Study and Simulation of A Hybrid System Composed of Solar Panels and Fuel Cells

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ABSTRACT

In this scientific investigation, we focused on examining a hybrid system comprising a photovoltaic generator and a fuel cell, which collectively supply electricity to isolated sites. These systems offer several advantages, including economic viability, reduced environmental impact compared to conventional gas turbines and internal combustion engines, and decreased reliance on fossil fuels. The main objective of this study was to design a hydrogen PVFC hybrid system that would efficiently operate under varying conditions. To achieve our research goals, we carefully selected and analyzed each component of the system to ensure optimal performance of the entire system. The study used MATLAB/Simulink, incorporating converters to simulate and evaluate the system's behavior.

Keywords: Photovoltaic generator, Fuel cell, Hybrid system

1 Introduction

The global trend is moving towards renewable energies to combat global warming and decrease greenhouse gas emissions. Given the environmental implications of conventional energy methods, there's a growing emphasis on adopting renewable technologies such as photovoltaic, wind, biomass, and fuel cells [1]. Among these, fuel cells are highlighted for their cleanliness, efficiency, and versatility in applications ranging from vehicles to spacecraft. Recent research has delved into a hybrid system that integrates a photovoltaic generator with a fuel cell [2]. This hybrid system is designed to provide a consistent power supply, even during times of limited solar energy. It presents a sustainable alternative to traditional diesel generators, especially in remote areas. The research's main objective was to improve the efficiency, reliability, and economic viability of this hybrid setup for stationary applications [3]. In the proposed system, photovoltaic and fuel cell function as the primary energy sources, with a battery serving as a supplementary source.

2 Methodology

In this etude hybrid system was conceived to ensure that every component, be it the PV generator or the fuel cell, was used to its maximum potential, optimizing both energy production and consumption. Figure 1 illustrates the studied system describes a combination of photovoltaic (PV) and fuel cell (FC) hybrid energy system for stationary applications. The system includes solar panels and FC system working in parallel, the fuel cell is summed to generate electricity to supplement any lack of solar radiation. The hybrid power systems based on solar PV and fuel cells are a viable alternative to diesel generators [3]. The fuel cell generator can efficiently complement the fluctuating renewable resource of the solar PV system to satisfy the energy demand. The proposed hybrid system with PV and FC as shown in figure 02. Whereas primary sources and Battery as an auxiliary source connected in parallel with the load side. Where the PV is connected via a boost converter and the FC is connected by an interleaved two-phase boost converter.

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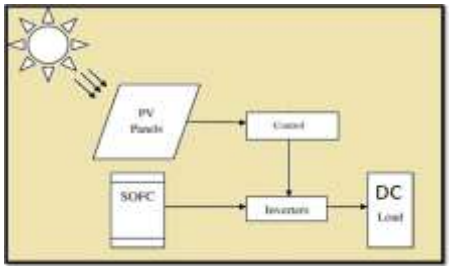

Figure 1: *General structure of hybrid electrical system*

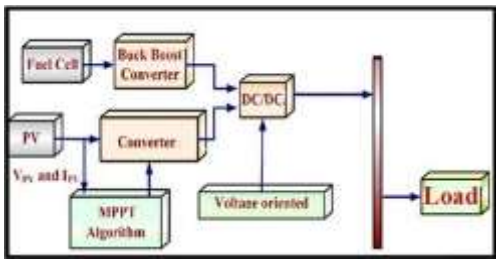

Figure 2: *Hybrid electrical system studied*

3 Results and Discussion

The SC has enormous capacitive energy over the DC bus capacitance, but with slower dynamic. The control low is written as to ensure safe operating for the FC stack, the transient power must be limited. Thus, a low-pass filter is employed to ensure the desired trajectory. We caused a load variation in the 2s and 4s points (See figure 03) we notice that the VDC voltage has changed due to the load variation (See figure 04). With a PI speed control we added in the system and when we caused a variation load in points 2s and 4s we notice the presence of a small spontaneous disturbance in the measured VDC signal then a return to the reference (See figure 05).

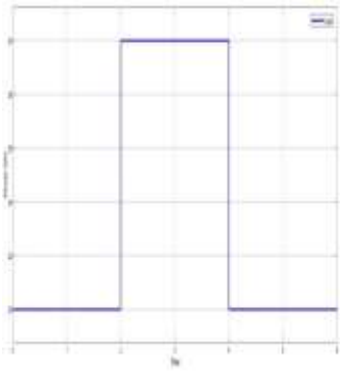

Figure 3: *Load variation*

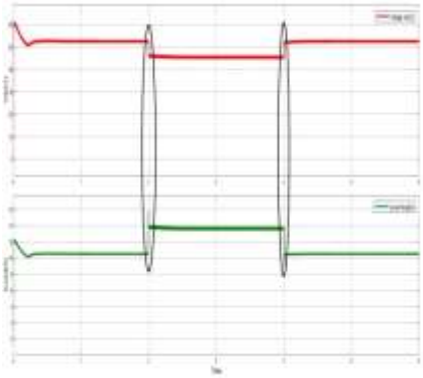

Figure 4: *FC Current and Voltage without control*

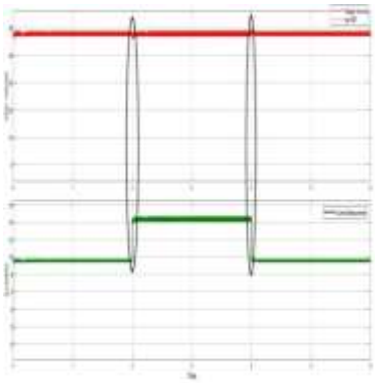

Figure 5: *FC Current and Voltage V_{dc} with V_{dc} control*

4 Conclusion

The research introduced a system harnessing both a photovoltaic generator and a fuel cell as dual energy sources. Aimed at discovering optimal solutions for autonomous power systems, the study delves into the synergy of these renewable energy sources for consistent energy production in isolated sites. Termed as a hybrid system, the crux of the control proposed ensures a stabilized DC bus voltage. By integrating a fuel cell with a solar panel within a DC micro-grid, the system promises sustainable and uninterrupted clean energy supply.

How to Cite

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