

Penelitian ini menyajikan evaluasi komparatif integrasi Pembangkit Listrik Tenaga Surya (PLTS) untuk aerasi kolam ikan di Pesantren Tani Muhammadiyah Yogyakarta, yang bertujuan mengatasi tingginya biaya energi dan kerentanan pemadaman listrik (PLN) serta memberikan rekomendasi skenario terbaik. Evaluasi membandingkan tiga skenario: murni PLN (Skenario 1), PLTS substitusi energi (Skenario 2), dan PLTS bersistem Uninterruptible Power Supply/UPS (Skenario 3). Kajian mencakup aspek teknis (*Performance Ratio*/PR, keandalan baterai, efisiensi listrik), ekonomi (LCC, NPV, IRR, PP, DPP, PI pada tingkat diskonto BI 4,75% dan WACC 13,49%), serta lingkungan (Δ GHG, GRC). Hasil evaluasi merekomendasikan Skenario 3 sebagai yang paling optimal. Secara teknis, sistem mencapai PR 82%, memproduksi energi 2.080,5 kWh/tahun dan menghemat biaya listrik Rp3.535.872/tahun. Baterai Lithium-Ion 24V 100Ah terbukti andal memberikan cadangan daya $\pm 2,8$ jam untuk memitigasi risiko mortalitas ikan. Secara ekonomi (WACC 13,49%), Skenario 3 mencetak NPV Rp24.054.015, IRR 31,41%, PI 2,16, dan DPP 4,32 tahun. Melalui reality check terhadap penurunan siklus panen dan degradasi panel, skenario ini tangguh mempertahankan NPV positif Rp3.051.230 dan IRR 15,96%. Pada aspek lingkungan, sistem mereduksi 45,25 Ton emisi CO₂ dengan nilai GRC menguntungkan sebesar Rp1.512,56/kg CO₂. Kesimpulannya, berdasarkan evaluasi teknis, ekonomi, dan lingkungan, integrasi Skenario 3 direkomendasikan untuk mengamankan ketahanan finansial operasional dan keberlanjutan agribisnis budidaya ikan nila.

Kata Kunci: Evaluasi PLTS, Aerasi Kolam Ikan, Ikan Nila, Analisis Tekno-Ekonomi, Green Reduction Cost, UPS, Energi Terbarukan, Budidaya Air Tawar.

ABSTRACT

This study presents a comparative evaluation of solar photovoltaic (PV) system integration for pond aeration at Pesantren Tani Muhammadiyah Yogyakarta, aiming to address high energy costs and vulnerability to grid power outages while providing recommendations for the optimal scenario. The evaluation compares three scenarios: grid-only (Scenario 1), PV energy substitution (Scenario 2), and PV with Uninterruptible Power Supply/UPS (Scenario 3). The assessment covers technical aspects (Performance Ratio/PR, battery reliability, electrical efficiency), economic aspects (LCC, NPV, IRR, PP, DPP, PI at BI discount rate of 4.75% and WACC of 13.49%), and environmental aspects (Δ GHG, GRC). The evaluation recommends Scenario 3 as the most optimal. Technically, the system achieves 82% PR, produces 2,080.5 kWh/year, and saves Rp3,535,872/year in electricity costs. The 24V 100Ah Lithium-Ion battery reliably provides ± 2.8 hours of backup power to mitigate fish mortality risk. Economically (at 13.49% WACC), Scenario 3 yields NPV of Rp24,054,015, IRR of 31.41%, PI of 2.16, and DPP of 4.32 years. Through a reality check against harvest cycle decline and panel degradation, this scenario remains positive NPV of Rp3,051,230 and IRR of 15.96%. Environmentally, the system reduces 45.25 tons of CO₂ emissions with a favorable GRC value of Rp1,512.56/kg CO₂. In conclusion, based on technical, economic, and environmental evaluation, Scenario 3 integration is recommended to secure operational financial resilience and agribusiness sustainability of tilapia farming.

Keywords: *PV System Evaluation, Pond Aeration, Tilapia, Techno-Economic Analysis, Green Reduction Cost, UPS, Renewable Energy, Freshwater Aquaculture*