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Liquefied biomethane from sugarcane vinasse and municipal solid waste: Sustainable fuel for a green-gas heavy duty road freight transport corridor in Sao Paulo state

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ABSTRACT

Diversifying the energy components of a country's transport sector is essential to guarantee the fuel supply to consumers and increase the market dynamics and competitiveness. Among the known alternative fuels, biogas is a renewable source and after upgrading to biomethane, it presents a similar composition to natural gas (>90% of CH4; 35–40 MJ m−3). In addition, it can be produced from a wide variety of biological resources and at different scales In this study, two scenarios have been developed that evaluate the use of liquefied biomethane (LBM) as a diesel replacement option in the freight sector of an area of 248,223 km2 (equivalent to the area of the UK). Sugarcane vinasse (SVC) and Municipal Solid Waste (MSW) were the sole feedstocks for biogas production. The first scenario, non-restricted scenario (NRS), covered the entire territory while, the second scenario, restricted scenario (RS), includes only the area where gas pipelines are available. An economic assessment of the entire biogas value chain including, biogas production units, purification, transport and end-use was performed. The minimum selling price (MSP) of biomethane throughout the biogas chain was then estimated. LBM is estimated to be a cost-effective and affordable fuel choice compared to diesel. The technical potential of biogas production by the sugarcane mills and landfills of Sao Paulo state can replace up to half of the diesel consumed in the territory. The minimum distances and optimal locations methodology indicated the need for 120 liquefaction plants in the NRS, 35 injection points in the RS, and 7 refuelling stations to supply LBM throughout the state of Sao Paulo. The units for CO2 removal had the greatest influence on capital costs (~60%) in both scenarios. Expenditure associated with the gas injection operation and

its transport comprised more than 90% of the operating costs of the RS. Electricity purchasing represented the highest share of the operating costs at biogas purification (20%–30%) and biomethane liquefaction (65%–91%) units. Personnel costs are observed along the entire biogas chain, especially, in the biomethane transport step (40%), indicating an opportunity to generate wealth, jobs, and income. Despite our projections for the cost-effective and competitive supplies of LBM as a diesel replacement fuel, policy support measures such as a feed-in tariff, are likely to be necessary in order to overcome non-technical barriers and gain wider acceptability.

Keywords

Sugarcane vinasse; Municipal solid waste; Liquefied biomethane. Transport sector; Economic assessment; Diesel replacement