Renewable Energy Study

Ray Floyd
Northwest College Wyoming

Abstract

Through a NASA grant, the Science and Math Division at xxxxxxxxxxx College was able to start a multiple step project on the study of the benefits and effects for renewable energy sources applicable to local conditions. In particular, a wind generator was installed as the first step. The second step, or project, was to determine the effectiveness of the wind generator in the local area. Once that was completed, the next step plans to install solar cells to determine the effectiveness of that source and the practical application of a combination of wind and solar power for future use. The project enables pre-engineering and computer engineering students an opportunity for installation, maintenance, data gathering, and analysis during their first two years of engineering studies.

Introduction

The Science and Math (S&M) Department at xxxxxxxxx College is a typical two-year community college having pre-engineering classes such as Calculus, Statics, Dynamics, Strength of Materials, Chemistry, Physics, and other early engineering offerings. With current interests in renewable energy sources, the S&M Department decided that some additional emphasis on such alternate power generation sources would be a good addition to the current program offerings. Such activity would not be a substitute for current classes, but offered as a special project for interested students on a pay-for-hours basis. The students would be paid for their participation, and would be expected to complete a term paper for the particular project phase they had completed. It was also of interest to see if sufficient interest was found in the students to build a class offering around the renewable energy sources study.

The S&M Department developed a multi-phase plan to implement renewable energy systems. The plan has a number of phases, with future work to continue to benefit student's knowledge of such systems. The phases planned were:

Phase 1 – Select and install a Wind Generator. Monitor the generator operation for power output and conditions related to that power.

Phase 2 – Add an anemometer for wind speed and direction. Summarize wind speed versus power generation. (Phase 1 and Phase 2 have been completed)

Phase 3 – Add a solar panel array power system. Monitor the solar power operation for power output and conditions related to that power.

Phase 4 – Analyze overlap between wind generator and solar panel power generation.

Phase n – Continue to maintain, operate, and analyze data by students as funding permits.

Phase 1

The desire to develop alternative power generation methods have brought about a number of avenues as alternatives to fossil fuel power stations, including hydroelectric, solar power, geo-thermal power, and wind power generation solutions. One problem with the developed alternatives for fossil power generation is the question of applicability of the alternative to the particular geographic conditions of the installation. This project was intended to develop information on the applicability of alternative resources for power generation in the Big Horn Basin area.

Xxxxxxxxxxxxx College completed the purchase, installation, and operational test of a wind-power generator manufactured by Xzeres, Inc., Skystream Residential Wind Turbine, Model 3.7, 2.4 KW. This activity was completed as part of a NASA grant NNX10AJ89A in the amount of $15,216. While the project noted had been completed satisfactorily, the project had not satisfactorily closed the loop of data gathering, analysis, and sharing. That was the goal of Phase 2. The intent of this phase was to; 1) design and implement an application program to gather power generation data on a periodic basis and store that data for analysis,2) generate weekly summary reports of wind speeds and power generation, 3) generate an annual summary report of the operational characteristics of the wind power generator operation in the Big Horn Basin, and 4) expand the wind-powered project to include an equivalent solar-powered array to determine the most economical solution for application within the Big Horn Basin.

While this project had definite tasks for completion and possible application, it would also be a foundation for a future project to include solar power generation, and the possible use of both for effective alternative power generation in the Big Horn Basin satisfying the final objective.

When the installation of the wind generator was complete, the data collection phase was started. A remote data collection PC was installed to interface to the wind generator system, collecting power generation on a fifteen minute basis and logged remotely. The wind generator had an RF transmission capability allowing the wind generator to be remote up to 300 feet from the PC. The consistency of the data collection was poor due to noisy systems and general power fluctuations. As a general statement, the wind generator did perform as expected, with some questions at times due to communication and system failures. The majority of this period was in the use of programmers to collect, assemble, and analyze the data being recorded from the wind generator, which included date, time, and power generated during the prior period. From the results, more questions were raised as to wind conditions, communications methods, and data collection and conversion. The Wind Generator is illustrated in Figure 1.

Figure 1 – The Wind Generator

Phase 2

In order to better understand the operation of the wind generator, when it ran or when and why it stopped generating power, a decision was made to seek funding for the addition of an anemometer system to collect wind speed and direction correlated with the output of the wind generator. It was also tasked with an improvement of the data collection process of the wind generator.

From that, an anemometer system was purchased and installed. The system provided a radio frequency communication link similar to the wind generator, but on a non-interfering basis. A PC application was provided to record the data on a selectable basis, and a remote access application for data collection on campus. For this application, the best time basis available was at ten minute intervals. The wind generator was also changed to a local PC so the data could be collected on a dependable basis. The two systems were synchronized to report the data collected on a common time basis to enable analysis of conditions under which power generation started and stopped. This data analysis was required for the completion of this phase. The anemometer system in shown in Figure 2.

Figure 2 – Anemometer System

The next activities primarily centered on the data gathering from the wind generator and anemometer. Each data set had to be converted for importing into MATLAB, where entries were then date/time matched to begin the data extraction process. One problem noted earlier was that the wind generator recorded its data in fifteen minute intervals while the anemometer recorded in ten minute intervals. This was resolved by averaging the data into two one-half hour periods for the final data analysis. The anemometer system provided much more information than was required for the study, and was simply extracted as needed for wind speed, wind direction, and maximum gusts speeds. A typical data stream is illustrated in Figure 3.


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"1";"01.01.2009 04:00 AM";"24.54";"71.6";"54";"72.2";"49";"52.0";"---";"---";"---";"---";"0.00";"0.00"
"2";"01.01.2009 06:00 AM";"24.49";"71.1";"49";"72.4";"46";"50.5";"---";"---";"---";"---";"0.00";"0.00"
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Figure 3 – Typical data for anemometer

The data for a three month period was analyzed on a day-by-day basis. For that period, the wind generator provided a 1.75 Kwh average output with an average wind velocity of 10.8 mph.

There were brief periods where the wind generator would drop out of rotation with wind speeds of less than 3 mph. Such brief shutdowns were more than compensated for through the battery/inverter operation of the wind generator. From the data analyzed, the wind generator would appear to be a satisfactory alternative power generator, with short periods of power being sourced elsewhere.

Phase 3

A question resulting from Phase 2 was could a hybrid system composed of a wind generator and a solar panel array be used to bridge the periods when there was insufficient wind to drive the wind generator in periods longer than normal. To answer that question, the S&M Department requested funding support from the xxxxxxxxxxx Foundation to purchase and install a 1500 watt solar array panel. This request has been granted in conjunction with funding to support student activity in the installation, operation, and data analysis of the solar array operation. This work is to take place during the Fall Semester of 2017. All equipment has been purchased so work can begin immediately after school begins in August 2017. The information gained during this phase will be available as part of the presentation at the ASEE Conference in the spring of 2018.

Phase 4

This phase will begin in the Spring Semester 2018, where the data from the wind generator and the solar panel will be analyzed for power generation on a twenty-four hour basis, depending on which system can provide the necessary power source. If neither will suffice, the question then becomes can the combination provide sufficient power without other commercial systems being required. This phase will be in progress at the time of the ASEE Conference in the spring of 2018, but a progress report will be provided as part of the meeting presentation.

Phase n

Perhaps more correctly referred to as the future, the S&M Department expects to continue to seek funding, either through the normal budget cycle or the xxxxxxxxx Foundation to continue the monitoring and data analysis of this project. The Department believes that such efforts would be beneficial for students as a laboratory, as an example of a commercial power grid, and as an example of renewable power source alternatives. We believe that this system will be beneficial to the future student's engineering knowledge base.