

Assessing the Environmental and Social Sustainability of Innovative Waste-to-Biomethane Pathways: The LIFE-W2B Project Approach

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INTRODUCTION & AIM

The transition towards a circular bioeconomy requires innovative solutions to overcome the current limitations of anaerobic digestion (AD) and gasification (GF). Traditional AD processes often struggle with woody lignocellulosic residues and the management of large volumes of digestate, while gasification remains sensitive to feedstock moisture and consistency.

The LIFE-W2B project ("Sustainable Transformation of Waste to Biomethane, through Innovative Upgraded Anaerobic Digestion and Gasification") aims at addressing these challenges by integrating Solar Drying to these processes into a holistic waste management system. University Niccolò Cusano (UNC) will lead planned activities for evaluating the real impact of this integrated process. The LIFE-W2B project proposes a technical solution where solar drying is used as a core pretreatment to optimize subsequent energy recovery (**Figure 1**). Specifically:

- **Anaerobic Digestion:** Applied to the easily biodegradable fraction of waste
- **Gasification:** Utilizing solar-dried residues (including those from AD) to produce syngas
- **Biomethanation:** Converting both biogas and syngas into high-purity biomethane
- **Nutrient Recovery:** Producing biochar from gasification, which serves as a long-term carbon sink and a nutrient-rich soil amendment.

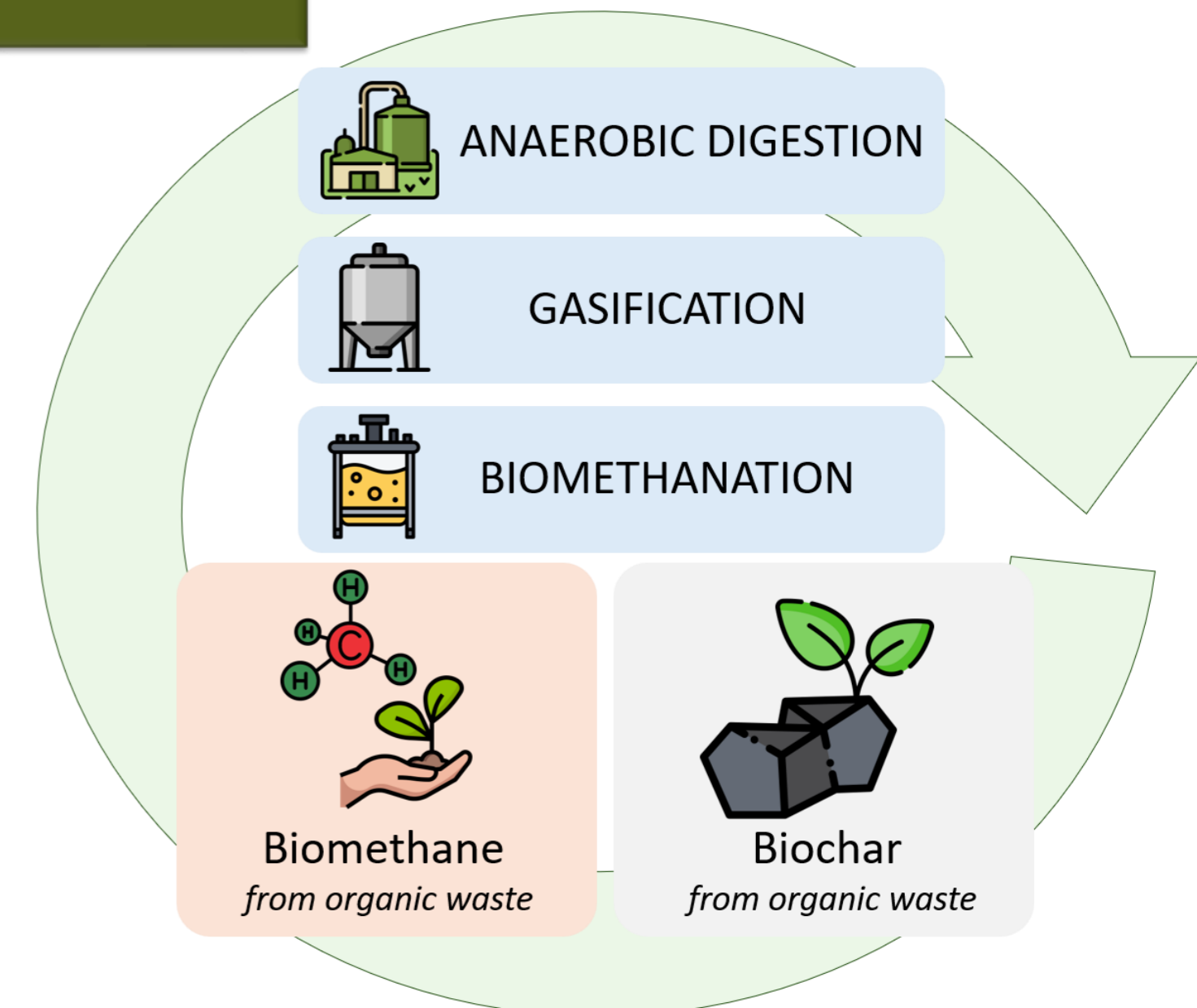


Figure 1. Processes within the W2B project.

