picture of the passive solar mount.

inverter will then tie the current coming from the new solar array into Whittemore Hall.

Operational Description

This Solar Array upgrade will address three main points. First, new Solar Panels with greater efficiency will be installed. These new panels will output at least 165 Watts a piece while the use of least six, in new the array. Second, the array will be mounted on a state of the art passive solar tracking system. This system uses water that is heated by the sun and gravity in order to rotate and turn with the sun during the day. This eliminates the wasted power at hours where the sun may not be hitting the array directly. At all times the array will be receiving maximum solar radiation with this new mounting system, as the sun will be hitting the panels point normal. Finally, a new more efficient inverter will be purchased. This inverter will contain data logging capabilities and thus replace the old and complicated data logging system. This data logging is easily hooked up to a PC through a modem and will help with debugging and checking the new efficiency of the array.

The main point of this new array is the mounting system that will help increase the array output power by around 25-40% compared to fixed mounting systems. This increase in efficiency is equivalent to removing three panels from the array and still getting the same amount of power. If three panels were actually removed this could save almost $2400. Therefore, by including this new mounting system is the equivalent of

gaining 200 watts of power free. The flow chart below shows a general setup of how the new solar array will be tied into the Whittemore Hall's power grid.

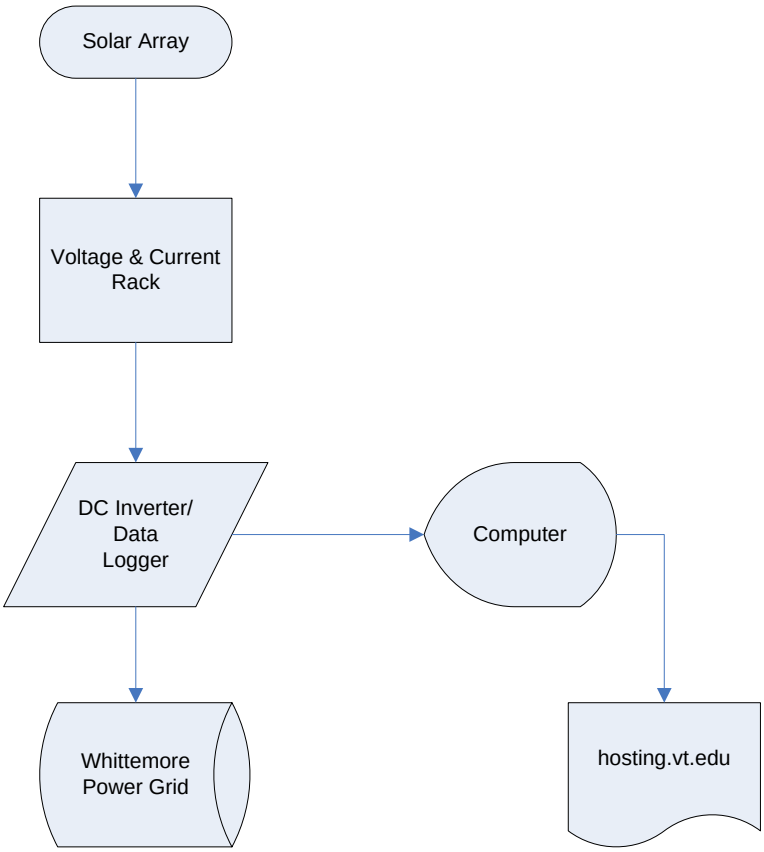


Figure 1: Flow chart of the new Solar Array

Requirement Specification

The new array will help Virginia Tech obtain more efficient power returns from a new set of solar panels or even the existing panels that remain from past research. Currently the solar array has some panels that need to be replaced and thus is not running at its full capacity. In order to improve the current solar array and therefore provide Whittemore with more power, a new set of panels will be needed. These new panels will be more efficient and have a much longer life expectancy then the current panels.

One new Inverter for the array will provide increased power transfer. This allows the system to convert the AC voltage to DC so that it can tie directly into the power grid and therefore eliminate the need for batteries on the roof.

Along with the new panels, the best way of maximizing the amount of sunlight received is through the use of a solar tracking mounting system. This system will have to be able to receive data about the sun's position by reading its intensity. The system will have to be easy to maintain and will be completely autonomous so that there will be no need to move the solar panels for each season. The system will also contain no motors and will be controlled solely by the sun and gravity limiting problems with motors, gears, and controls.

