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Energy Harvesting and Storage System for Marine Applications

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Abstract : Rigorous international maritime regulations are in place to limit boat and ship hydrocarbon emissions. The global sustainability goals are reducing the fuel consumption and minimizing the emissions from the ships and boats. These maritime sustainability goals have attracted a lot of research interest. Energy harvesting and storage system is designed in this study based on hybrid renewable and conventional energy systems. This energy harvesting and storage system is designed for marine applications, such as, boats and small ships. These systems can be utilized for mobile use or off-grid remote electrification. This study analyzed the use of micro power generation for boats and small ships. The energy harvesting and storage system has two distinct systems i.e. dockside shore-based system and on-board system. The shore-based system consists of a small wind turbine, photovoltaic (PV) panels, small gas turbine, hydrogen generator and high-pressure hydrogen storage tank. This dockside system is to provide easy access to the boats and small ships for supply of hydrogen. The on-board system consists of hydrogen storage tanks and fuel cells. The wind turbine and PV panels generate electricity to operate electrolyzer. A small gas turbine is used as a supplementary power system to contribute in case the hybrid renewable energy system does not provide the required energy. The electrolyzer performs the electrolysis on distilled water to produce hydrogen. The hydrogen is stored in high-pressure tanks. The hydrogen from the high-pressure tank is filled in the low-pressure tanks on-board seagoing vessels to operate the fuel cell. The boats and small ships use the hydrogen fuel cell to provide power to electric propulsion motors and for on-board auxiliary use. For shore-based system, a small wind turbine with the total length of 4.5 m and the disk diameter of 1.8 m is used. The small wind turbine dimensions make it big enough to be used to charge batteries yet small enough to be installed on the rooftops of dockside facility. The small dimensions also make the wind turbine easily transportable. In this paper, PV, sizing and solar flux are studied parametrically. System performance is evaluated under different operating and environmental conditions. The parametric study is conducted to evaluate the energy output and storage capacity of energy storage system. Results are generated for a wide range of conditions to analyze the usability of hybrid energy harvesting and storage system. This energy harvesting method significantly improves the usability and output of the renewable energy sources. It also shows that small hybrid energy systems have promising practical applications.

Keywords : energy harvesting, fuel cell, hybrid energy system, hydrogen, wind turbine
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