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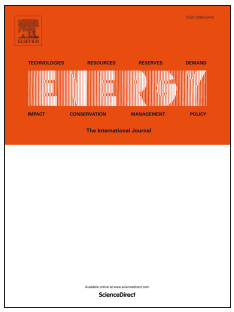

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ABSTRACT

This work presents a thermo-economic simulation model of a hybrid renewable power plant based on wind turbine and photovoltaic technologies, coupled to an energy storage system. The total plant capacity is 200 kW (190 kW and 10 kW, for photovoltaic and wind turbine, respectively), whereas the energy storage capacity is 400 kWh. Aim of this work is to design a renewable power plant showing limited fluctuations (with respect to the ones typically achieved in case of solar systems) with marginal amounts of electricity purchased or sold to the grid, maximizing the electricity self-consumption. The thermo-economic model, developed in TRNSYS environment, allows one to determine the best system configuration and maximize the economic profitability by considering the time-dependent tariffs applied to the electricity exchanged with the grid and the possibility to store electricity. Different system layouts with or without the storage system and for different users are considered. Results show negative profit indexes of the layouts including the storage system (-0.27 in the worst case vs. 0.61 in the best case without the storage), due to its lower efficiency and its higher capital cost, although a remarkable reduction of the operating costs and an enhancing of the self-consumed energy.

KEYWORDS: Dynamic simulation, energy storage, wind and solar energy

1. INTRODUCTION

It is well known that the future of the energy systems will be based on renewable energy sources, due to their low environmental impact and to the depletion of fossil fuels. Several renewable technologies are presently available (PhotoVoltaic PV or thermal solar, biomass, geothermal, waves, hydropower, wind). However, among all those technologies, photovoltaic panels (PV) and wind turbines (WT) are the most profitable ones, from the economic point of view [1]. In addition, hybrid systems based on the combination of both PV and WT technologies, are extremely attractive since a more stable profile of the overall yearly electricity production can be achieved. In fact, it is well-known that the PV summer electricity production is higher than the winter one, whereas, the electricity production by WTs increases during the winter season. In addition, night-time wind energy production is often dominant over the daylight one, decreasing the electricity bought from the grid during night hours, when the PV production is null. Nevertheless, in these systems the fluctuations of both solar radiation and wind velocity lead to unavoidable oscillations of the electricity production. In fact, although the integration of PV and WT technologies allows one to achieve a more stable power production profile, solar radiation and wind are unpredictable resources which unavoidably determine certain variations in the system power production. Therefore, in order to mitigate the effects of intermittency of solar and wind energy, suitable electricity