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Hydrogen Strategy for RED III Compliance in a Refinery

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The European Union aims to achieve carbon neutrality by 2050. As part of the path toward a climate-neutral economy, environmental regulations are being continuously introduced and tightened. The latest Renewable Energy Directive (RED III), set to take effect from 2030, focuses on the energy, industry, and transport sectors. The Directive specifies the target share of renewable fuels in overall fuel consumption across these sectors. Notably, RED III requires a minimum 5.5% share of biofuels and 1% share of renewable fuels of non-biological origin (RFNBO), which can be generated through electrolysis using renewable energy. Hydrogen is an important component in refineries where it is utilized for polypropylene production and removal of undesirable elements such as sulfur or nitrogen from feedstocks. Currently, majority of hydrogen is produced by reforming processes. To comply with the RED III targets, a portion of hydrogen production should be substituted with RFNBO. In this work, several methods for achieving RED III targets are analyzed. RFNBO can be produced directly within the refinery. This can involve either generating a quantity of RFNBO sufficient to meet the refinery's own needs or facilitating production within the Slovak Republic. Alternatively, RFNBO can be sourced from countries where renewable energy is less expensive. Green ammonia may serve as an effective hydrogen carrier, which can be stored and subsequently decomposed in the refinery. Another scenario considers a situation in which RFNBO is neither produced nor purchased, which would incur penalties. To meet biofuel targets, biomethane can be acquired, contributing to lower carbon emissions. Additionally, hydrogen can be produced via thermal pyrolysis of natural gas or biomethane. During the pyrolysis reactions, CO_2 is not directly produced. Instead, solid carbon is formed, resulting in a lower carbon footprint compared to reforming process. Combinations of strategic pathways are evaluated and compared using a Multi-Criteria Decision Analysis (MCDA). The objective is to identify viable strategy for integrating renewable fuel solutions into refinery operations.

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