

# Indikator Keberlanjutan Pencampuran FAME-HVO-Minyak Solar Menggunakan Life Cycle Sustainability Assessment = Sustainability Indicator of FAME-HVO-Petroleum Diesel Blends Using Life Cycle Sustainability Assessment

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## Abstrak

Penggunaan minyak sawit sebagai bahan baku bahan bakar memiliki isu keberlanjutan. Studi keberlanjutan sebelumnya telah membahas isu lingkungan dari bahan bakar nabati berbasis kelapa sawit, tetapi belum memperhatikan aspek manusia. Secara konseptual, pendekatan keberlanjutan adalah keseimbangan antara aspek sosial, ekonomi, dan lingkungan. Penelitian ini bertujuan untuk menganalisis indikator keberlanjutan rantai pasok produksi bahan bakar nabati berbasis kelapa sawit campuran Fatty Acid Methyl Ester (FAME), Hydrotreated Vegetable Oil (HVO), dan Minyak Solar menggunakan Life Cycle Sustainability Assessment (LCSA). Emisi gas rumah kaca, ekosistem, dan kesehatan manusia diperhitungkan sebagai aspek lingkungan, kemudian biaya produksi, penghematan devisa, dan kerugian pungutan ekspor sebagai aspek ekonomi, dan penciptaan lapangan kerja dan pendapatan sebagai aspek sosial. Pembobotan ketiga aspek keberlanjutan diterapkan secara setara, kemudian dinilai berdasarkan peringkat indikator keberlanjutan. Campuran FAME, HVO, dan minyak solar diskenariokan berdasarkan standar kualitas EURO1, EURO2/3, EURO4, dan EURO5. Hasil LCSA menunjukkan EURO5 memiliki kinerja keberlanjutan tertinggi dengan skor 3,22, sedangkan EURO1 memiliki kinerja keberlanjutan terendah dengan skor 2,00. Penggunaan minyak kelapa sawit (CPO) memberikan kontribusi terhadap kinerja lingkungan dan ekonomi. Land-use change dan harga dari CPO adalah parameter yang paling signifikan mengurangi kinerja lingkungan dan ekonomi, di sisi lain juga menciptakan lapangan pekerjaan dan meningkatkan pendapatan seiring semakin tingginya campuran bahan bakar nabati. Dari hasil LCSA disarankan untuk memenuhi spesifikasi kualitas bahan bakar serta pemilihan bahan baku yang berkelanjutan.

.....The use of palm oil as a raw material for fuel has sustainability issues. Previous sustainability studies have addressed the environmental issues of palm oil-based biofuels, but have not considered the human aspect. Conceptually, the sustainability approach is a balance between social, economic, and environmental aspects. This study aims to analyze supply chain sustainability indicators for the production of palm oil-based biofuels with a mixture of Fatty Acid Methyl Ester (FAME), Hydrotreated Vegetable Oil (HVO), and Diesel Oil using the Life Cycle Sustainability Assessment (LCSA). Greenhouse gas emissions, ecosystems, and human health are taken into account as environmental aspects, then production costs, foreign exchange savings, and export levy losses as economic aspects, and job creation and income as social aspects. The weighting of the three sustainability aspects is applied equally, then assessed based on the ranking of sustainability indicators. The mixture of FAME, HVO, and diesel oil is screened based on the EURO1, EURO2/3, EURO4, and EURO5 quality standards. The LCSA results show that EURO5 has the highest sustainability performance with a score of 3.22, while EURO1 has the lowest sustainability performance with a score of 2.00. The use of palm oil (CPO) contributes to environmental and economic performance. Land-use change and the price of CPO are the parameters that most significantly reduce environmental and economic performance, while also creating jobs and increasing income as the biofuel mix increases. From

the results of the LCSA, it is recommended to meet the fuel quality specifications as well as the selection of sustainable raw materials.