Hybrid Wind Solar Generator

PROJECT PLAN

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1 Introduction

1.1 Project statement

The development of a hybrid wind and solar power generation system.

1.2 purpose

As “Green” energy is a growing industry, implications are developing on the supporting architecture of the power grid. Building this hybrid power generation device will allow us to test the role renewable energy will have on peak loads and the necessary supporting architecture.

1.3 Goals

Design the hybrid system using software simulation in order to better understand its inner workings.

Purchase and set up a wind turbine.

Combine the newly purchased wind turbine and the already existing solar panels so that their generated powers combine together.

Create labs for EE 452 centered around the hybrid system so future ISU students can use the hybrid system as a learning tool.

2 Deliverables

To complete the goals listed above, we will need to understand how wind and solar energy systems work on a component level, as well as on a simulation level. Each team will need to do research on their respective topic and build a simulation model that accurately reflects what the system should accomplish.

Specifically, Solar team will need to study and verify the photovoltaic effects through varying temperature and irradiance on the system, as well as by studying the effects of the absence and presence of the maximum power point tracking, a battery bank, and finally a load. From there, we will move onto the hardware component of the project in order to verify our results and gain an overall understanding of how the system works in everyday weather conditions.

Wind team will need to develop a similar model that can monitor the output of a system with changing variables. How these variables affect the output include wind speed, rotor area, and power coefficient. Once we implement the hardware, we will need to make sure to include equipment to monitor wind speed, voltage, and power flow so we can compare our system to the simulation.

Once both the wind and solar components are working individually, we will need to combine them in simulation and then, based on the simulation, combine the hardware. We will need to verify that the systems are working together and then develop reproducible lab experiments to be used in EE 452.

3 Design

3.1 Previous work/literature

The previous group utilized a photovoltaic array and a simulated wind turbine via wind controlled motor that was linked to a generator. Our current solar team was provided two Kyovera Solar KD135GX-LPU solar panels, a MPPT, a battery bank, a rectifier, boost converter, and an inverter. We were also given a great deal of literature pertaining to both Solar and Wind energy by Ankit Singhal, our project TA. This literature includes:

Bhuvaneswari, G., and R. Annamalai. "Development of a Solar Cell Model in MATLAB for PV Based Generation System." *2011 Annual IEEE India Conference* (2011): 1-5. Web.

DenHerder, Tyson. "Design and Simulation of Photovoltaic Super System Using Simulink." *Electrical Engineering Department California Polytechnic State University San Luis Obispo* (2006): n. pag. Print.

Hansen, Anca D., Poul Sorensen, Lars H. Hansen, and Henrik Bindner. "Models for a Stand-Alone PV System." *Riso National Laboratory, Roskilde* (2000): 1-78. Print.

Mishra, Bibek, and Bibhu P. Kar. "MATLAB Based Modeling of Photovoltaic Array Characteristics: A Thesis in Partial Fulfillment of Requirements for the Award of the Degree of Bachelor of Technology in Electrical Engineering." *Department of Electrical Engineering National Institute of Technology* (2012): 1-42. Print.

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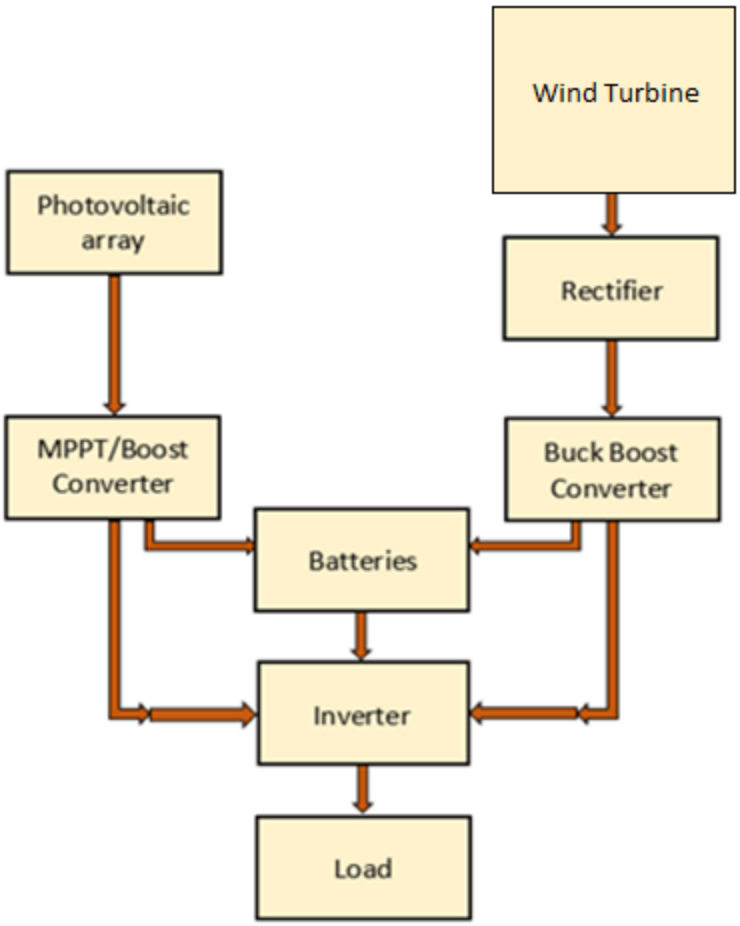
Yu, Ting-Chung, and Yu-Cheng Lin. "A Study on Maximum Power Point Tracking Algorithms for Photovoltaic Systems." *Department of Electrical Engineering Lunghwa University of Science and Technology* (n.d.): 1-10. Print.

