# Design and Implementation of a Small Scale Standalone Hybrid Solar PV and Wind Energy System

PROJECT PLAN


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19
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# Table of Contents

**NOTE: Due to weather related issues, Group could not meet with professor to receive full details on what is required for the project. Project plan will be adjusted and revised according when meeting with the professor next week.**

# 1 Introductory

## 1.1 Acknowledgement

Prior Senior Design team that worked on this project for supplying us with their deliverables. Professor Venkataramana Ajjarapu for supplying equipment needed for completion of this project. Pranav Sharma for aiding us and guiding us in the right direction when issues arise.

## 1.2 Problem Statement

To revise, improve, and expand the current solar and wind generation lab for the class, EE 452, that allows the lab to be more user friendly and educational by improving on how to better communicate characteristics and function of a stand-alone Photovoltaic (PV) system. The focal point of the project is to allow students to further understand concepts and ideas of a stand-alone system through a lab that reflects these concepts and ideas. Revising and improving current labs will be beneficial to connect concepts and ideas in class to lavatory experiments. Concepts and ideas in class and in lab can be related to standalone applications and grid connected technology. If time allows, an implementation of wind energy will be developed as a lab, but that is still pending.

## 1.3 Operating Environment

The operating environment for this project consist of indoor laboratory and outdoor laboratory if weather allows. Since the project both takes in solar and wind energy systems, the ideal placement for equipment would be outside. The equipment must be able to withstand the elements of the outdoors. Due to weather being unpredictable, it will be difficult to have solar energy on cloudy days, and implementation of wind energy would be unusable if no sufficient wind is produced.

## 1.4 Intended Users and Intended Uses

To design a project that allows students to further their understanding of standalone PV system that implements both solar and wind energy. Allow students to understand the importance of solar and wind energy and applications in real life scenarios. Due to the technological advances in wind and solar energy, renewable energy has been more common throughout the world. Thanks to this, there is an increase in demand for renewable energy thus Electrical Engineers need to understand concepts, processes, and challenges in renewable energy.

### 1.5 Assumptions and Limitations

The limitation of this project is that it can only be used in the laboratory at Iowa state. Since this project is to improve, and revise solar and wind labs in the class of EE 452, the design will only be used in the labs for the specific class. Due to weather being unpredictable, it will be hard to produce solar energy without sunlight, and produce wind energy without wind. Weather conditions need to be met to complete labs based on concepts of wind and solar energy due to weather.

### 1.6 Expected End Product and Other Deliverables

Deliverables required by client has not yet been specified. Deliverables that assumed required by client will be improvement of specific labs in class of 452. Improving the current standalone PV system created by the prior senior project group. Possibly improving the current system and if time allows, implementing wind energy into lab. Outline of revised lab and documentation of lab that has been revised or created for future students to complete. An outline of concepts that is needed to complete the lab that outlines ideas of solar and wind energy.

## 2 Proposed Approach and Statement of Work

### 2.1 Objective of the Task

The goal is to improve, revise, and expand the standalone PV system. Create, revise, improve labs that combines concepts learned in class relate to experiments in labs. Have labs reflect the importance of renewable energy. Lab manuals needs to be clear and concise, can be completed in 3-hour time period, reflects course concepts and materials, and have relative relation to real world problems. Lab should reflect ideas of fundamentals of MPPT, Power measurements, PV cells, Buck/Boost Converters, Irradiance and temperature dependences. Improvement on the work station created by prior group may need to be updated to be organized, intuitive, safe and reliable for students taking the course. All materials need to be well organized, explained, and be intuitive to students. Labs will be updated and revised if new applications are used or newer version of software is used.

More will be addressed when meeting with Professor Ajjarapu this week, functional requirements and non-function requirements will be adjusted or change depending on meeting..

### 2.2 Functional Requirements

Modeling solar panel using Simulink with visually representation of overall project. Being able to model every component of project to test setup in order to safely set up design.

### 2.3 Constraints Considerations

Understand how to model a solar cell with I-V, P-V curves plotted from model. Have proficient knowledge on how maximum power point tracking relationship to I-V, P-V curves and how different algorithms used to attain max power from a solar panel. The idea of charging/discharging battery and the pros and cons of using a rectifier, inverter, boost/buck chopper in the standalone power system.

