ABSTRACT

The thesis examines the integration of renewable energy systems from solar, hydro, and geothermal power plants to supply electricity to a hydrogen plant in Kuala Tungkal, through a power swap mechanism. This research could serve as one of the inputs supporting the Joint Study Agreement between Pertamina, Keppel Infrastructure, and Chevron New Energies International Pte Ltd to provide green hydrogen to Singapore. To ensure reliable energy supply and operational sustainability, this study evaluates the performance, reliability, risks, and investment feasibility of a renewable energy generation system connected to the national electricity grid in Jambi Province.

The research methodology combines load flow simulation using ETAP, financial analysis and risk analysis using Excel. Several scenarios are analyzed, including low renewable energy generation and grid losses, to measure the resilience of the electricity system. Reliability indicators such as Expected Energy Not Supplied (EENS) and reverse margin are used to measure system performance. Financial feasibility is analyzed through the calculation of Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period.

The results show that the 200 MW solar power plant in Kuala Tungkal provides a significant contribution to supporting hydrogen production during the day, while the power swap system with PLN maintains the reliability of energy supply from the difference in supply at night when there is no supply from the solar power plant. This system is projected to achieve a renewable energy portion of more than 90% by 2030 also with the support of REC-Renewable Energy Certificate so that the hydrogen produced can be assessed as green hydrogen, with the financial model showing a positive NPV value and IRR above 40%, indicating investment feasibility. Risk analysis reveals that losses in power transmission and equipment failure can be minimized through scheduled maintenance and power swap.

This study concludes that the integration of renewable energy with a power swap mechanism can improve supply reliability, reduce the risk of variability, and ensure sustainable hydrogen production. These findings provide strategic insights for energy planners and stakeholders in supporting the clean energy transition in Indonesia.

Keywords: Renewable Energy integration, Power Swap Mechanism, Load Flow Simulation, Risk Analysis, Financial Model