3.2 Proposed System Block diagram



3.3 Assessment of Proposed methods

The approach we would prefer to take is to research and simulate the solar and wind systems separately before integrating them into one system. As we are doing this, we are looking into purchasing and installing a wind turbine, as well as getting familiar with the solar panels and system the previous senior design group left us. Once all simulations are complete with suitable results, we would like to look into integrating the hardware and equipment to verify the results of the simulations and construct a lab for EE 452.

3.4 Validation

Pre-Confirmation of the system is done with combined simulation of both solar and wind aspects with supporting devices and simulated load. We will be able to measure wind speed and replicate it in the simulation. We are also currently looking into ways to measure the irradiance. Ideas we've had are: buying a device that directly measures irradiance, approximate irradiance from temperature, or use an infrared light sensor and arduino to approximate irradiance. True confirmation of the system is achieved by powering a fully resistive load that will vary based on peak and nonpeak times.

4 Project Requirements/Specifications

4.1 functional

Working simulations in simulink will be achieved before hardware decisions and experimentation occurs, except the wind turbine emplacement. We will have a fully operating simulated system using a generic wind turbine before we purchase a wind turbine, but we won't be able to include its specific attributes until we receive and test our specific wind turbine.

Our solar panels will utilize MPPT control for efficient power output and then to a boost converter. The wind turbine will produce AC power that is rectified and then sent to a Buck/Boost converter. Both systems meet to charge the battery and from the battery go through the inverter to power the load.

4.2 Non-functional

Analysis of solar and wind emplacement for maximum power generation. MPPT logic improved to maximize power more effectively and understanding the role of external factors such as temperature on solar panels.

5 Challenges

Challenges for this project range anywhere between being able to meet as a group, to get work done, to getting approval to purchase and install a wind turbine on the Coover Hall premises. The solar team has been researching the photovoltaic effect in terms of temperature and irradiance, as well as effects of having an MPPT and battery in the system. However, we are using models that were built by previous groups, and are not well documented making it difficult to move onto the hardware portion of the project.

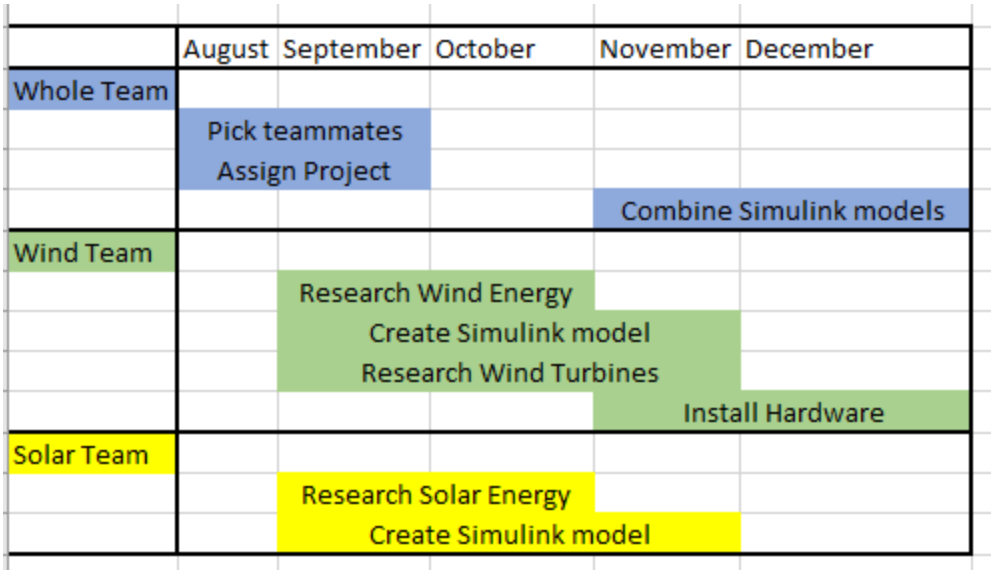
The process of purchasing and installing the turbine will likely come in over the current budget. With help from Professor Ajjarapu, we may be able to overcome this obstacle, however we are still faced with system constraints based on possible placement of the wind system. We are currently trying to choose between putting the turbine in either the courtyard, which may not receive the minimum amount of wind

necessary to generate power, or putting it in a Northwest corner of the Coover property, which costs extra because of the landscaping and aesthetic work that would need to be done.

