

INTISARI

Provinsi Jawa Timur memiliki potensi biomassa limbah padi rata-rata sekitar 9,6 juta ton per tahun. Penelitian ini melakukan optimasi multi-objektif rantai pasok biomassa limbah padi untuk program *co-firing* di Pembangkit Listrik Tenaga Batubara (PLTU) Paiton, dengan tujuan meminimalisir biaya transportasi dan emisi karbon dioksida. Pendekatan *linear programming* diterapkan untuk menentukan skema distribusi biomassa yang optimal, termasuk pemilihan lokasi *pre-collecting hub* (pusat pengumpulan) yang sesuai. Emisi karbon dioksida dari kegiatan transportasi diperkirakan menggunakan *Greenhouse Gas Protocol (GHG Protocol)*, berdasarkan konsumsi bahan bakar dan faktor emisi. Hasil pengoptimalan menunjukkan bahwa penerapan distribusi skema *hub transport* secara signifikan mengurangi biaya logistik dan emisi CO₂, dibandingkan dengan skema *direct transport* dari sumber biomassa ke pembangkit listrik. Skema *hub transport* mengurangi konsumsi BBM tahunan sebesar 411.509 liter, menghasilkan penghematan biaya BBM sebesar Rp2.798.259.588 dan menurunkan emisi sebesar 1.106,96 ton per tahun (31,06%). Temuan ini menyoroti bahwa desain rantai pasokan berbasis skema *hub transport* dapat meningkatkan efisiensi logistik sekaligus mendukung tujuan pengurangan emisi di sektor energi CO₂.

Kata kunci: rantai pasok biomassa, *co-firing*, *linear programming*, *GHG Protocol*, limbah padi

ABSTRACT

East Java Province has an average rice waste biomass potential of approximately 9.6 million tons per year. This study conducts a multi-objective optimization of the rice waste biomass supply chain for the co-firing program at the Paiton Coal-Fired Power Plant (CFPP), with the aim of minimizing transportation costs and carbon dioxide (CO_2) emissions. A linear programming approach is applied to determine the optimal biomass distribution scheme, including the selection of a pre-collecting hub (collection center) location. Greenhouse gas emissions from transportation activities are estimated using the Greenhouse Gas (GHG) Protocol, based on fuel consumption and emission factors. The optimization results demonstrate that implementing a hub transport scheme distribution significantly reduces both logistics costs and emissions, compared to direct transport scheme from biomass sources to the power plant. The hub transport scheme reduces annual fuel consumption by 411.509 liters, resulting in fuel cost savings of Rp2.798.259.588 and lowers CO_2 emissions by 1.106,96 tons per year (31,06%). These findings highlight that hub transport scheme can enhance logistics efficiency while supporting emission reduction goals in the energy sector.

Keywords: biomass supply chain, co-firing, linear programming, Greenhouse Gas Protocol, rice waste