



Development and analysis of a solar and wind energy based multigeneration system

Sinan Ozlu *, Ibrahim Dincer

Department of Mechanical Engineering, University of Ontario Institute of Technology, 2000 Simcoe Street North, L1H 7K4 Oshawa, Ontario, Canada

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Abstract

This paper concerns development and analysis of a solar-wind hybrid multigeneration system. Energy, exergy, exergoeconomic and exergoenvironmental analyses are performed. The analysis studies are undertaken by developing and constructing the codes in Engineering Equation Solver software. The effects of various input conditions on the system performance are investigated through both energy and exergy efficiencies, and an optimization study is undertaken of system efficiency and power output are obtained. The average number of Toronto suites that the system can supply is calculated. As a result, it is seen that energy and exergy efficiencies are higher than equivalent single energy systems. The system has 43% maximum energy efficiency and 65% maximum exergy efficiency. Maximum turbine output is 48 kW, while cooling effect is 28 kW and heating effect is 298.5 kW. There is resultant savings of 1614 tons of CO₂ per year by the system. This multigeneration system is capable of supplying at least at a minimum 49 suites.

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1. Introduction

Renewable energy sources (solar, wind, etc.) are attracting more attention as alternative energy sources to conventional fossil fuel energy sources. This is not only due to the diminishing fuel sources, but also due to environmental pollution and global warming problems (El-Shatter et al., 2002). Renewable energy sources are the only clean and continuous energy solution to satisfy current and future requirements. A system that can utilize more than three sources is called a multigeneration energy system. The efficiency of multigeneration systems are higher than the combined efficiency of separate units. Multigeneration systems that use renewable sources combine the power of clean

energy with high efficiency. Moreover, they help to supply different needs of a public unit such as a multi-suite building or a neighborhood.

One of the main challenges in this subject is the lack of study, especially a totally renewable based multigeneration energy system to produce electricity, cooling, heating, hot water and hydrogen simultaneously. This has made the proposed system quite interesting. Efforts to develop more efficient multienergy systems, attracts many researchers.

Another challenge is the scheduling and modeling of the sources, solar and wind in this case. Solar energy is not constant, the intensity changes during the day and throughout the year. There is no sun at all at night. Moreover, neither wind presence nor wind speed is a factor that can be guaranteed. The problem can be simplified by making some assumptions such as taking the average solar intensity and wind speed.

* Corresponding author.

E-mail address: Sinan.Ozlu@uoit.ca (S. Ozlu).

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