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Economic Feasibility Study of Two Renewable Energy Systems for Remote Areas in UAE

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Abstract- Safari camps are getting great deal of attention recently due to the economical and touristy benefits. However, these camps are located in remote rural areas in UAE desert where there is no grid power supply; the installed electric source typically is diesel generators. Due to the cost of fuel supply and the impacts of the generator vibrations on desert landscape, two renewable systems have been investigated. One is a conventional renewable system consisting of PVs and battery storage. The second system is a combination of PVs and fuel cell where hydrogen is provided via water electrolysis. This economical and feasibility study aims to compare the performance of both systems (Fuel cells and Batteries) using HOMER software. System capital cost and maintenance are included in the cost study. The cost of the fuel cell system is higher than the PV/battery system by about 50%. However, lead acid batteries assumed in the study have low life span and can pose serious environmental risks if not discarded properly.

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Key words: Fuel Cell, Water Electrolysis, Hydrogen Production, Efficiency, Battery-less solar system.

1. Introduction

Safari camps in UAE are fully powered using diesel generators due to their remote locations, but the high diesel fuel prices have a direct influence on the cost of electricity in remote communities. Also it costs about 550K AED/Km to erect power to remote areas in UAE [1]. In addition, diesel generators vibrations affect the desert landscaping [2, 3]. Municipalities are adding new regulations on generator vibrations. Additionally high operating and maintenance costs of diesel generators contribute to high electrical cost in UAE desert camps. As a result, renewable energy power supply is reasonable solution due to its environmental friendly characteristics. Also, UAE has legislated new policies to encourage the use of renewable energy. For instance, Abu Dhabi's Economic Vision - 2030 aims at generating 7% of Abu Dhabi's energy requirements from renewable resources. In Dubai, it is planned to generate 1% of electricity needs from renewable sources by 2020 and 5% by 2030 [4].

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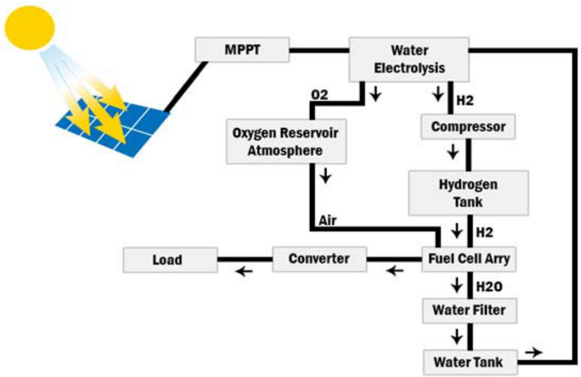
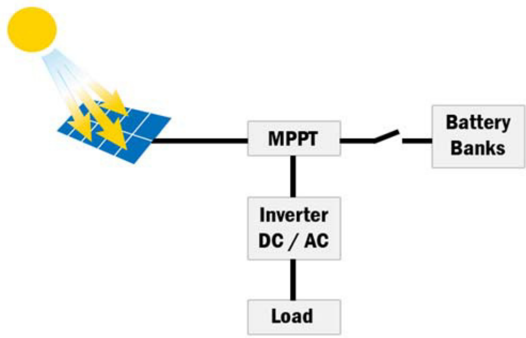
Fig.1: Safari camp in Alain.

Conventional renewable energy systems use batteries as a storage unit because of the intermittent nature of renewable energy sources in general, such as solar and wind sources in addition to the out-of-synchronization nature of those generation sources with the loads. It shall be noted that batteries are a must for this solution because the bulk of safari camp power is required during night hours. However, batteries have numerous failure modes in addition to recurring cost of maintenance and replacement [5]. Moreover, defected batteries must be disposed carefully and professionally, since batteries contain various hazardous materials, including heavy metals and acids, they can pose serious environmental risks if not discarded properly. Another environmental friendly system is proposed by using a combination of PEM (Polymer Electrolyte Membrane) water electrolysis and fuel cell array to feed the load. Unlike voltaic cells (i.e. Batteries), water electrolysis convert the electrical work to power reactant favorable non-spontaneous reactions such as decomposition reaction (i.e. H_2O decomposition). By using solar cells and water, electrolysis effect can be obtained. By controlling the electric field inside the electrolysis, H_2O will break into Oxygen and Hydrogen in the positive and negative electrodes respectively. Hydrogen is assumed to be compressed in H_2 tanks and will be used again as an input for the fuel cell. However, this approach suffers from lower system efficiency due to the additional electrolysis operation. The preliminary block diagram is illustrated in the following figure for fuel cell and battery cases in Fig.2a and Fig.2b.



(a)



(b)