Innovative exploitation of Solar Energy for optimizing Waste Management

G. Tavoularis[1], T. Manios[2], A. Maragkaki[2]. F. Galliou[2], C. Tsompanidis[1], E. Ieremiadi[1]

[1]ENVIROPLAN S.A., Athens, Gerakas, 153 44, Greece
[2]Department of Agricultural Technology, Technological Educational Institute of Crete, Heraklion, 71410, Greece

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ELENI IEREMIADI
Chemical Engineer, M.Sc.

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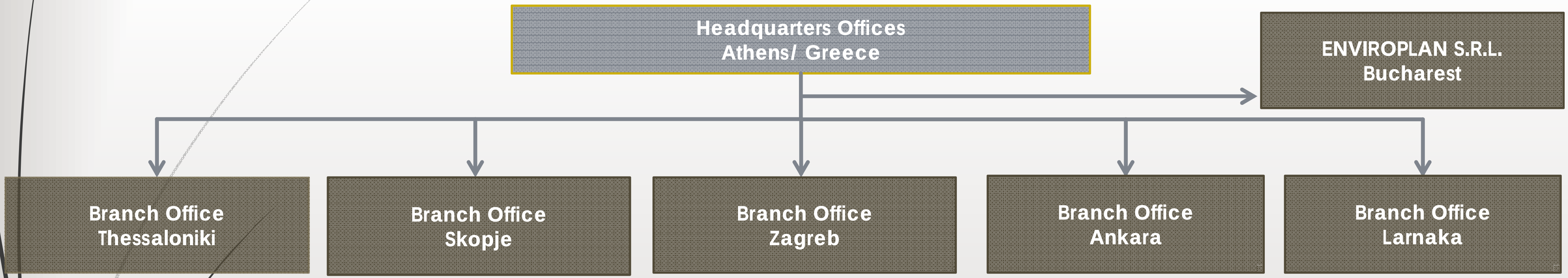

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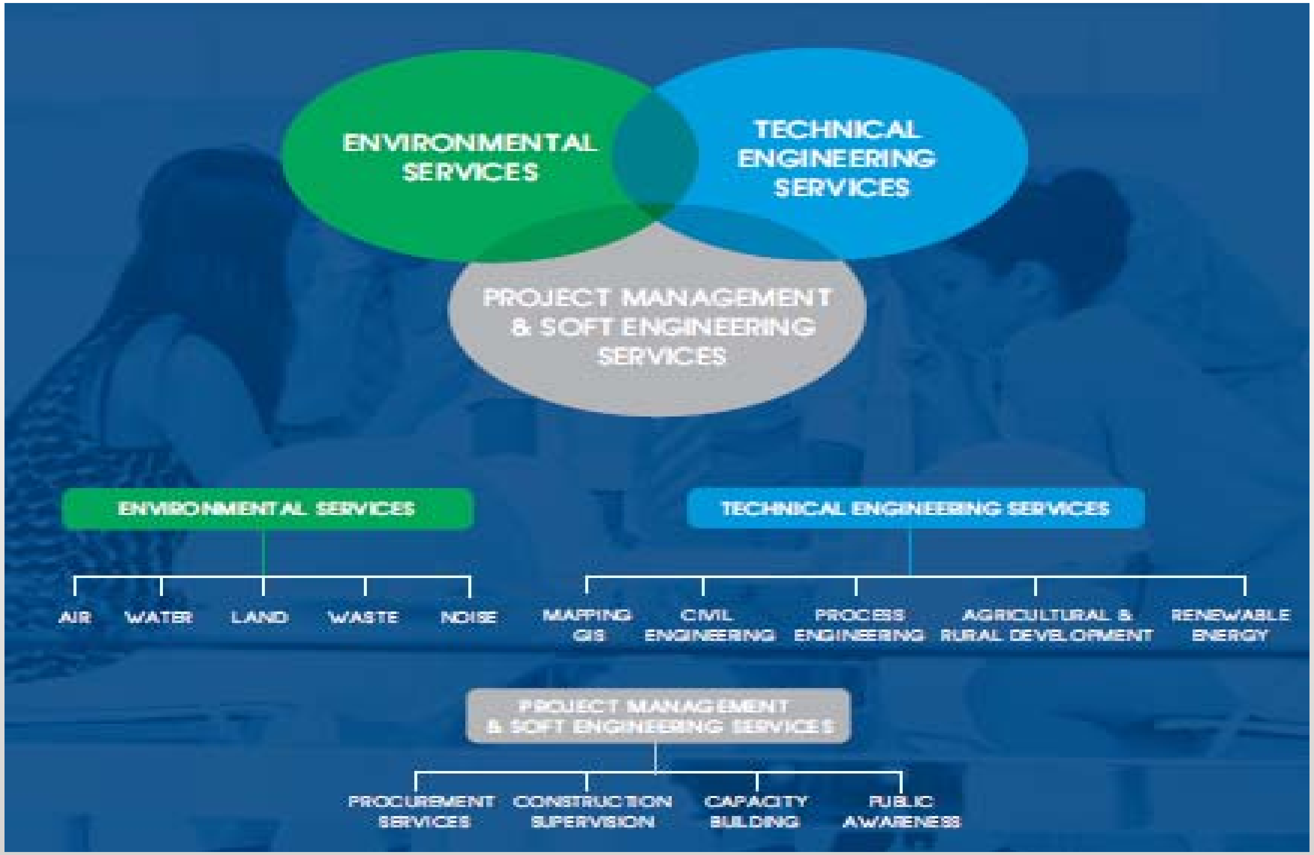

