LIFE-INOFEED: Design Optimization and Pilot Scale Construction of Upgraded Decentralized Bio-Waste Drying Units

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The **LIFE24-ENV-EL-LIFE-INOFEED** project addresses the pressing challenge of agri-food bio-waste management by developing and demonstrating an innovative decentralized solution for its valorisation into safe and marketable feed components. This work presents the optimization of the prototype unit designs, which forms the basis for the construction of the upgraded Autonomous On-Site Drying Units (AOSDU), constituting the technological core of the project.

Building upon an existing prototype, the upgraded AOSDU has undergone a comprehensive redesign supported by advanced engineering development and detailed construction planning. The optimization process concentrated on enhancing modularity, structural robustness, airflow distribution, drying homogeneity, and overall energy performance, with particular emphasis on the efficient integration and utilization of solar-assisted energy systems.

Within the project framework, at least five fully integrated pilot-scale AOSDU units will be constructed and deployed at the premises of collaborating bio-waste producers. These include supermarkets, auction houses, olive mills, poultry slaughterhouses, and catering/hospitality facilities, where significant quantities of organic by-products are generated. Each unit will be housed within a standard 20-foot container, enabling cost-efficient manufacturing, simplified transportation, rapid on-site deployment, and high operational flexibility. In addition, upgraded automation systems, real-time process monitoring, and enhanced safety features have been incorporated to guarantee operational reliability, consistent product quality, and full compliance with EU feed safety and environmental regulations.

The upgrade AOSDU consists of the following three (3) district modules:

Shredding Module (SD)

The SD ensures controlled size reduction and homogenization of incoming bio-waste streams prior to drying. It is designed to handle heterogeneous agri-food residues, producing uniform particle size, to improve drying efficiency and process stability. The SD includes a shredding and pulverizing system, with powerful cutting mechanisms, overload protection systems and adjustable outlet size to optimize downstream airflow distribution and moisture removal efficiency

Drying Module (DM)

The DM is the central processing unit. It is designed to ensure uniform moisture reduction of the materials through optimized airflow management and controlled thermal conditions. The drying system incorporates two insulated drying chambers, high-performance ventilation components and real-time monitoring of temperature and humidity parameters to ensure consistent drying kinetics, product stabilization and compliance with feed safety standards. Emphasis is placed on energy efficiency, operational reliability and scalability in modular sections.

Solar Panels Module (SPM)

The SPM energetically supports the drying process by harnessing renewable energy from solar radiation, significantly reducing reliance on conventional energy sources. By integrating optimized photovoltaic (and/or solar thermally assisted systems) within the containers, the unit ensures efficient energy capture and a high degree of operational autonomy. Advanced smart energy management systems maximize the use of available solar energy, lowering operating costs and minimizing the carbon footprint, while simultaneously enhancing the overall environmental sustainability of the system.

This work presents the evolution of the prototype in situ drying unit into a fully optimized pilot-scale innovative unit. Advanced mechanical and technical solutions have been implemented to enhance performance, modularity, and scalability, demonstrating the technical maturity of the upgraded AOSDU system. Through LIFE-INOFEED, a replicable circular economy model is established, transforming bio-waste from an environmental burden into a valuable secondary raw material for the animal feed sector.

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