

# **Environmental and techno-economic analysis of a biomethane energy community in southern Spain**

P. Gómez-Sánchez de Rojas; J. Victoria Rodríguez; C. Morales Polo;  
M.M. Cledera Castro

## **Abstract-**

**The increasing focus on renewable energy has spotlighted bioenergy from waste materials, emphasizing waste-based biorefinery processes for waste management and renewable energy production. Anaerobic co-digestion has emerged as a viable alternative, producing higher energy&ndash;density biogas. This study conducts a comparative environmental life cycle analysis of current waste management practices, fertilizer consumption, and domestic heat consumption with the incorporation of a biomethane plant in a small municipality in South-Spain. It evaluates the combination of more than two substrates while conducting a comprehensive analysis of the full range of available waste to optimize biomethane production and minimize the carbon footprint.**

**Additionally, a novel business model is introduced, involving energy communities comprising municipal stakeholders, small businesses, and households engaged in gas self-consumption. This model aims to benefit the municipality economically and environmentally, ensuring local energy supply security and potentially offering affordable renewable fuel prices through European funding subsidies. Currently, while gas-based community energy models exist, the injection of biomethane into the grid for community consumption is yet to be realized. However, the European Union&rsquo;s goals of promoting a circular economy and empowering rural sectors indicate progress towards this objective. From 2027, a new EU Emissions Trading System 2 scheme will impose emissions payments on buildings and small industries, highlighting the need for cost-effective decarbonization strategies where biomethane could play a crucial role.**

**The environmental impact assessment reveals that implementing a biomethane injection system significantly mitigates all environmental impact categories. A well-balanced co-digestion mixture enhances biomethane production and emission abatement, achieving an 89% reduction in CO<sub>2</sub>-eq emissions in domestic heating. Establishing a cooperative model with municipal collaboration proves viable, with a 17% internal rate of return and a possibility to decrease the price paid by the energy community below 40&euro;/MWh. Potential revenue from biogenic CO<sub>2</sub>-eq, compost, and gas sales through Guarantees of Origin and Proof of Sustainability further enhances profitability, underscoring the environmental and economic potential of anaerobic co-digestion within energy communities.**

**Index Terms-** Anaerobic co-digestion; Biomethane energy community; Environmental life cycle assessment; Cost-benefit analysis; Rural decarbonization

Due to copyright restriction we cannot distribute this content on the web. However, clicking on the next link, authors will be able to distribute to you the full version of the paper:

[Request full paper to the authors](#)

If your institution has an electronic subscription to Sustainable Energy Technologies and Assessments, you can download the paper from the journal website:

[Access to the Journal website](#)

**Citation:**

*Gómez-Sánchez de Rojas, P.; Victoria Rodríguez, J.; Morales-Polo, C.; Cledera-Castro, M.M. "Environmental and techno-economic analysis of a biomethane energy community in southern Spain", Sustainable Energy Technologies and Assessments, vol.82, pp.104496-1-104496-13, October, 2025.*