ABSTRACT

The development of renewable energy has become a critical necessity in

reducing dependence on fossil fuels. One of the promising renewable energy sources is

biogas, particularly that produced from the anaerobic digestion of organic waste.

However, the utilization of biogas in laboratory environments still faces challenges,

especially in the real-time monitoring of critical parameters. This research aims to design

and implement an Internet of Things (IoT)-based monitoring system for methane gas

(CH₄) concentration and pH levels in the biogas fermentation process at the Smart

Microgrid CoE Laboratory, Telkom University.

The system consists of two ESP32 microcontrollers, an MQ-4 sensor for

methane gas detection within a closed sampling chamber, and a pH 4502C sensor

connected directly to the biogas digestate. Data is transmitted to Firebase in real-time and

displayed through a mobile application developed with Flutter. The sensor data

conversion process utilizes a multi-segment linear interpolation method for the MQ-4 and

linear regression for the pH sensor.

The test results demonstrate high accuracy, with the average relative error

for both CH₄ and pH sensor readings below 2%. The system successfully monitored

fluctuations and anomalies in methane production and identified the relationship between

pH values and CH₄ emissions. The IoT communication test revealed stable connectivity,

an average latency of ± 417 ms, and a 100% data transmission success rate. Based on these

results, the system is deemed suitable for automatic, accurate, and real-time monitoring

of biogas energy on a laboratory scale.

Keywords: *Biogas, Methane, pH, Internet Of Thing, Firebase, Flutter*