

Biohydrogen with negative CO₂ emissions from municipal solid waste for decarbonising the public bus fleet. Application to the municipality of Madrid

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Abstract-

This study assesses the production potential, environmental impact, and economic viability of generating biohydrogen from biomethane obtained from the organic fraction of municipal solid waste (MSW) using steam methane reforming with carbon capture and storage (CCS). As the emissions are biogenic, CCS results in negative emissions. The methodology is based on a previously developed model, including techno-economic analysis based on the levelised cost of hydrogen (LCOH) and mobility (LCOM), and environmental assessment, focusing on production potential, cost estimates, and emissions impact. A case study is conducted to assess the feasibility of using this biohydrogen with negative emissions to decarbonize Madrid's public bus fleet. The findings reveal that Madrid's MSW could meet the entire hydrogen fuel demand if the fleet consisted of fuel-cell buses. However, given the high costs of replacing the entire fleet, a net-zero solution is proposed, combining 60% fuel-cell buses with existing natural gas-powered buses. In this configuration, the negative emissions from biohydrogen offset the fossil emissions from natural gas and 40% of biomethane is saved. The cost of the net-zero fleet ranges between 192.55 and 209.37 €/100 km, comparable with 100% natural gas fleet, which ranges between 176.19 and 217.69 €/100 km.

Index Terms- Biohydrogen; Municipal solid waste; Greenhouse gases (GHG); Steam methane reforming; Carbon capture and storage (CCUS); Fuel-cell electric vehicles (FCEV)

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