Since the philosophy of the company is the multidisciplinary approach of the technical and environmental subjects, more than 60 scientists and engineers from various disciplines are occupied in ENVIROPLAN.

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✓ European Bank for Reconstruction and Development (E.B.R.D.)
✓ World Bank (W.B.)
✓ Local authorities/Ministries
✓ Waste Management Organizations-Public Utility Companies
✓ Private sector

Research Activity - Innovation

- ✓ National Technical University of Athens (NTUA)
- ✓ Agricultural University of Athens (AUA)
- ✓ Technological Educational Institute of Crete (TEIC)
- ✓ Harokopio University (HU)
- ✓ etc.

- ✓ Environment
- ✓ Solid Waste
- ✓ Water
- ✓ Wastewater
- ✓ Energy
- ✓ Industry
- ✓ etc.

Info for ENVIROPLAN

- **ENVIROPLAN S.A. (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 both projects.

The FertEnergy Project

- **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.
- 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.

The FertEnergy Projects' Aim & Objective

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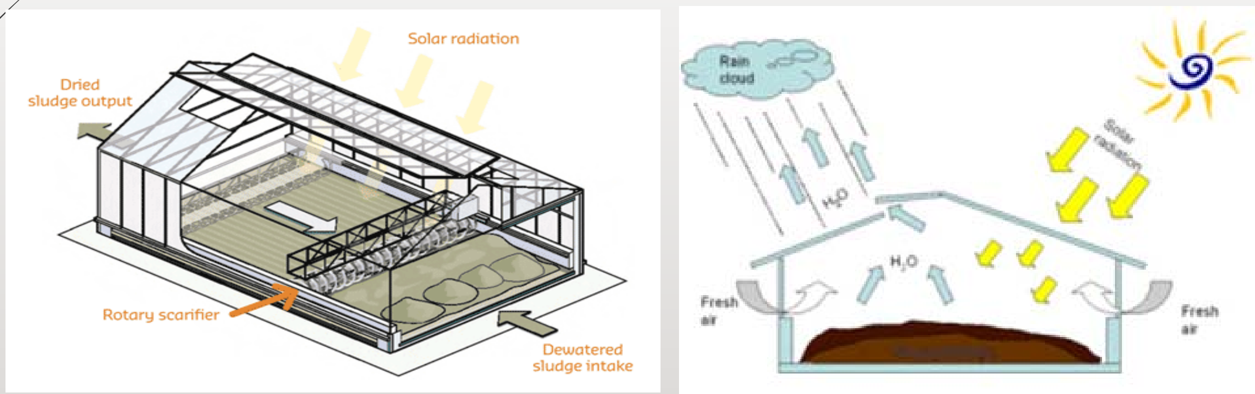


Picture 1. Solar drying into a greenhouse unit

FertEnergy – The pilot Unit

Picture 3. General view of the Solar drying greenhouse unit

Picture 4. Inside view of the Solar drying greenhouse unit (four corridors)

