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Technical Configuration of Main Units, Costs, Requirements and Limitations: Lessons Learned

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Abstract

Integrating anaerobic digestion with biomass gasification enables the recovery of carbon retained in the recalcitrant solid fraction that anaerobic digestion alone cannot exploit (Paniagua et al., 2022). Gasification converts dry residues into a syngas mixture (CO, H2, CO2, CH4) whose quality depends on gasifier type and operating parameters (Mishra & Upadhyay, 2021; Aguado et al., 2023), which is then biologically methanated with renewable hydrogen supplied by solar-driven water electrolysis (Muñoz et al., 2015). Although established at pilot scale, deploying these routes in integrated plants is constrained not only by unit performance but also by process interfaces, certification, balance-of-plant requirements and after-sales support. This work presents lessons learned from the technical and economic specification of key equipment within the LIFE-W2B project.

A structured market assessment was carried out for: (i) a biomass gasification unit with a feed capacity of 50 kg h−1, intended to produce hydrogen-rich, low-nitrogen syngas for downstream biomethane production; (ii) an electrolyzer with a target hydrogen production of up to 1.30 Nm3 h−1 at 0 - 5 bar and 99.5% purity; and (iii) low-pressure gasholders of approximately 10 m3 for biogas, syngas and biomethane storage. The submitted offers were compared in terms of technology, process completeness, product-gas quality, CE/ATEX/PED compliance, utilities, automation, commissioning, training, warranty, maintenance, local technical support, delivery time and quoted capital cost.

Gasification offers ranged from €280,000 to €389,000. However, several lower-cost systems were primarily designed for pyrolysis, biochar production or internal syngas combustion and did not include complete tar, moisture and gas-conditioning systems required for external syngas utilization. In addition, CE conformity was frequently linked to the standard operating mode and did not necessarily cover syngas recovery for biomethane upgrading. For hydrogen production, locally supported electrolyzer solutions were quoted at €105,000 - 113,500, whereas a higher-specification international PEM system was quoted at approximately USD 258,800 (≈ €240,000). Double-membrane gasholders for biogas and biomethane were quoted at €31,400 - 42,000 for two 10 m³ units; nevertheless, syngas compatibility remained a critical limitation because specific gas constituents may damage polymeric membranes.

The assessment demonstrates that capacity and purchase price alone are insufficient selection

criteria. Procurement specifications should explicitly define gas composition and pressure, purification needs, operating-mode certification, system boundaries, installation responsibilities, safety requirements and service response. Early vendor engagement and interface-based evaluation can prevent hidden costs, redesign and integration delays during pilot-scale implementation.

Keywords: waste-to-biomethane, gasification, electrolyzer, gas storage, equipment procurement

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