METHOD

The early-stage activities by UNC are focus on establishing a robust framework for environmental and social assessment based on real-world data collected from the pilot facility in Crete. UNC will conduct a comprehensive environmental Life Cycle Assessment (LCA) to compare the LIFE-W2B approach against conventional scenarios. The assessment will prioritize primary data collected directly from the pilot unit, ensuring high reproducibility and verifiability, and allowing for a precise evaluation of the process's capacity to act as a carbon sink. A Social-LCA (S-LCA) will be implemented to evaluate factors such as community well-being, health and safety, and social equity within the waste management chain (**Figure 2**).

EXPECTED OUTCOMES

The Social-LCA is expected to provide a comprehensive understanding of the social benefits and potential trade-offs associated with the LIFE-W2B concept (**Figure 3**). Preliminary expectations indicate positive outcomes in terms of local job creation, increased social acceptance of circular waste management solutions, and enhanced stakeholder engagement across the value chain. Furthermore, the integration of renewable biomethane production and resource recovery technologies is expected to contribute to regional sustainable development objectives while improving the social perception of organic waste valorization practices.

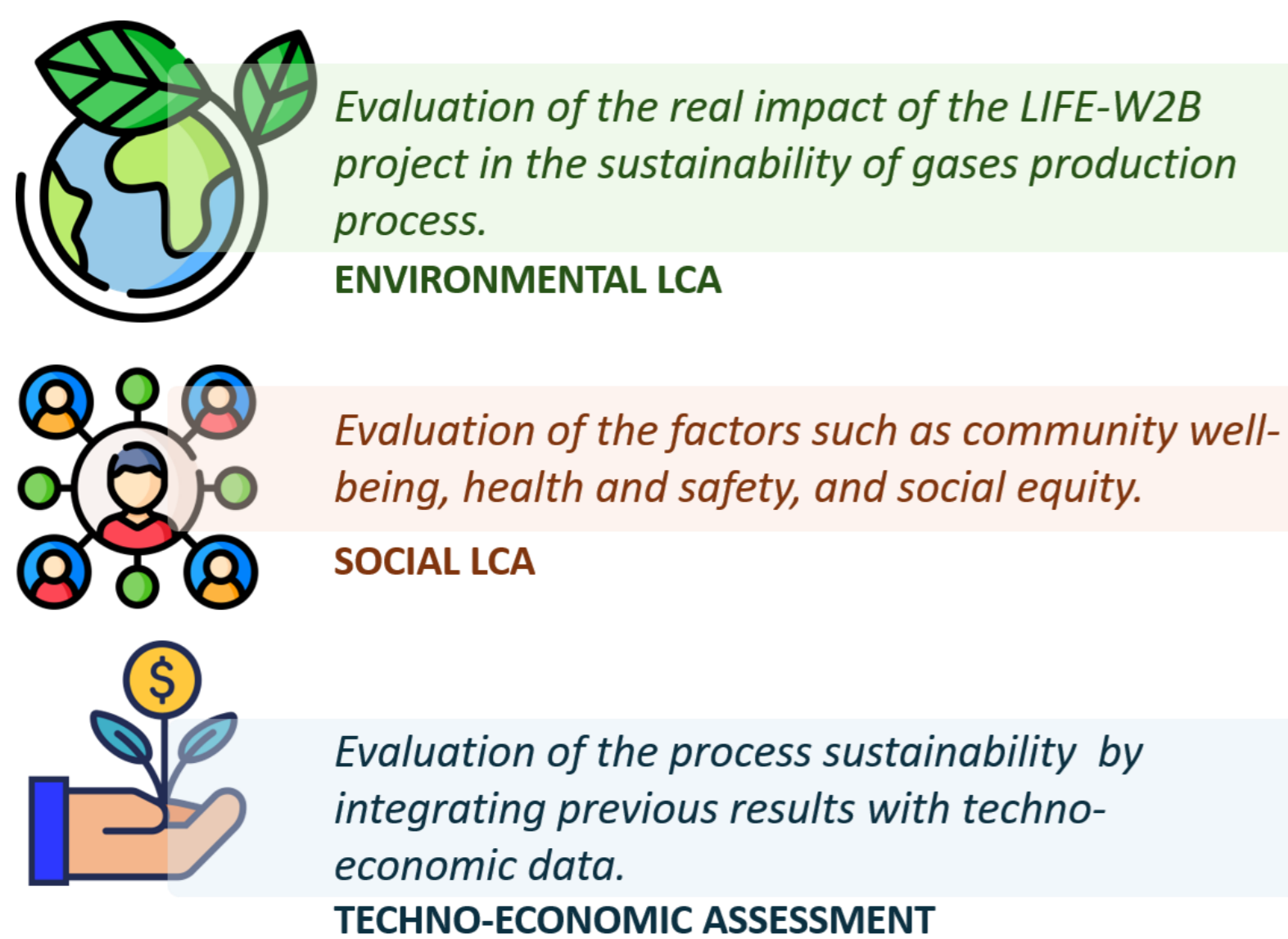


Figure 2. Sustainability assessment framework.



Figure 3. Expected benefit of the W2B project.

CONCLUSIONS

The LIFE-W2B project proposes an integrated pathway combining solar drying, anaerobic digestion, gasification and biomethanation to maximize carbon recovery from organic waste streams.

- A comprehensive sustainability framework based on Environmental LCA, Social LCA and techno-economic assessment is being developed to evaluate the real impacts of the proposed system.
- The project outcomes will support the deployment and replication of sustainable waste-to-biomethane solutions across Mediterranean regions.