

Performance Analysis of Solar Panels Using a TEC1-12706 Peltier Cooling System with an Arduino Uno Microcontroller Based Control System

Ir. Michael Joko Wibowo, M.T. (*Undergraduated Thesis*)

Dandy Ramadhana
*Renewable Energy Engineering Study Program
Department Of Engineering*

ABSTRACT

Solar panels are one of the renewable energy technologies capable of converting solar radiation into electrical energy. However, their performance is influenced by various factors, making it necessary to improve their output power and efficiency. This study aimed to analyze the performance of a solar panel using a TEC1-12706 Peltier cooling system controlled by an Arduino Uno based on temperature, voltage, current, output power, and efficiency parameters. The research employed a quantitative experimental method. The experiment was conducted using two monocrystalline solar panels with identical specifications: one panel without a cooling system and another equipped with a TEC1-12706 Peltier cooler controlled by an Arduino Uno. Data were collected over a period of 10 days from 09:00 a.m. to 03:00 p.m. at 30-minute intervals. The measured parameters included solar irradiance, panel surface temperature, output voltage, output current, and panel surface area. Output power was calculated from the product of voltage and current, while panel efficiency was determined by comparing the output power with the input power, which was obtained from the product of solar irradiance and the panel surface area. The results showed that the TEC1-12706 Peltier cooling system reduced the panel surface temperature at an average cooling rate of 0.3°C per minute and increased the panel efficiency by 1–1.5 percentage points compared with the panel without cooling. The Wilcoxon Signed-Ranks Test indicated significant differences in voltage, current, and output power ($p < 0.001$). Although the cooled panel produced a lower voltage than the uncooled panel, the increase in current and output power indicated a more optimal energy conversion process. However, the improvement in panel performance was not sufficient to offset the Peltier module's power consumption of approximately 75 W during operation. Therefore, the TEC1-12706 Peltier cooling system was effective in reducing the operating temperature and improving solar panel performance but was not energy-efficient when considering the overall system energy consumption.

Keywords: *Solar Panel, Peltier Tec1-12706, Arduino Uno, Cooling System, Efficiency.*