ABSTRACT

A solar power plant generates optimal output when it receives radiation (sun peak hours) of 1000 W/m², following Standard Test Conditions (STC), and when all production equipment operates efficiently. The equipment will function well if optimal maintenance is performed.

According to project planning data, the estimated maintenance cost is USD 22/kWp per year. However, the initial project data does not specify the maintenance activities required for the plant. Solar power plants are generally considered low-maintenance, typically requiring only routine maintenance. Optimal expenditure is necessary to maintain the health of the plant's equipment, ensuring that production output remains optimal.

Based on cost management principles [1], the life cycle cost (LCC) method can be used to calculate the total expenses incurred throughout the plant's lifespan, which can then be compared to total production over the same period. This study examines both investment costs and maintenance activities. A simulation of energy cost calculations (LCOE) was carried out using three different maintenance scenarios.

In this case study, three maintenance scenarios are evaluated to determine the effectiveness of maintenance and the production potential of the solar power plant over its lifetime. The study utilises Life Cycle Cost (LCC) and levelized cost of Energy (LCOE) methods to calculate energy costs (IDR/kWh). This study identifies the most optimal maintenance scenario regarding maintenance costs and effective electricity output.

The maintenance strategies include routine/preventive maintenance, corrective maintenance in case of failure, and condition-based or predictive maintenance to prevent more significant disruptions. The Life Cycle Costing (LCC) method analyses three maintenance scenarios. Scenario 1 follows the initial project plan, with routine maintenance costing USD 22 per kWh annually. Scenario 2 considers only routine maintenance, while Scenario 3 combines preventive, corrective, and condition-based (predictive) maintenance. The LCOE calculation ensures that maintenance activities are effective and appropriately targeted. Higher costs will result in higher energy costs.

The results indicate that Scenario 3 is the most cost-effective, producing 24,112,415 kWh over 20 years, with an LCC of IDR 31,938,987,291 and a Levelized Cost of Energy (COE) of IDR 1,325 per kWh. The findings emphasize the importance of optimal maintenance strategies to enhance the performance of solar power plants in tropical climates.

Keywords: Solar Power Plants; Tropical Climate; Radiation; Production; Costs; Maintenance; Life Cycle Cost (LCC); Levelized Cost of Energy (LCOE)