

ABSTRAK

Lahan pertanian tidak produktif selama musim kemarau menjadi masalah bagi warga Gunungkidul yang mayoritas ekonominya ditopang oleh pertanian. Penelitian untuk meningkatkan hasil pertanian dilakukan melalui metode intensifikasi agrosilvopastura dengan cara menanam bawang merah pada musim kemarau. Hasilnya, produktivitas lahan meningkat 460%-688%. Namun, kebutuhan utama untuk mengimplementasikan metode tersebut adalah air untuk irigasi. Sumber air yang tersedia berada 60 m di bawah permukaan tanah. Dibutuhkan pompa air berdaya listrik 1,42 kW untuk menaikkan air guna irigasi. Dengan sumber energi dari matahari, harga air dari pompa lebih murah dibandingkan dengan PDAM dan BUMDES. Oleh karena itu, penelitian ini merancang sistem pompa air bertenaga surya 4 kWp dengan lama operasional 10 jam. Performa pembangkit juga dievaluasi, mencakup efisiensi dari komponen pembangkit dan nilai keekonomiannya (LCOE). Penelitian ini dimulai dari pemetaan kebutuhan energi, survei lapangan, desain dan uji prototipe PLTS, implementasi dan analisa performa sistem. PLTS *off-grid* DC-coupled berkapasitas 4kWp mampu menyalakan pompa selama 10 jam per hari. Efisiensi dari PV masih bisa ditingkatkan karena ada pengaruh shading dari pohon yang menghalangi iradiasi ke panel sebesar 20%. Proporsi pembebanan AC pada inverter sangat berpengaruh terhadap efisiensi. Semakin kecil daya yang digunakan dibandingkan dengan kapasitas, maka akan semakin tidak efisien performa inverter. Dari hasil analisis keekonomian, didapat LCOE sebesar Rp 3.727,24/kWh dan LCOW sebesar Rp 2.115,022/m³.

Kata kunci: Agrosilvopastura, PLTS *off-grid*, pompa air, efisiensi, LCOE, dan LCOW

ABSTRACT

Unproductive farmland during the dry season has become a problem for the majority of Gunungkidul residents whose economy relies heavily on agriculture. Research to enhance agricultural yields has been carried out through the method of agrosilvopastoral intensification, specifically by cultivating shallots during the dry season. As a result, land productivity has increased by 460% to 688%. However, the primary requirement to implement this method is water for irrigation. The available water source is located 60 meters below ground level. A 1.42 kW water pump is needed to lift the water for irrigation. With solar energy as the power source, the cost of water from the pump is more economical compared to the Public Water Supply (PDAM) and Village-Owned Enterprises (BUMDES). Therefore, this research designs a solar-powered water pump system with a 4 kWp solar capacity and 10 hours of operational duration. The solar module performance is also evaluated, the efficiency of its components and the Levelized Cost of Energy (LCOE). The research process consists of energy needs assessment, field surveys, prototype design and testing of the Solar Power Plant (PLTS), system implementation, and performance analysis. The 4 kWp off-grid DC-coupled PLTS is capable of powering the pump for 10 hours daily. The efficiency of the PV system can still be improved as shading from trees obstructs approximately 20% of the panel's irradiation. The proportion of AC loading on the inverter significantly affects efficiency. The less power used compared to its capacity, the less efficient the inverter's performance becomes. From the economic analysis results, the LCOE and LCOW are calculated to be Rp 3.727,24 per kWh and Rp 2.115,022 per m³.

Keywords: Agrosilvopastura, PLTS, LCOW, LCOE, water pump and system efficiency