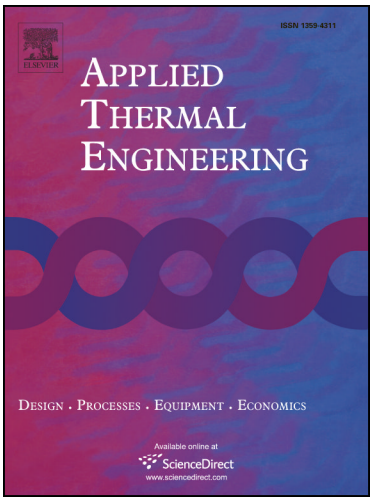

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Hydrogen at the Rooftop: Compact CPV-Hydrogen system to Convert Sunlight to Hydrogen

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Abstract

Despite being highest potential energy source, solar intermittency and low power density make it difficult for solar energy to compete with the conventional power plants. Highly efficient concentrated photovoltaic (CPV) system provides best technology to be paired with the electrolytic hydrogen production, as a sustainable energy source with long term energy storage. However, the conventional gigantic design of CPV system limits its market and application to the open desert fields without any rooftop installation scope, unlike conventional PV. This makes CPV less popular among solar energy customers. This paper discusses the development of compact CPV-Hydrogen system for the rooftop application in the urban region. The in-house built compact CPV system works with hybrid solar tracking of 0.1^{o} accuracy, ensured through proposed double lens collimator based solar tracking sensor. With PEM based electrolyser, the compact CPV-hydrogen system showed 28% CPV efficiency and 18% sunlight to hydrogen (STH) efficiency, for rooftop operation in tropical region of Singapore. For plant designers, the solar to hydrogen production rating of 217 kWh_e/kg_{H2} has been presented with 15% STH daily average efficiency, recorded from the long term field operation of the system.

Keywords: CPV, Hydrogen, Solar to Hydrogen, Concentrated Photovoltaic, Solar Cell.

1. Introduction

In current alarming situation of greenhouse gas emissions, global warming is drastically affecting the environment **[1-4]**. Use of renewable energy resources as primary energy supply is the only solution for sustainable future **[5-8]**. Among all of the energy sources, solar energy has the highest energy potential that is many times higher than the current global energy demand **[9-11]**. On the other hand, solar energy is only available during diurnal period, but with intermittent supply **[12]**. In order to compete with the conventional fossil fuel based power plants, the sustainable energy source must also be able to provide steady power supply with high energy density **[13]**. However, due to solar intermittency, there is a need for energy storage system for steady power supply **[14]**.

The simplest method of solar energy utilization is its conversion into electricity through solar cell. Although, conventional single junction solar cells are having 99% share in current