FertEnergy – The pilot Unit

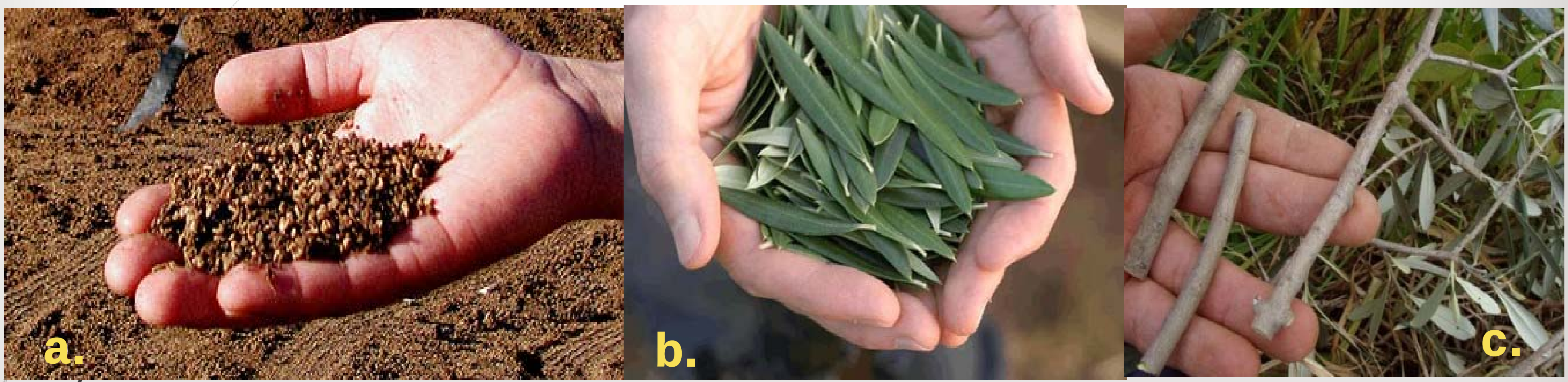
Picture 3. During solar drying system operation ...

Picture 4. Solar drying system – mechanical mixing rotation drum

FertEnergy - Production of **Solid Biofuels**

- **Projects objective was to demonstrate Olive oil by products** and **agro residues** Managing System, which uses solar drying processes for the treatment of olive oil mill residues in order to decrease the high energy consumption derived from the drying operations, thus decreasing the environmental impact of these residues. The resulting by-products, once dried out, have a final application as fuel.

FertEnergy – Biofuels production



Picture 7. a. Three phase olive pomace (POM), **b.** Olive leaves, **c.** Biomass from pruning

FertEnergy – Biofuels production - Results

- Moisture 47% → 9.6% (POM_a) after 56 days
- Moisture 52% → 8.52% ($PL_{a\&b}$) after 56 days
- Moisture 45% → 9.32% ($PLP_{a\&b\&c}$) after 64 days

FertEnergy - Production of **Organic Fertilizers**

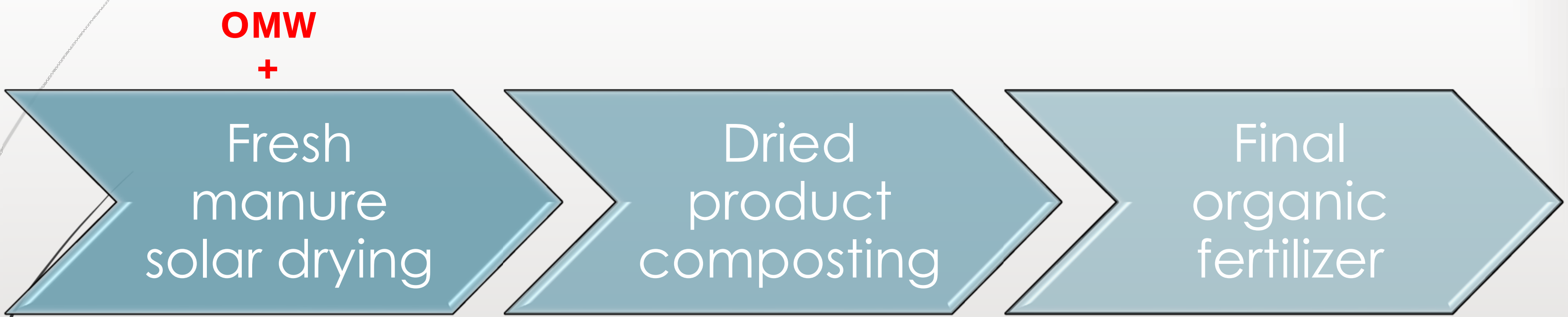
- **Projects objective** was to demonstrate a Manure and Olive Mill Wastewater (OMW) Managing System, which allows the utilisation of specific characteristics of these wastes, transforming their mixture, into a high nutrient containing end New Product, which can be safely and easily used, in all ranges of agriculture and horticulture, REPLACING in a significant scale inorganic chemical fertilisation.

