

Background

During times where there is high supply of power and low demand from the population, power generated from wind turbines are stored in discrete energy storage systems known as microgrids.

Microgrid is a critical infrastructure which provide backup power during power outage, increase grid stability and provide power for isolated rural communities. Throughout the world there are currently approximately 1800 microgrids with a typical capacity of 100kW to multiple megawatts. Ref:[1]

Current microgrid systems are expensive to build they invoke the cost of purchasing large area of land and the building costs to environmentally protect the energy storage system from extreme temperatures. The cost of a microgrid system can vary from as little as £250,000 to 100 million and according to (c2es,2017) they size of microgrids are estimated to grow by 2020. Ref:[2]

A typical wind turbine is hollow and there is a large amount of free space and with the mast of the wind turbine as a container to environmentally protect the contents within we can embed an energy storage system within and remove the microgrid. If you can imagine that there are many wind turbines which has this property, we can consider a study of cost feasibility.

With the progression of modern battery technology, a high density of energy can be stored within a small size package. one such example includes lithium-ion cells which typically weighs 48g and contains a capacity of 2,850mAh. Ref:[3]

Initial research has been conducted by professor T.C Yang, which the document suggests that there is no solution on the market which integrates groups of batteries within the wind turbine. The scheme proposed can be further developed to push development for this study. Ref:[4]

Aim

The aim of this project is to design and integrate an energy storage system within a small-scale wind turbine, with the goal of the solution being novel and cost effective when compared to the conventional microgrid.

Objectives

Embed a storage system within a small sized wind turbine prototype, the wind turbine must act as a single unified system where power generated from the generator needs to be distributed to both the battery and the load. To achieve this a model of the system will be design and simulated in software before implementation using MATLAB/Simulink.

A circuit will be used to monitoring, maintenance and protection of the battery should be possible with the design of a BMS (battery management system) solution. The wind turbine will need to be able to generate energy for both the load and the battery with the correct voltage.

Methodology

The methodology is a logical flow of steps which will be followed to build the system. The end goal is to have a small wind turbine model with integrated storage system, the following steps to reach that goal is as follow:

1. Research existing renewable energy systems which interfaces with battery such as a solar system and carefully choose components for design
2. Design a simulation of the system within MATLAB/Simulink
3. 3D model a small-scale wind turbine with integrated battery system
4. Design a circuit for connecting the whole system together.
5. Write software to control the battery management system to ensure that the system works safely and functionally.
6. Assemble and test the small-scale model

Tools/components - to use and to learn

Software tools

Matlab/Simulink – Test and understand conceptually if the system can work functionality through simulation of batteries, generators and load.

3D modelling tool – For producing a small scale 1:1 real life model of a wind turbine, this will be used to verify if components can be mounted properly within the wind turbine

Programming IDE for chosen micro-controller – The system which will be developed is a type of embedded system and the language C will be used for programming to a micro-controller.

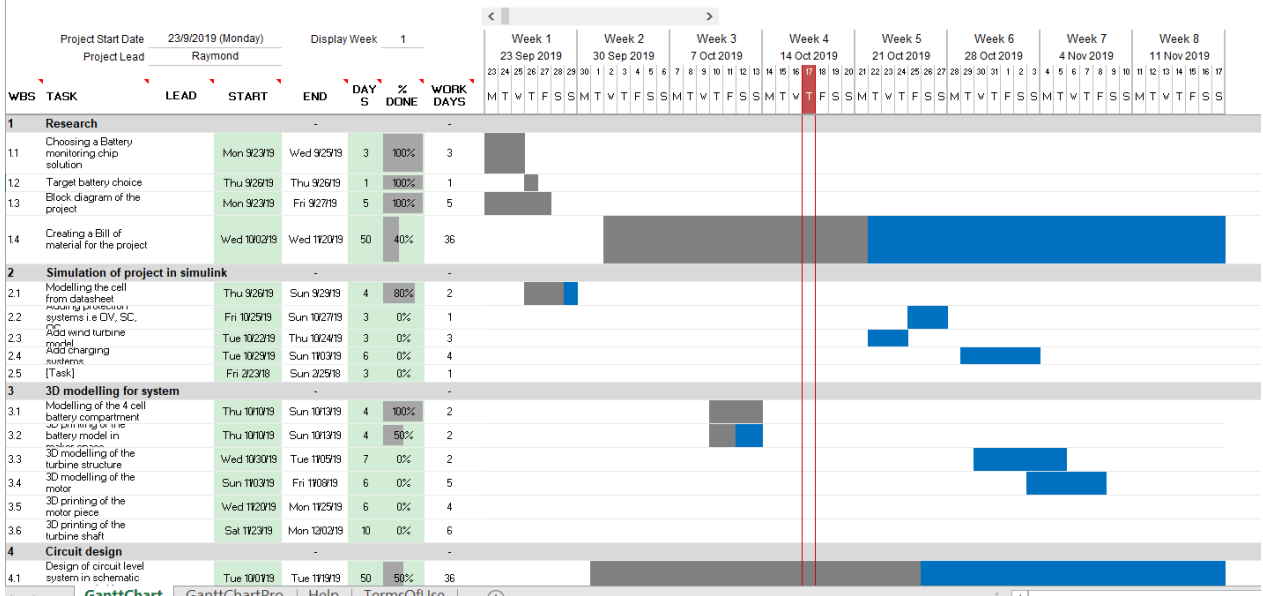
Hardware tools

3D printing machine – used to print parts for the model

Gantt chart

Using the Gantt chart is a proven method of keeping the project on track, the following Gantt chart image shows a small representation of the goals for the project.

Project title - Embedded battery wind turbine



Reference

[1] citation: <https://microgridknowledge.com/microgrid-benefits-eight/>

[2] Citation: <https://www.c2es.org/site/assets/uploads/2017/06/microgrids-what-every-city-should-know.pdf>

[3] citation: Samsung INR lithium cell datasheet

[4] Citation: "Initial study of using rechargeable batteries in wind power generation with variable speed induction generator" by professor T.C Yang from University of Sussex