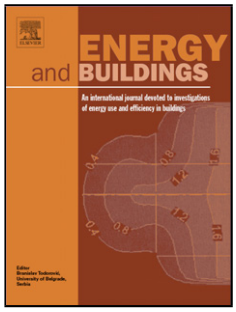

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Author: Nien-Che Yang Wei-Chih Tseng

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Impact assessment of a hybrid energy generation system on a residential distribution system in Taiwan

Nien-Che Yang*, Wei-Chih Tseng

Department of Electrical Engineering and Innovation Center for Big Data and Digital Convergence, Yuan Ze University, 135 Yuan-Tung Road, Chung-Li 32003, Taoyuan, Taiwan, ROC

E-mail: ncyang@saturn.yzu.edu.tw

Tel: +886-3-4638800 Ext.7114; Fax:+886-3-4639355

Abstract: In this paper, a Monte Carlo based three-phase power flow method is proposed to evaluate the impact of a variety of a hybrid energy generation system on a residential distribution system. First, the proposed deterministic power flow method is exploited based on graph theory, circuit theory and nonlinear numerical solution methods. The proposed Monte Carlo based power flow method is developed based on the proposed deterministic power flow method and a commercial software package OPTIMUS. Various distributed generations (DGs) are also combined in the proposed method. In this paper, the hybrid energy system in the University of Yuan Ze is used as a sample case. The hybrid energy system consists of a 5kW photovoltaic (PV) system, a 3kW wind power system and a 2kW hydrogen-fuel cell (HFC) system. Then, a comprehensive study of the hybrid energy microgrid system, in terms of steady-state voltage deviations, power flows, power losses, reverse power flows, short-circuit fault currents, maximum allowable DGs capacity and voltage unbalance factor, is performed to evaluate the impacts of the hybrid energy system on the utility power grid. The research results are of value to the pre-determination of impacts of the hybrid energy system on the residential distribution systems.

Keywords: Distributed energy resources, distributed generations, deterministic power flow analysis, graph theory, injection current, microgrids, Monte Carlo power flow analysis.

1 Introduction

With the purpose of reducing greenhouse gas emissions and local pollutions, many new developments in power systems have occurred in recent years. Hybrid energy microgrid systems may offer a revolutionary application in power systems [1-3]. In general, there are several distributed generations (DGs) involved in a hybrid energy microgrid system. The DGs may employ the traditional energy sources, such as diesel, gas and coal or the renewable energy resources, such as wind, solar and hydrogen. Due to the advantages of DGs applications, the use of DGs, such as photovoltaic (PV) [4-7], wind turbines [8, 9] and fuel cell systems, is rapidly growing throughout the world. To improve the reliability, flexibility and efficiency of a utility system, some experts and scholars have concentrated on the economic and environmental evaluation of renewable energy use in residential distribution systems. In Ref. [10], the sizing and techno-economical optimization of a stand-alone hybrid PV/wind system with battery storage was presented. In Ref. [11], an electrical energy analysis of a building has been performed to evaluate the power quality of the hybrid energy system. In this hybrid energy system, electrical energy is generated by a 5kW PV system and is stored by a 2.4kW