Chapter 5

Conclusion

The conclusion chapter provides a summary of what has been done, lessons learnt and what lies ahead following completion of the project.

The simulation model for a small scale renewable energy facility proved to be an effective tool to design and simulate a renewable energy facility, at various geographical locations, utilizing either wind energy, solar energy or hybrid thereof. By incorporating the environmental data analysis of the intended site, with the hardware models of the wind and PV technologies into a single integrated simulation package, we were able to provide a quick and accurate assessment of each respective renewable energy technology's potential at the site under investigation. The accuracy of the simulation model is increased not only by utilizing proven statistical methods for the data analysis, but by eliminating the *middle man* between the hardware models and the data they require from an environmental data analysis.

5.1 Verification and Validation

Verification of the various simulation modules provided satisfactory results. Constant feedback and comparison of the modules helped to identify and eliminate problems at an early stage and gave rise to some additional techniques being implemented to increase the accuracy and performance of the simulation model.

The simulation model was successfully implemented in LabView and satisfying the primary and secondary objectives as set forth in section 1.3, thus proving to be a valid solution. A brief summary of the simulation model's main functionality is as follows:

- Model system hardware components:
  - PV panels;
  - Wind turbines;
  - Battery bank;
- Environmental data analysis:
  - Calculate the optimal tilt angle for the PV panels;
  - Wind speed analysis to provide future wind speed probability information;
- Probable power output:
  - PV probable power output;
  - Wind turbine probable power output;
- System configuration optimization*:

*Subject to integration with the financial model.

5.2 Research contribution

This project has generated multiple research contributions, apart from the simulation model itself, during the completion thereof. The findings of the Dynamic Resolution Analysis Simulation (DRAS) proved to be one of the most significant research contributions. The DRAS partially addressed the issue regarding the effect of the wind data's resolution on subsequent calculations. Initial simulations indicated that the power output difference of a wind turbine generator followed a fairly linear trend relative to the resolution of the data used for the simulations.

5.3 Recommendations and future work

Due to the time constraints of the project, not all the possible avenues could be explored, nor could all the questions discovered, be answered. A few avenues to be considered for future work include:

- Further investigation of the anomalies encountered during DRAS in the figures from section 4.2.1 is warranted;
- Incorporate more forms of renewable energy e.g. concentrated solar power (CSP), etc.;
- Verification of the simulation model with the results of an actual renewable energy system;