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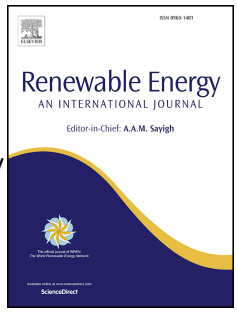

Techno-economic and environmental optimization of a household photovoltaic-battery hybrid power system within demand side management

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Techno-economic and environmental optimization of a household photovoltaic-battery hybrid power system within demand side management

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Abstract

This paper presents a power management system of a household photovoltaic-battery hybrid power system within demand side management under time of use electricity tariff. This system is easy to implement by employing cheap electrical switches, off-the-shelf chargers and inverters. Control system models combining both power dispatching level and home appliance scheduling level are proposed to minimize the residents' energy cost and energy consumption from the grid with the practical constraints strictly satisfied. In addition, the resident comfort inconvenience level is considered in the control system models. The trade-off among operating cost, energy consumption and inconvenience is considered and a multi-objective optimization problem is formulated. The optimal control strategies are derived by solving a mixed-integer nonlinear programming problem. Simulation results show that the energy cost and energy consumption from the grid can be largely reduced with the proposed strategies. These results are important for customers to dispel their major uncertainty in determining whether to newly install or update to such photovoltaic-battery hybrid power systems.

Keywords: Solar energy; Hybrid power system; Optimal control; Demand side management

1. Introduction

The global energy consumption continues to increase due to population growth, continued urbanization, and economic development with great threat to environment. Most of the energy consumed around the world comes from fossil fuels, and that would continue to provide most of the world's energy in future. It is reported that, liquid fuels, natural gas, and coal would still account for 78% of total world energy consumption in 2040 though renewable energy is the world's fastest-growing source of energy [1]. Therefore, much more coal, oil and natural gas will be burned to generate electrical energy and then supplied to residential, industrial and commercial consumers via the grid year after year. As a result, increasing amount of carbon dioxide (CO_2) and other air pollutants are emitted into the atmosphere, resulting in not only

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