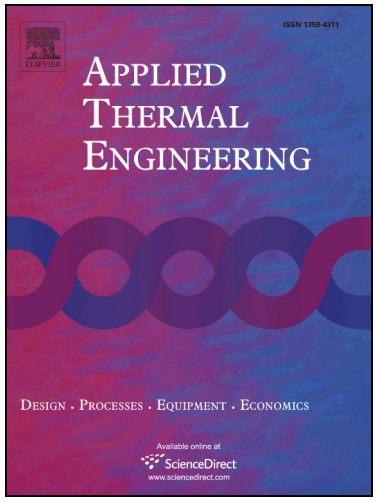

Research Paper

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THERMODYNAMIC AND ECONOMIC ASSESSMENT OF OFF-GRID PORTABLE COOLING SYSTEMS WITH ENERGY STORAGE FOR EMERGENCY AREAS

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ABSTRACT

This study aims to investigate performance and cost aspects of a solar powered portable cooling system to conserve first aid supplies for off-grid areas with energy storage. Due to the intermittent nature of solar energy availability, two energy storage options are considered for a stationary system. Additional to the standalone system without energy storage, hydrogen is selected to be the storage medium by considering electrolysis at day time, and use of a hydrogen fuel cell unit at night time. This system consists of solar photovoltaic cells, a Polymer Exchange Membrane (PEM) electrolysis unit (PEME), hydrogen tank, a PEM fuel cell unit (PEMFC), and a vapor compression refrigeration (VCR) system to condition a container rated with ~11 kW cooling load. The second system utilizes pumped – hydro storage (PHS) technology using a simple pump – turbine couple by storing water at a higher reservoir during day time and utilizing it to produce hydro power at night. Existence of higher reservoir brings a significant additional cost for the PHS system, making this configuration almost four times more costly than that of the hydrogen storage option, even though the storage efficiency of the PHS system is significantly higher than the hydrogen storage.

Keywords: Emergency areas, Syria, PEM electrolyser, PEM fuel cell, pumped-hydro storage, air conditioning,

1. Introduction

Poverty, scarcity, starvation, infectious and epidemical diseases, and wars interrupt daily routines of communities which cause physical, economical, and social losses due to unstable natural or human based disasters [1]. It is of importance and crucial to have ready to act supplies during and after any emergency situation, where the primary services are first aid, feeding, and electricity, respectively [2]. For regions where