Interreg Co-funded by the European Union NEXT MED

Sludge2Energy

Pyrolysis of Dried Sewage Sludge for the Production of Energy and Biochar, as a Multifactor Process for Energy Efficiency and Reduction of Gas Emissions - Sludge2Energy

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Project Description

The Sludge2Energy project investigates the integration of solar drying and pyrolysis as a circular and low-carbon strategy for sustainable sludge management. Increasing evidence highlights environmental risks associated with the direct land application of sewage sludge, including the presence of emerging contaminants such as microplastics, pharmaceuticals, and antibiotic-resistant microorganisms. Recent studies have demonstrated that sewage sludge may act as a significant reservoir of pharmaceutical contaminants requiring advanced stabilization strategies. Pyrolysis offers a promising mitigation pathway by thermochemically converting dried sludge into syngas for energy recovery and biochar, which can potentially serve as a soil amendment and a stable carbon sequestration material.

Pilot areas

Wastewater treatment plant (WWTP) of EOAL, Larnaka, Cyprus
- ➢ Existing solar drying system (SD)
- ➢ Installation of Pyrolysis Unit

Aqaba Water Company facility (AWC), Aqaba City, Jordan
- ➢ Existing SD system
- ➢ Installation of Pyrolysis Unit

Manisa Wastewater Treatment Plant (MASKİ), Manisa, Türkiye
- ➢ Existing SD system
- ➢ Installation of Pyrolysis Unit

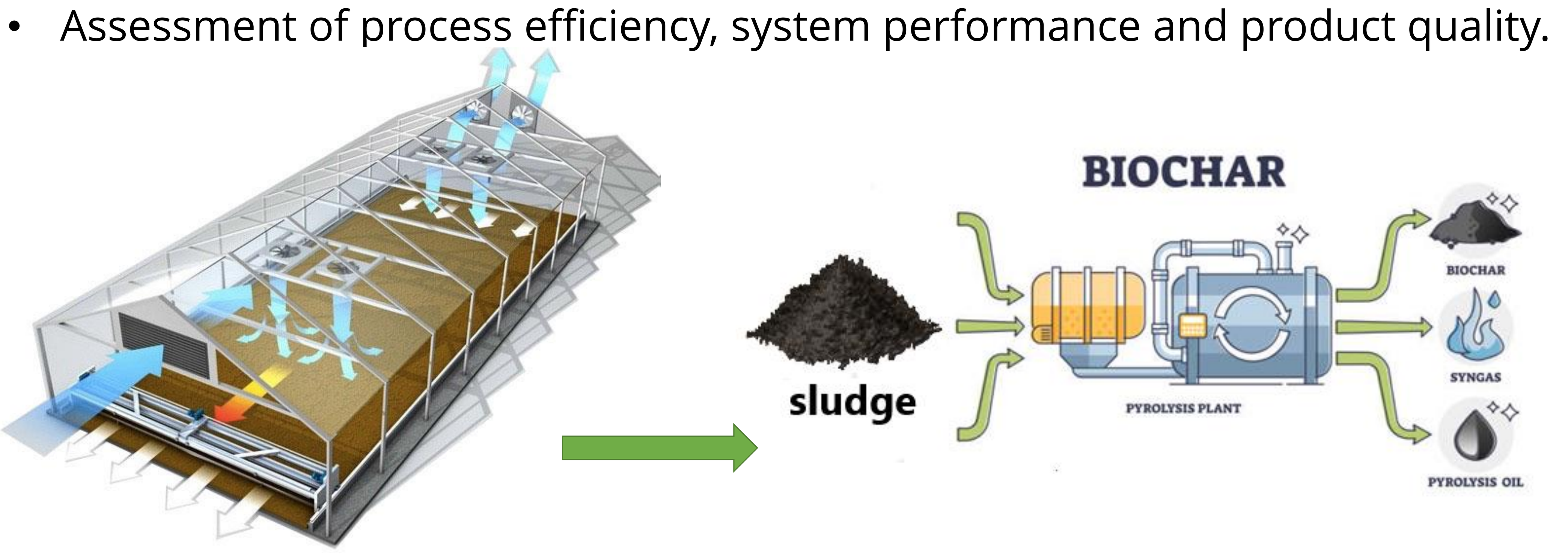
Hellenic Mediterranean University (HMU), Crete, Greece
- ➢ Existing SD system
- ➢ Existing Pyrolysis Unit

Objectives

- Reduce the environmental and health impacts of sewage sludge management.
- Introduce and promote the use of pyrolysis to convert dried sludge into energy and environmental resources.
- Foster the production of renewable energy from local waste materials.
- Produce biochar for agricultural use and for stable carbon sequestration.
- Support the transition from a linear sludge management model to a circular and sustainable approach.

Methodology

- Deployment of four pyrolysis units (3 new and 1 existing).
- Evaluation of the conversion of solar-dried sewage sludge into syngas and biochar.
- Physicochemical characterization of sludge prior to the pyrolysis process.
- Monitoring of key operational parameters, including temperature, residence time and feed rate.
- Assessment of process efficiency, system performance and product quality.



Biochar Soil Application

- Biochar characterization to determine physicochemical properties.
- Controlled soil application experiments with sludge-derived biochar.
- Analysis of soil, crop and sediment samples to evaluate soil quality and nutrient retention.
- Monitoring of crop productivity and potential contaminant release.

Environmental and socioeconomic performance

- Life Cycle Assessment (LCA): carbon emissions & footprint comparison.
- Social LCA (S-LCA).
- Economic evaluation.

Expected Results and Impacts

- ➢ <u>Environmental</u>: reduction of surface and groundwater pollution due to decreased direct application of sludge to soil; carbon sequestration through biochar; overall reduction in greenhouse gas emissions.
- ➢ <u>Energy-related</u>: generation of renewable energy from non-conventional sources; reduced energy consumption linked to sludge handling and disposal.
- ➢ <u>Social and health-related</u>: decreased public health risks, especially regarding the spread of contaminants such as pharmaceutical residues, bacteria, and antibiotic-resistant genes.
- ➢ <u>Economic</u>: lower sludge disposal costs; creation of new value chains for waste recovery; development of replicable and adaptable solutions for similar contexts throughout the Mediterranean region.

Acknowledgments: *Interreg NEXT MED 2021-2027 – Sludge2Energy_A_T_2.1_0522 is co-funded by the European Union under the Interreg NEXT MED Programme. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or the Interreg NEXT MED Programme authorities .*