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Design optimization and sensitivity analysis of a hybrid renewable power generation system coupled with a reverse osmosis desalination unit

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ABSTRACT

This paper presents a multi-criteria optimization based on parametric sensitivity analysis for the sizing of a hybrid renewable production system (photovoltaic-wind) coupled to a water pumping and reverse osmosis water desalination unit. A dynamic simulator of the proposed system which includes photovoltaic-wind (PV/wind) renewable generators, three motor-pumps (well pumping, water storage and desalination), reverse osmosis desalination unit, three water tanks, annual consumption data of freshwater with a sampling step of 10 min, annual data of weather conditions (Southern Tunisia), energy management and life cycle analysis indicators is developed. An energy management strategy is integrated into a dynamic simulator in order to share the power flow during the system operation. A parametric sensitivities-optimization method based on a genetic algorithm allows us to find the best configuration between the PV array areas, the wind turbine swept area and the capacity of the storage tanks with a reduced process time. The best configuration is predicted on the basis of the minimum primary energy requirement (environmental indicator) with an Loss of Power Supply Probability equal to 0% (reliability indicator). As a result, optimization based on sensitivity analysis is a good way to make the system more effective and run more smoothly.

Keywords: Renewable energy; Hybrid PV/wind system; Energy management; Optimization; Parametric sensitivity; Desalination

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