

Techno-Economic Analysis of a 1.1 kWp Hybrid Solar Power System at Tito Garage Workshop Jember

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ABSTRACT

Energy plays a fundamental role in economic dynamics and social welfare. However, the utilization of available renewable energy sources has not yet been optimized. This gap becomes increasingly critical when associated with national carbon emission reduction targets. Tito Garage Workshop is an MSME with electricity consumption reaching 41,241 kWh/month, resulting in carbon emissions of 415.70928 kgCO₂. Therefore, a 1.1 kWp hybrid photovoltaic (PV) system is implemented. However, the feasibility of this investment needs to be analyzed. This study aims to evaluate the investment feasibility of a 1.1 kWp hybrid PV system at Tito Garage Workshop in Jember and to assess the impact of adding a self-cleaning system on economic aspects. The method used is a techno-economic analysis approach employing Net Present Value (NPV), Discounted Payback Period (DPP), Benefit-Cost Ratio (BCR), and Internal Rate of Return (IRR). The results indicate that the system generates 1,666.225 kWh/year and is economically feasible, with an NPV of IDR 6,717,858.01, a DPP of 6.8 years, a BCR of 1.37, and an IRR of 5.73%. The addition of a self-cleaning system increases operational costs by 10.35%, resulting in an NPV of IDR 4,707,434.01, a DPP of 7.71 years, a BCR of 1.24, and an IRR of 5.85%. Electricity savings from the grid reach 29.99% or IDR 16,724,24. The potential reduction in carbon emissions is 1,399.69 kgCO₂. The installation of a 1.1 kWp PV system with a self-cleaning and water cooling system is considered feasible to implement.

Keywords: carbon emissions, photovoltaic (PV), PV cleaning system, techno-economic