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Performance assessment of three grid-connected photovoltaic systems with combined capacity of 6.575 kW_p in Malaysia

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ABSTRACT

This research aims to evaluate the performance of grid-connected photovoltaic systems based on three PV technologies along with a composite PV system installed at the rooftop of the engineering tower building, University of Malaya, Kuala Lumpur, Malaysia. The grid-connected PV systems are based on poly-crystalline (p-s_i), mono-crystalline (m-s_i), and thin-film (amorphous silicon (a-s_i)) technologies. The performance evaluation is based on the monthly and annual data that is monitored from January 2016 to December 2019. A comprehensive analysis is conducted on eleven performance parameters such as; performance ratio, capacity factor, array yield, final yield, PV array efficiency, PV system efficiency, inverter efficiency, AC energy, array losses, system, and the overall losses. Results show that p-s_i based PV system performs better with high annual average (array yield (1309.7 h), array efficiency (12.17%), and system efficiency (11.33%)) accompanied by less degradation in eleven parameters as compared to a-s_i and m-s_i PV systems.

Moreover, the performance ratios of p-s_i and a-s_i PV systems are found higher than the values reported in some of the existing literature studies, subjected to similar and different climatic conditions. The results also indicate that environmentally the composite PV system has the potential to avoid 28143.7 kg of CO_2 emissions in four years. This research is expected to deliver valuable statistics to individuals and organizations about the real performance of grid-integrated PV systems in Malaysia, including other tropical climate regions in the world.

1. Introduction

A spike in modern technology has triggered an exponential rise in the demand for electrical energy. Among different types of energy, electrical energy has a significant contribution to the society. The primary fossil fuel sources used for the generation of electrical energy are coal, oil, and natural gas. The extensive usage of these sources has put a real threat to their life. The approximate life of coal, gas, and oil reserves is 107, 37, and 35 years respectively (Akhter et al., 2019). On the other hand, excessive usage of fossil fuels creates an alarming condition for global warming due to pollution created from greenhouse gas (GHG) emissions (Adaramola et al., 2014). To deal with this energy crisis and climate issues, solar energy has attained prime importance among governments, decision-makers, sponsors, industrialists, and climate researchers, in contrast to other renewable energy sources (Clayton et al., 2015).

Solar energy has immense potential for electrification in both rural and decentralized areas (Halabi et al., 2017). The PV systems have attained global acceptance due to their massive potential for

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