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Techno-economic feasibility analysis of Kuwait-specific photovoltaic-based street lighting system

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Abstract

Nowadays, the surge in energy demand due to economic growth and extreme weather conditions has put immense pressure on the usage of fossil fuels in Kuwait. As a result, scheduled load-shedding is performed in some regions during the summer season to meet the energy demand. To address this issue, this paper proposes a photovoltaic-based street lighting system as an alternative solution to meet the rising energy demand in Kuwait during the daytime. This study initially investigates the existing street lighting systems in the state of Kuwait. Subsequently, three different configurations of photovoltaic panels are proposed based on the existing streetlight pole structures. The simulation models are then developed and evaluated using physical security information management and PVSyst simulation platforms, aiming to validate their performance against conventional power generation models in Kuwait. The proposed photovoltaic system is designed based on feedback information collected from the existing installed capacity. Finally, an overall energy model is presented to demonstrate how solar potential can offset energy consumption during peak demand hours. Practical testbed data from the Al-Jahra residential area of Kuwait is used for validation. The results indicate that the proposed photovoltaic street lighting system can generate a maximum power output of 18.8 GWh in August and a minimum of 11.8 GWh in December, compared to the monthly consumption of 30.45 GWh. The study showcases the economic viability of the solution, with an average degradation ratio of 13% of the total cost. Moreover, the proposed system contributes to a reduction in CO2 emissions from traditional power plants. © The Author(s) 2023.

Author Keywords

Photovoltaic system; physical security information management software; PVsyst; street lighting system

Index Keywords

Economic analysis, Electric load shedding, Energy management, Energy management systems, Fossil fuels, Information management, Solar panels; Energy demands, Information management software, Photovoltaic systems, Photovoltaics, Physical security, Physical security information management software, Pvsyst, Security information managements, Street lighting system, Techno-economic feasibility; Energy utilization

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