Aim of this work was to determine if the condensation of manure, after composting and solar drying process with the addition of olive mill wastewater, for utilization of nutritive elements with low cost technologies can result or produce an alternative low cost organic fertilizer, rich in nutrients (OMW addition in different types of manure).

FertEnergy – Organic Fertilizers production

Picture 8. a. Fresh olive mill wastewater, **b.** Fresh manure, **c.** Organic fertilizer (final product after mixing a. & b.)

FertEnergy – Organic Fertilizers production - **Results**



Picture 9. Steps sequence in the pilot unit. After fresh manure solar drying with addition of OMW, composting of dried product follows, for the production of organic fertilizer

- Total organic carbon content is about 70%
- N/P/K content is 4.1 /1.8 /11.2
- This product can be used mainly as an organic potassium fertilizer

FertEnergy - Dissemination

Poster

Banner

Leaflet

The SOLARGAS Project

- **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.

The SOLARGAS Projects' Aim & Objective

- Optimizing the energy performance of anaerobic plants through:
  - optimization of their feed (variety, condition / quality, quantity and combination of residues) to be lead to qualitative and quantitative upgrading of the biogas produced, and
  - co-exploitation synthesis gas (syngas) resulting from the gasification of dry wastes and mainly of dry digestion.

The SOLARGAS Projects' Aim & Objective

- Improving economic performance (in addition to increasing energy production) through a reduction in operating costs resulting from better inflow and outflow management, but also the possibility of producing other products of a marketable nature such as bio-boosters (e.g. utilization of surplus quantities of seasonally available residues), compost or even solid fuels.

