Innovative exploitation of Solar Energy for optimizing Waste Management

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Enviroplan SA (ENV), as part of its strategic development plan, has invested heavily in innovation, through research and development projects. The company has been participating and in several times leading in many innovative projects. One of the most successful recent example of this shift in business orientation is the utilization of solar drying technology for alternative production processes, both regarding fertilisers production (FERTENERGY project), as well as, maximization of anaerobic digestion units performance (SOLARGAS project). Both processes are based on initial concepts and research results of a relevant team in the Technological Educational Institute of Crete (TEIC) that cooperates in the both following projects.

FertEnergy: *Production of Organic Fertilizer and Biofuels from Olive Mill Wastes*. This project has been funded from the General Secretariat for Research and Technology, NSRF 2007-2013. The total project budget was 661.950,00€ and the funding was 488.595,00€. The projects' objective was the development and the evaluation - environmental and economic – of a process that will allow the simultaneous conversion of residues and by-products produced by olive mills (and other agricultural residues - manure) in solid biofuels that can be used to generate renewable electricity and heat energy and in organic fertilizers that can be used in agriculture. More specific, concerning organic fertilizers, the aim of this work was to determine if the condensation of manure, after composting and solar drying process with parallel addition of olive mill wastewater, for utilization of nutritive elements with low cost technologies can result or produce an alternative low cost organic fertiliser, rich in nutrients. Central innovative element of the process using the most available energy source in Greece - and generally in the Mediterranean basin - that of the sun and as a result this solar drying technology.

Solargas: *Solar Drying as a Tool for Organic Wastes Anaerobic Digestions' Economic and Environmental Upgrade.* This project is a new project for ENV and it has been funded from the General Secretariat for Research and Technology, NSRF 2014-2020. The total project budget is 449.451,20 € and the funding is 359.560,96 €. The SOLARGAS' object is to optimize the economic and environmental footprint of the organic residues' anaerobic digestion units, through the automated, functional solar drying units' integration, which will allow the maximization of the available waste's utilization and the digestate's utilization. The project's center is the residues' anaerobic digestion and the biogas production, and the effort to upgrade it. However, a number of tools are added to this, which could argue that it is a completely new production technology, the most important of which products are ENERGY.

ENV with TEIC carried out, with great success, the FERTENERGY project which uses solar drying processes for the treatment of olive oil mill residues to decrease the high energy consumption of the drying operations, thus decreasing the environmental impact of these residues (Maragkaki et al., 2016; Galliou et al., 2018). Concerning the Fertenergy project, a pilot greenhouse solar drying unit has been constructed at Peza Union area (Pic. 1), in Heraklion, Greece. The greenhouse unit consists of four parallel concrete corridors (5m width & 20m length) completely covered by a special plastic material, resistant to unfavourable climatic conditions. The greenhouse's total area is 538m^2 (Pic. 2).

Materials (agro-industrial residues) are mixed inside the greenhouse unit using a mechanical mixing rotation drum. Solar drying processes can be a very attractive technology for the moisture's removal. The mean evaporation rate was found to be 5.2 kg $H_2O/m^2/d$ for a drying period of 6 months (February-August). Using free solar energy for drying agro-industrial residues can be beneficial from the point of view of energy consumption and, consequently, the drying system cost. The main innovation of the process is using the most abundantly available energy source in Greece – and the Mediterranean basin generally - the sun.

The result of this project was, on the one hand, the acquisition of extraordinary experience in solar drying and, on the other, the development of an experimental installation, which is an excellent precedent for the implementation of the SOLARGAS project. Making use of this available infrastructure will allow the immediate start up of the project and the exploitation of the Fertenergy's results.

Picture 1. General view of the Solar drying greenhouse unit *(Fertenergy)*

Picture 2. Inside view of the Solar drying greenhouse unit

Picture 3. During solar drying system operation

Picture 4. Solar drying system – mechanical mixing rotation drum

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