A new set of solar panels will consist of the following specifications meeting or exceeding the criteria below:

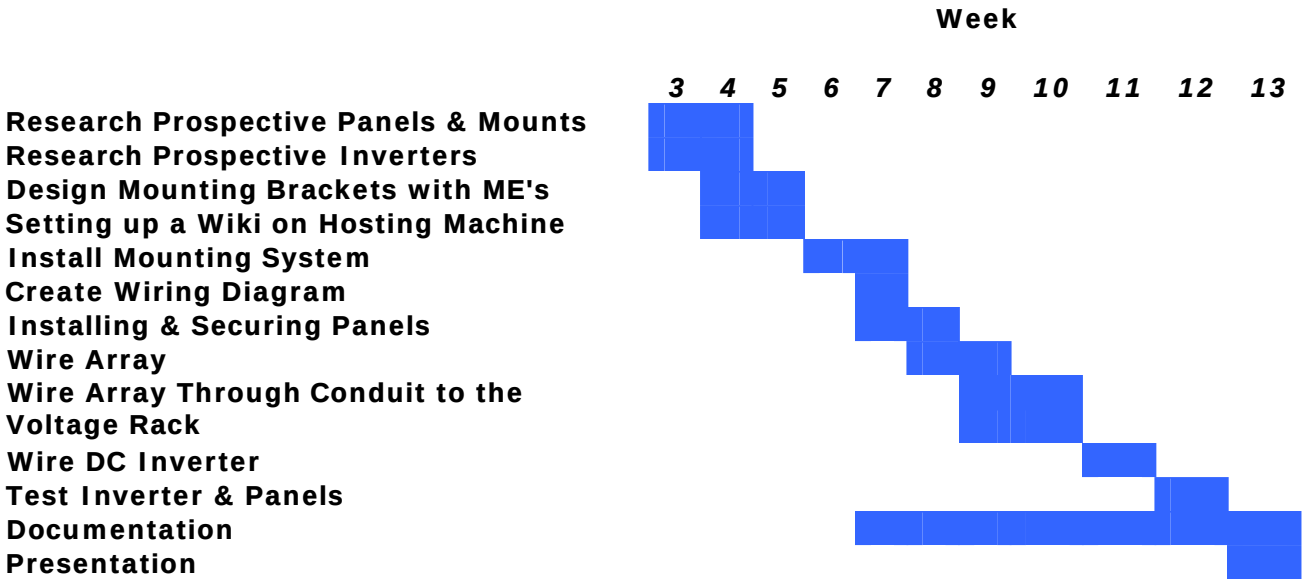
- ⇒ 165 Watt Output Power (Max) Panel(s)
- ⇒ 12 Volt Output Voltage
- ⇒ Grid-Tie System
- ⇒ Under 60 lbs
- ⇒ 20 Year Life Span for Panel

The new Inverter will be a combination of a data logger as well as an inverter. The Inverter will have to meet or exceed the criteria below:

- ⇒ Able to handle 2500 Watts of Power
- ⇒ Max Voltage 300 Volts
- ⇒ Max DC Current 9 Amps
- ⇒ Efficiency > 90%
- ⇒ PC Logging capability
- ⇒ Report kWh and check performance of system

The solar tracking mount will have to meet or exceed the criteria specified below:

- ⇒ Passive track mount (No Motors)
- ⇒ Universally sizeable to accommodate different panel sizes
- ⇒ Life Range 30 Years
- ⇒ Ability to handle Six Panels by a wide variety of companies
- ⇒ Increase efficiency of array by 30% or more



Design Deliverables

Upon completion of this project, all information regarding our research will be provided along with, and, implementation of the new solar array. And track mounting system in an IEEE formatted report. This report will be accompanied by a link to the wiki used for the solar array documentation and progress throughout the construction and completion of the project. The final report and wiki will be presented in Adobe PDF format.

Once the project is complete, we will take pictures of the new solar array, passive track mounted system, and dc inverter/data logger and post them to the solar website. This final report will be presented on a compact disc with all wiring diagrams, manual, wiki documentation, and pictures of the work progress as well as completion.

Preliminary Test Plans

The project will first begin by the creation and starting of a wiki on a dedicated machine provided by hosting.vt.edu. This machine will serve as a documentation headquarters to only the group members that are working on the new solar array project. This documentation approach is easily editable, and constantly accessible, making it easier to find students previous work, ideas, and to-do lists online. This is more feasible than searching through many papers for this kind of information. This will only take one day to setup.

The next step in the project will begin by working with the senior Mechanical Engineers of Virginia Tech, if needed, to create and install a safe and secure mount for the passive tracking solar array mount. Once the design has been completed and fabricated, we will mount the passive tracking system onto the roof of Whittemore Hall along with the solar array. We will then test the new DC inverter/data logger to make sure it is functioning properly before tying the new solar array's power into the building's power grid.

Implementation Issues

The most common problem is the weather conditions while working on the roof of Whittemore Hall. Depending on weather conditions, it maybe unsafe to work and thus may delay the final installation and wiring of the solar array. The arrival of the ordered equipment may also affect the installation. Depending the arrival date of ordered equipment is on time and that all equipment works perfectly, this may also cause major time delays. During installation, equipment may also be damaged and required to be uninstalled and sent back to the manufacturer which would also pose delays.

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Appendix A

Figure A-1

Passive Track Mounted Solar Array – Courtesy of Zomeworks

This passive track mounted solar array allows for the mounted solar panels to move with the sun, providing 25-40% more efficiency all the while using no power, or motors. This mounting system is liquid balanced, and will allow for the array to move with sun depending on how the liquid inside the mounting system is heated. It provides for a maintenance free option to solar panels tracking the sun.