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Assessment of Biomethane Production Potential in Spain: A Regional Analysis of Agricultural Residues, Municipal Waste, and Wastewater Sludge for 2030 and 2050

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Abstract-

This study evaluates Spain’s biomethane production potential for 2030 and 2050, focusing on agricultural residues, livestock manure, municipal solid waste (MSW), and wastewater treatment plant (WWTP) sludge. The research aims to provide a regional analysis based on historical data on livestock populations, cultivated land, waste availability, and demographic projections. Using utilization coefficients and technological assumptions derived from existing biogas infrastructure, the study estimates that Spain could generate 9.71 TWh of biomethane by 2030, slightly below the national target of 10.41 TWh. By 2050, agricultural and livestock residues are expected to contribute 30.04 TWh, accounting for nearly 80% of total biomethane production, while the relative share of MSW and WWTP sludge will decrease. Andalusia, Castilla-La Mancha, and Castilla y León emerge as key contributors due to their extensive agricultural and livestock sectors. Catalonia and Madrid maintain significant roles driven by urban waste generation. The findings underscore the need for infrastructure expansion, particularly enhancing biomethane injection facilities into the natural gas grid, alongside financial incentives to support industry growth. This study highlights the role of biomethane in Spain’s renewable energy sector, emphasizing its potential to reduce greenhouse gas emissions, optimize organic waste utilization, and contribute to a sustainable energy transition.

Index Terms- biomethane; anaerobic digestion; circular economy; regional analysis; agricultural residues; wastewater sludge; municipal solid waste

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