

Optimized Energy Management in Hybrid Photovoltaic-Battery-Fuel Cell Systems for Enhanced Sustainability

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Abstract : This paper explores strategies to enhance energy efficiency, sustainability, and reliability through the integration of photovoltaic (PV) technologies, batteries, and fuel cells within hybrid energy systems. These systems capitalize on the intermittent availability of solar energy, the energy storage capabilities of batteries, and the flexible power generation of fuel cells. Photovoltaic panels convert sunlight into electrical energy, which can be stored in batteries for future use. When solar energy is insufficient, batteries and fuel cells operate simultaneously, reducing the strain on individual components and extending the overall lifespan of the batteries. The synergy between these elements results in a dynamic and optimized energy management approach. By leveraging the complementary strengths of PV panels, batteries, and fuel cells, these hybrid systems enhance reliability while promoting sustainability. This approach also addresses the limitations of single-source energy systems by mitigating power fluctuations and ensuring continuous energy supply, even in varying environmental conditions. Moreover, the integration of these technologies contributes to reducing the carbon footprint of energy production, aligning with global efforts to transition to cleaner and more resilient energy systems. The findings of this study highlight the potential of hybrid energy systems to revolutionize energy management practices, offering a viable solution for both residential and industrial applications. This comprehensive approach not only maximizes system longevity but also supports the development of a sustainable and efficient energy infrastructure for the future.

Keywords : photovoltaics system, fuel cells, battery storage, energy management.

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