6 Timeline

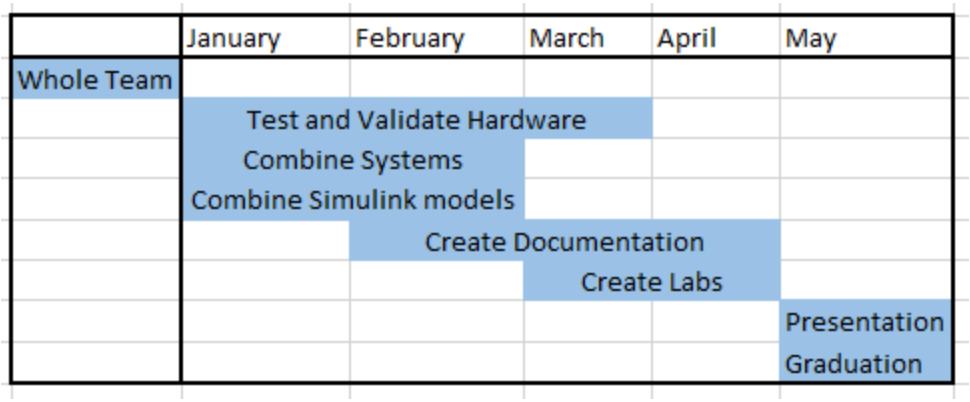
6.1 First Semester

The timeline can be generalized to three different stages. The first stage ranging between August to September regarded formalizing the administrational side of things. Second stage ranging between September to October has Solar and Wind groups working on their respective simulations and research. The last stage of this semester ranging from November to December have the simulations being combined and the wind group installing the hardware for the new wind turbine.



6.2 Second Semester

Second semester will see the entire group working together. Hardware testing and continued combined simulink models will be the beginning tasks that will turn out the entire combined system by March. Midway through the system's construction is when formalized documentation and labs will begin development before presentation and our graduation.



7 Conclusions

In conclusion, after completion of our project according to the aforementioned plan, our Senior Design Team will have created a simulated wind turbine, simulated solar array, a simulated hybrid (wind and solar) system and physical hybrid system that will be able to operate completely off-grid. In addition to the power generating components of the wind turbine and solar panels, our design will also include a system to ensure maximum power efficiency (Maximum Power Point Tracking system), a system to store unused power and a system to simulate a load or a demand for power. Once the system has been implemented lesson plans will need to be developed so that the hybrid generation station can be included as part of the course curriculum for EE 456.

Some of our other short term goals include working with the Wind Energy Student Organization (WESO) to potentially provide funding for our wind turbine and long-term support even after our group has graduated. Coordination with Facilities Planning & Management is also necessary in order to mount a wind turbine in the Coover courtyard or on the roof. The process to achieve our goals is already underway and our team is making sound progress to finish our project.

8 References

Bhuvaneswari, G., and R. Annamalai. "Development of a Solar Cell Model in MATLAB for PV Based Generation System." *2011 Annual IEEE India Conference* (2011): 1-5. Web.

DenHerder, Tyson. "Design and Simulation of Photovoltaic Super System Using Simulink." *Electrical Engineering Department California Polytechnic State University San Luis Obispo* (2006): n. pag. Print.

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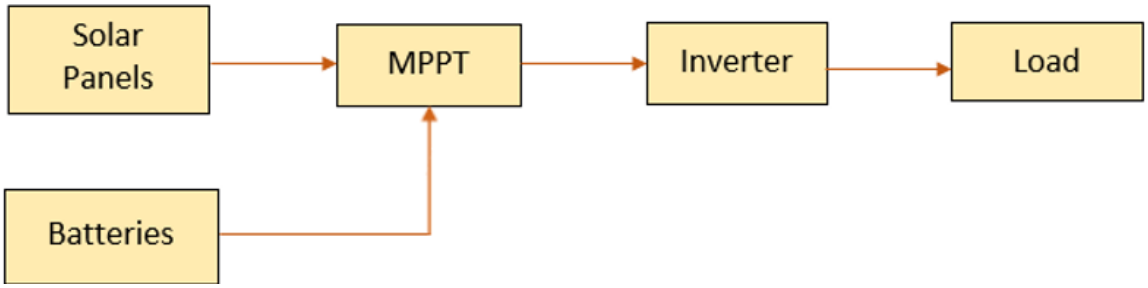
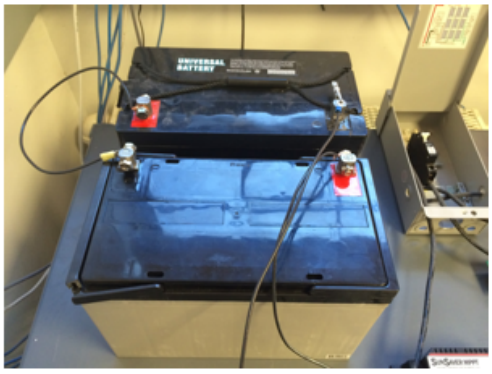
9 Appendices



Solar panels

Panel combiner

MPPT



Batteries