ABSTRACT

The utilization of wind energy as one of the renewable energy sources is increasingly in demand due to its sustainability potential and its contribution to reducing dependence on fossil fuels. This research aims to design a performance monitoring system for low-speed wind turbines based on the Internet of Things (IoT) using an anemometer sensor and an inverter. The system was developed to support learning and research in the Smart Microgrid Laboratory as a platform for simulation and renewable energy studies. The main focus of this study is to create a device capable of monitoring wind turbine performance parameters, including wind speed, current, voltage, and output power, in real time and integrated with an IoT network.

The research method includes hardware development by integrating an anemometer sensor, current sensor, voltage sensor, and an inverter controlled by an ESP32 microcontroller. The software was developed to handle data acquisition, signal processing, and transmission to a web- and mobile-based IoT platform. System validation was conducted through a series of experiments to ensure measurement accuracy, output power stability, and data communication reliability with a maximum deviation target of ±20% and transmission delay of less than 2 seconds.

The results show that the designed system is capable of accurately and in real time monitoring the parameters of the wind turbine. The obtained data can be accessed through an IoT dashboard with an availability rate above 95%, thereby supporting analysis and decision-making in energy management. Thus, this research contributes to improving learning efficiency in the laboratory and provides a foundation for the development of intelligent and sustainable renewable energy technologies.

Keywords: *Anemometer, Internet of Things, Inverter, Monitoring System, Renewable Energy, Wind Turbine.*