CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In this study, a semi-analytical mathematical model of a proposed small-scale (20 kW_e) biomass-hybrid parabolic trough solar power plant (BSPP) has been created by means of thermodynamic analysis of the mass & energy transfer balances and conversion processes that occur within the power plant. Due to the fact that this is a mathematical model of a proposed rather than an actual power plant, it is not possible to validate the entire power plant model.

However, the collector system (CS) model of the power plant was used to simulate the HTF exit temperature of the EPC collector at the Energy Park, and it was found that the CS model is adequate to predict the fluid exit temperatures of the solar trough collector. The average % deviation of the fluid exit temperatures between simulated and experimental values was found to be no higher than 6.0%. The collector's fluid exit temperature is essentially an indication of its thermal performance. Since the thermal performance of the collector determines the thermal output of the other sub-systems in the power plant, validating the CS model is considered a validation of the power plant model in this study.

To demonstrate its usefulness as a simulation tool, the BSPP model was used to carry out a parametric study for two important parameters of a solar thermal power plant, namely the HTF mass flux and the collector area. For sunny condition in solar mode, the optimal collector area is found to be 210 m^2 and the corresponding optimal HTF mass flux is evaluated to be 0.154 – 0.368 kg/s. Similarly for partly cloudy condition in solar mode, the optimal collector size is found to be 355 m^2 while the corresponding optimal HTF mass flux is 0.276 – 0.610 kg/s. A sensitivity analysis was also carried out to evaluate the effect of parameter change on the performance of the power plant in terms of its power output. The four parameters selected for the analysis were collector area, concentration ratio, direct irradiance and fluid mass flux. The results of the analysis showed that for a +/- 10% change in the value of the direct irradiance, collector area, fluid mass flux and concentration ratio, the corresponding % change in power output of the power plant is about +/- 11.0%, +/- 9.5%, +/- 0.6% and +/- 0.2% respectively. This means that the performance of the power plant is most sensitive to variations in the direct irradiance and least sensitive to variations in the concentration ratio.

With regards to the operation of the proposed 20 kW_e BSPP, levelized electricity cost (LEC) analysis is used to evaluate the cost effectiveness of operating the power plant in pure solar mode versus hybrid mode. The analysis showed that the LEC of using a 355 m^2 collector in solar mode is about 2.3 times that of using a 210 m^2 collector in combination with a 114 kW_{th} gasifier in a hybrid mode. This means that it is more cost effective for a BSPP to operate in a hybrid mode rather than in a pure solar mode.

In general, the results obtained using the mathematical model created in this study have shown that it is possible to operate a parabolic trough solar thermal power plant under Thailand's climatic conditions when it is hybridized with a biomass energy source derived from the gasification of an agricultural residue such as rice husk.

5.2 Recommendation

The following recommendations are proposed to enhance the usefulness of this study:

(a) It would be useful if a study on predictive process control systems can be incorporated into the current work in order to increase the effectiveness of the existing power plant model.

(b) It would be useful if a detailed techno-economic study can be carried out to evaluate a more realistic levelized electricity cost of the biomass solar power plant based on the scenario that multiple units can be installed nationwide throughout the country.