Standards will comply with the IEE standards. Standards are still being developed for solar power energy due to it being a relatively new power source. IEE standards include sizing, installation, and maintenance of lead acid batteries. If wind energy is implemented in the project, standards for measuring different parameters of wind turbines will be included. Standards for the city of Ames when importing solar energy will be also included. Ethnical issues will include the safety of students using the lab equipment. The equipment needs to be safe due to the possibility of measuring high amounts of voltage and current. Each lab manual needs to include a MUST README, that informs the students the possibility of measuring high voltage or current and safety precautions that needed to be taken. Informing the student of safety precaution is our responsibility.

### 2.4 Previous Work And Literature

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the **advantages/shortcomings**

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

### 2.5 Proposed Design

-Will provide later base on meeting with professor Ajjarapu this week

### 2.6 Technology Considerations

Currently the group is learning how the prior groups Simulink model works and how each component plays a part in the overall project design. Once that is completed, we will be able to have hands on run at producing the pervious group project. Learn about how it operates in a laboratory scenario and determine what needs to be updated and what needs to be fix or remove.

### 2.7 Safety Considerations

Handling of lab equipment. Students must be informed that there is a possibility of measuring high amounts of voltage and current. Each lab needs a README to inform the student if there is the possibility of measuring high voltage and current.

### 2.8 Task Approach

Describe any possible methods and/or solutions for approaching the project at hand. You may want to include diagrams such as flowcharts to, block diagrams, or other types to visualize these concepts.

### 2.9 Possible Risks And Risk Management

Currently since majority of the group members are in EE 452, we have not learned the basic knowledge of the overall course, therefore it will be a slight challenge to improve on the labs without testing them ourselves. We may have to switch out solar panels or add more solar panels to the project if needed. Mostly, knowledge of the overall system and how each component works with one another is key in order to minimize risks in this project.

### 2.10 Project Proposed Milestones and Evaluation Criteria

- Understanding prior group's work
- Being able to simulate prior groups work using Simulink and understanding each component and how it interacts with other components
- Reproducing the same results as prior group
- Improvements on the old system if needed
- Ideas to improve on pervious system
- If time allows, add wind implementation to current project

### 2.11 Expected Results and Validation // addressed After meeting with professor Ajjarapu

What is the desired outcome?

How will you confirm that your solutions work at a **High level**?

# 3 Project Timeline, Estimated Resources, and Challenges //Addressed after meeting with Professor Ajjarapu

## 3.1 Project Timeline

January 15-January 28: Talk with client and gain understanding of his expectations.

January 28-February 18: Work on understanding previous groups' work and modeling the system in Simulink.

February 19-March 4: Decide which part(s) of the lab we would like to focus on to improve, and begin modeling in Simulink.

March 5-May4: Begin implementing improvements and refine our goal as we encounter issues.

## 3.2 Feasibility Assessment

At the end of this project, we will be able to deliver an updated lab document to be used in EE 452. This new lab will either have new or more intuitive equipment, and hopefully a functioning wind turbine to be used to supplement learning.

# 4 Closure Materials

## 4.1 Conclusion

This project is to revise, improve, and expand the current solar and wind generation lab for the class, EE 452, that allows the lab to be more user friendly and educational by improving on how to better communicate characteristics and function of a stand-alone Photovoltaic (PV) system. Revise, and improve current labs in EE 452 that better reflect class material and incorporating them into a fun and interesting way in laboratory work. Thus, emphasizing the importance of renewable energy, wind and solar energy and how effective it could be in a global scale.

## 4.2 References

List all the sources you used in understanding your project statement, defining your goals and your system design. This report will help you collect all the useful sources together so you can go back and use them when you need them.

– This component shall completely identify any material taken from other sources and used in the development of the project to date or are known that will be used during the remainder of the actual project

– These references shall be complete so that any member of the plan's audience could find them

- Have these on a separate page.

### 4.3 Appendices

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. You may also include your Gantt chart over here.

– Any additional information that would be helpful to the evaluation of the project plan or should be a part of the project record shall be included in the form of appendices

– Examples of project documentation that might be included are property plat layouts or microprocessor specification sheets germane to the proposed project.