

ABSTRACT

Renewable energy is a source of energy derived from natural phenomena and can be replenished sustainably within a relatively short period. In contrast, *non-renewable energy* comes from limited resources that cannot naturally renew, posing long-term challenges in their use. To support the transition to clean energy, Telkom University has developed various renewable energy generation systems. However, to date, there has been no practical learning media specifically designed to represent the operating principles of these systems in an academic environment.

This study aims to design an intelligent system for a Renewable Energy Simulator (RES) consisting of a solar power plant (PLTS), wind power plant (PLTB), and micro-hydro power plant (PLTMH), by developing a digital interface media based on a website utilizing SCADA systems and IoT technology. The platform's key features include real-time and remote monitoring and control, based on measurement parameters from the operating simulators.

Comprehensive testing was conducted, including: (1) interface testing using the System Usability Scale (SUS) on 50 respondents, yielding a score of 84.4 classified as Grade A, indicating excellent usability; (2) IoT sensor testing showing the highest voltage measurement accuracy at PLTMH (97.64%) and PLTS (97.4%), and highest current measurement accuracy at PLTMH (88.16%); (3) Quality of Service (QoS) testing, with an average delay of 237 ms and throughput of 4450 bits, conforming to ITU-T G.1010 standards for interactive web services, indicating responsive and stable communication performance; and (4) High Availability testing demonstrating highly reliable system performance up to 50 Virtual Users (VU) with no errors, and stable operation at 60–70 VU with error rates within acceptable limits. The overall results show that the system is capable of real-time device monitoring and control with good network performance, high reliability, and a user interface that is very suitable for use. This system has the potential to become an effective interactive learning medium to support students' understanding of practical and comprehensive implementation of renewable energy technologies.

Key Word: Renewable Energy Simulator, SCADA, IoT, Website, Real-Time Monitoring, Remote Control, SUS, QoS, High Availability