ABSTRACT

Solar energy utilization for small-scale loads faces two primary challenges the efficiency reduction of static solar panels due to potential shading in urban areas, and the lack of power reliability from a solar-only system due to its intermittent nature. This research designs a PID controller-based *single-axis* solar module tracking system combined with a dual-source power supply system (Solar Panels and PLN) to overcome both of these problems. The methodology includes designing the tracking system using a *DC Wormgear Motor* and LDR sensors, as well as integrating the power sources via an *Automatic Transfer Switch* (ATS).

Test results show that the *single-axis* tracking system successfully increased energy yield by 17.32% compared to a fixed system. The implemented PID controller proved reliable, with a settling time of less than 2 seconds and an overshoot of under 5%. Validation of the power monitoring sensor (PZEM-015) also demonstrated high accuracy, with average measurement errors for voltage and current of 0.03% and 1.65%, respectively. The dual-source power supply system proved effective in maintaining a continuous electricity supply, demonstrating that this design is a reliable and efficient solution for solar energy optimization in challenging locations.

Keywords: *Dual-Source Power Supply System, PID Control Algorithm, Solar Energy, Solar Panel Tracking*