RETASTE Conference Abstracts
RETASTE-ANA-1498-In-person Oral
Rethymno, September 16-18, 2026
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DOI:10.5281/zenodo.23678282

The DigeStar Project: Innovative Materials and Methodologies for Upgrading and Valorizing Anaerobic Digestate

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Abstract

Anaerobic digestion (AD) is a well-established route for managing organic waste and recovering energy, yet the fate of the resulting digestate remains a critical barrier to the development and operational viability of AD plants. While digestate has traditionally been valued as a liquid fertilizer, advances in analytical capabilities have revealed the presence of organic pollutants (pharmaceuticals, aromatic hydrocarbons), pathogens, and antibiotic-resistant bacteria and genes, raising concerns for environmental and public health (Golovko et al., 2022; Lehmann and Bloem, 2021). At the same time, the recovery of nutrients, particularly phosphorus, now listed among the EU's critical raw materials, has become an urgent priority for a circular bioeconomy. DigeStar addresses these challenges through the systematic investigation, validation, and assessment of innovative products and methodologies that either enable the direct agricultural use of upgraded digestate or convert it into high-added-value products. The project evaluates (i) the addition of biochar and iron nanoparticles to anaerobic reactors to enhance microbial degradation of pollutants and improve digestate quality, exploiting their conductive properties, high surface area, and adsorption capacity; (ii) solar drying of digestate (and its separated fractions) combined with other residues, followed by pyrolysis, to produce nutrient-rich biochar free of organic contaminants and with reduced heavy-metal bioavailability; and (iii) bioconversion routes using the separated liquid and solid fractions for insect larvae rearing and cultivation of purple phototrophic bacteria (PPB), enabling simultaneous recovery of organics, N and P as biomass without aeration. All outcomes feed a Decision Support System (DSS) allowing AD operators to select optimal, cost-effective interventions for each installation. Complemented by techno-economic, life cycle (LCA) and social life cycle (S-LCA) assessments, DigeStar aims to transform digestate from a residue into a product, improving the environmental footprint, nutrient recovery, and public acceptance of anaerobic digestion.

Keywords: anaerobic digestion, digestate valorization, biochar, nutrient recovery, circular economy, pyrolysis

References

Golovko, O., Ahrens, L., Schelin, J., Sörengård, M., Bergstrand, K., Asp, H., Hultberg, M., Wiberg, K., 2022. Organic micropollutants, heavy metals and pathogens in anaerobic digestate based on food waste, Journal of Environmental Management, 313, 114997.

Lehmann, L., Bloem, E., 2021. Antibiotic residues in substrates and output materials from biogas plants

– Implications for agriculture. Chemosphere, 278, 130425.

Acknowledgments: This research has been co-financed by the European Union and Greek national funds through the Operational Programme "Competitiveness" (ESPA 2021–2027), under the call "Research – Innovate" (project code: ΕΚΠΑΡ01-0066307, acronym: DIGESTAR).

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