CHAPTER EIGHT

RESULTS AND CONCLUSIONS

The wind makes dust because it intends to blow,
taking away our footprints.

|L.C. Lloyd, Specimens of
Bushmen Folklore (1911)

The creation of a new hybrid power system simulation incorporating new wind turbines, diesel generators and other component models have resulted in a broad range of conclusions and recommendations.

8.1 Conclusions

An integrated system of simulating wind turbines, diesel generators, PV systems and associated power conversion and control devices can be successfully developed and employed for analysis of power systems. Hybrid system simulations are effective tools for the investigation of various design alternatives for autonomous power systems. The

capability of the simulator to include any or none of the generation resources in its library allows it to function as an integrated platform for the simulation of renewable systems in general. The TRNSED interface, as implemented in Windows, is a key component of the software, enabling all users to interact with the pertinent elements of the simulation in a productive manner.

The creation of wind turbine and wind cluster components for TRNSYS allows the use of wind turbine generators in any future TRNSYS modeling of wind systems. It is anticipated that wind energy projects will be installed in Wisconsin in the near future, and the availability of the wind components will allow researchers to be able to the simulate new designs as they become known. Wind turbines can be effectively modeled for time series simulations; it is not necessary, nor very useful to utilities, to use wind speed frequency distributions in the modeling of wind power systems. Wind turbine cluster modeling can be implemented in a time series analyses, by preprocessing of the cluster data arrays for later interpolation in the course of performing the time series simulations.

Diesel power systems play an important role in meeting demand for electric power all over the world. Where diesel fuel costs are high, wind power will play an important role in reducing the cost of delivered electrical energy. A successful feature of the design of the diesel controller was the capability of the controller to program itself with the performance characteristics of the diesels it needed to control. This feature mimics the set-up of real controllers.

An improved TRNSYS model for battery storage systems was developed which permitted variation in efficiency as a function of temperature and charge rate. Also, an

improved power converter model was implemented in TRNSYS, using a more accurate relation to describe inverter efficiency.

8.2 Recommendations

Improvements to the diesel dispatch model are recommended that allow for a greater diversity in strategies. This capability would make greater use of battery technology in hybrid systems. Additional strategic modeling of hybrid systems can be included in future improvements to the model.

Improvements to the wind turbine component model are not a priority, but a recommended future area of interest may be a dynamic systems model of a wind turbine for the modeling of wind systems on very short time steps. Improvements to the wind turbine cluster modeling include inclusion of a complex terrain model (whenever a validated model becomes available). Suggested improvements to the hybrid model include a probabilistic internal function to model the start-stop behavior of the diesels and turbines on a sub time-step basis. This would probably improve the accuracy of sub-hourly simulations of component interactions.

The hybrid systems simulator, as currently developed, does not include an economics modeler. Since the design of a hybrid system will ultimately rely upon the economics associated with alternatives, then inclusion of a built-in economics modeling capability may become an attractive improvement. Economic components are included in the TRNSYS Types libraries, and well-suited for this purpose.

The UW-Hybrid power system simulator is a robust platform for the investigation of the performance of renewable systems. It is recommended that the

software be actively supported and maintained as a basis for subsequent research in the areas of hybrids, wind, power conversion and storage.

An improvement to TRNSYS is envisioned which would allow more accurate modeling of start/stop events. Devices such as diesel generators and wind turbines start and stop during periods when the average would indicate the device would be in one state or the other for the whole timestep. However, since wind and loads always vary around the mean level on a probabilistic basis, the devices will in fact start and stop several times during the timestep. A valuable capability to be added to TRNSYS would be a probabilistic function which would allow determination of the frequency and impacts of these on a sub-timestep events, perhaps using standard deviation as an input.