Optimal Design for Hybrid Renewable Energy System Using Particle Swarm Optimization

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Abstract- This paper proposes the Particle Swarm Optimization (PSO) to minimize the Hybrid Renewable Energy System (HRES) Cost of Energy (COE) on different sizing between wind turbines and solar PV modules subjecting to a particular investment constraint. The wind speed and solar irradiation data from a particular site are used to determine the annual energy production (AEP) following the HRES configuration. While the turbine power curve converts the wind speed range to wind power, solar power generation model transforms solar radiation incident on PV modules. The investment cost of the solar PV system is interpolated from a commercial supplier data. However, the wind turbine cost is derived from the turbine component cost model of the National Renewable Energy Laboratory (NREL) and discounted to the present value using the inflation rate. Once a wind turbine and PV modules are configured as HRES, the COE as the objective function would be determined. The minimum COE from this study at 0.1204 $/kWh is in the 95th percentile of the global renewable power generation cost database from IRENA ranging between 0.06 – 0.22 $/kWh for solar energy and 0.04 – 0.10 $/kWh for wind energy but higher than the average value because of the low potential on both solar radiation and wind speed data from the particular site. However, PSO as the preliminary design method could be determined the optimal HRES with minimized COE when compare with the conventional design.

Keywords Hybrid Renewable Energy System, Solar Energy, Wind Energy, Particle Swarm Optimization.

1. Introduction

Renewable energy is the energy collected from the natural source and capable to regenerate within a short period. It could originate both directly and indirectly from the sun causing the natural movement or environment transform. Solar and wind energy as renewable energy could provide a high potential in electrical energy production because of available technology on commercial and economical investment proof. Moreover, many countries provide the various incentives to promote the utilization of both solar and wind energy to meet the stability of the energy capacity performance and indirectly affect the low carbon society including social behavior and awareness.

However, the uncertainty of the single renewable source decreases in the utilized reliability leading to the redundant system design and the need to install the amount of battery storage for the unavailable source period. For this reason, the Hybrid Renewable Energy System (HRES) is developed by integrating between the different renewable energy and the conventional source to stability, flexibility and reliability system as shown in Figure 1. The system could be configured into stand-alone with the storage unit or grid connection leading to decrease on both capital investment and cost of energy when compared with only single renewable source [1].

The conventional system design chooses the HRES configuration based on the average wind and solar information or the worst scenario data leading to the excessive system causing oversize neither wind turbine nor solar PV capacity. This situation rarely appears and unsteady caused by the long period of time-series data collection with the inconsistency of weather conditions and electrical