DEVELOPMENT OF A SOLAR PHOTOVOLTAIC SYSTEM EQUIPPED WITH A SUN TRACKER SYSTEM: A CASE STUDY IN KUCHING, SARAWAK

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ABSTRACT

A solar photovoltaic system consists of photovoltaic panel(s) and it converts energy of sunlight into electricity via photovoltaic effects. Installation of a sun tracker is one of the approaches to improve the performance of a solar photovoltaic system. A sun tracker is a device for orientating photovoltaic panel towards the sun. The aim of this paper is to examine the use of a solar photovoltaic system with a sun tracker in Batu Lintang, Kuching, Sarawak (1º32'09.73''N, 110º20'32.70E). A designed and developed solar photovoltaic system that equipped with a sun tracker is presented. Our developed solar photovoltaic system consists of five modules, i.e., a sensor system, a linear actuator system, a tracking mechanism, a battery storage system and charge controller, and a microcontroller system. The performance of our developed system is further analyzed and evaluated with experiments. Concluding remarks is further presented.

Keywords: *Solar photovoltaic system, Sun tracker, Case study, Sarawak*

1. INTRODUCTION

Solar energy is a clean and inexhaustible source of energy in everywhere of our world [1]. It has been identified as an alternative electricity source [2, 3] with respect to the increase in energy demand and cost [4]. Besides, solar energy is environmental-friendly as compared with other energy sources. In Saudi Arabia, it was reported that average 8182 tones of green house gases could be entering into atmosphere each year with each of 5 MW power plants [5].

Although solar energy offers lots of advantages to the environment, it still remains relatively expensive [6]. A search in literature reveals that many research works have been conducted to identify and to develop alternative approaches to increase the efficiency of a solar photovoltaic system. One popular approach is to keep the photovoltaic panel perpendicularly toward sun's position, thus, reduces the incident angle of radiation. However, the amount of extra energy collected by a tracked photovoltaic panel will be influenced by local condition as well [7, 8].

This line of study is popular and useful, and its importance has been highlighted by several recent publications. From the literature, Al-Mohamad [9] designed a sun tracker with a programmable logic-controller unit. The movement of a photovoltaic panel is further controlled and monitored. It was reported that the daily power output for the developed system increased by 20%, as compared with a fixed photovoltaic panel. Abdallah [10] performed an experimental study on extra power gain of a solar photovoltaic system with four different sun trackers, i.e., two axes, east–west, vertical and north–south tracking. There were increases of electrical power gain up to 43.87%, 37.53%, 34.43% and 15.69%, respectively, as compared with a fixed surface inclined 32° to the south in Amman, Jordan. Besides, Sungur [4] designed a two-axes sun tracker in Turkey and found a increase of 42.6% energy gain, as compared to fixed axes panel. Also, Baltas [11] conducted an experiment to compare the energy consumption between solar photovoltaic systems with continuous and stepwise tracking. It is reported that continuous tacking yields almost same energy as stepwise tracking. It is suggested that tracking motor can idle for 1 or 2 hours, and yet obtain more than 98% of energy as compared with continuous tracking. In [12], a theoretical study on the performance of an east–west oriented single-axis sun tracker in Taiwan is presented.

Motivated from the popularity of solar photovoltaic system, a solar photovoltaic system with a two-axis sun tracker is designed and developed. The sun tracker is able to track the location of the sun and it positions the photovoltaic panel towards the direction of sun. This will further improve the performance of the solar photovoltaic panel. Worth to be mentioned, a search in the literature reveals that no investigation on the use of solar photovoltaic system in Sarawak is reported. Our project started with a simulation of the irradiance of the sun in Kuching, Sarawak, Malaysia. Our developed solar photovoltaic system is further explained briefly. To evaluate the performance of our developed system, experiments are carried out in Kuching, Sarawak. These experiments are meaningful, as performance of a solar system is very much depending on weather and local condition. Our experimental results are further discussed.

The organization of this paper is as follow. In ection 2, our developed system is explained. In section 3, simulated