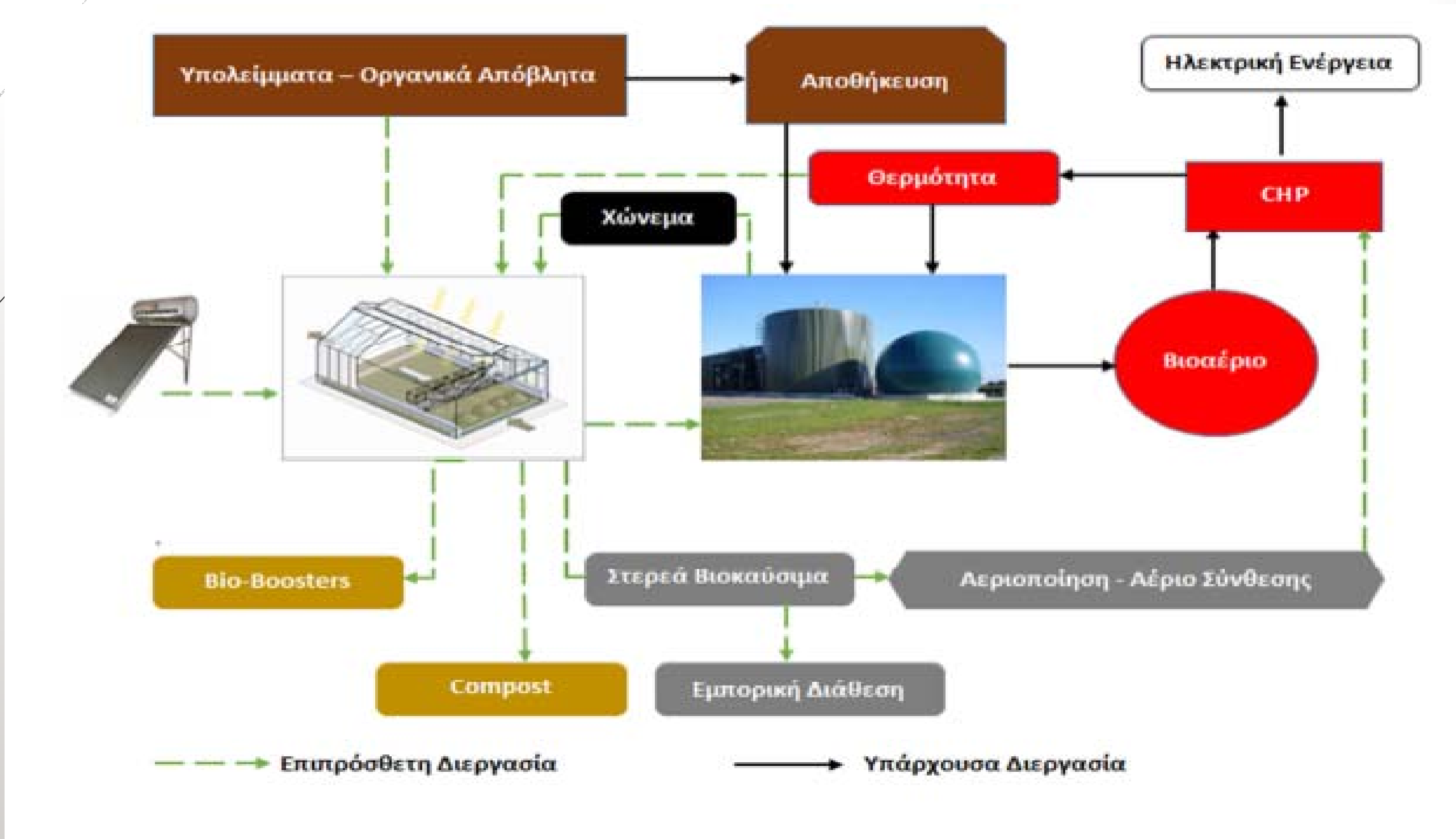
The SOLARGAS Projects' Aim & Objective

- Optimizing their environmental performance by making the most of their potential quantities of the largest variety of residues and the improvement of the total environmental footprint (more energy with fewer emissions of fossil dioxide fuels, substantial recovery of digestate - recovery of nutrients and organic matter).

The SOLARGAS Projects’ Aim & Objective

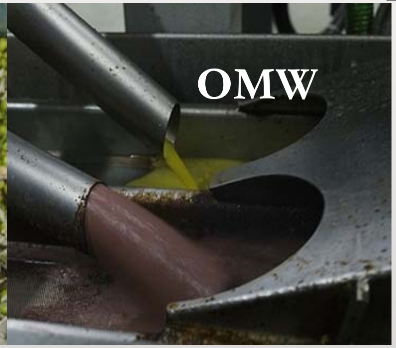
- The possibility of all of the above being feasible in any anaerobic digestion unit, through an automated co-operation / co-management of solar drying and anaerobic digestion, as well as the residuals and wastes available in the area, which will compose the new integrated production model.

SOLARGAS-Diagram of waste management



SOLARGAS- Agro-industrial wastes

Municipal Sewage Treatment Plant, Heraklion Crete



Crude Glycerol

SOLARGAS- Agro-industrial wastes

Sheep manure

Grape residue

SOLARGAS - Experiments

- Three “products” with three different concentrations of total solids (15-20%, 40-50%, >75%) will be created through solar drying by combing 9 different wastes (e.g. OMW, grape residues, cheese whey, sheep manure). Tests will be carried out with these products, in order to examine their activity in relation to anaerobic digestion.
- Also the produced bio – boosters will be examined concerning their “boosting” abilities during experiments in lab – scale continuous stirred – tank reactors (CSTR) and in pilot – scale anaerobic digester.
- Experimental reactors will be divided into three groups with HRT 21 days.
    - Group A (2 bioreactors), will be the controls and contain the base substrate (sludge or manure mixture) in total solids 10% and VS 7% to 9% respectively.
    - Group B (2 bio-reactors) will only contain the solution of the bio-booster at a concentration of 1%, 3% and 5% of the VS of the base substrates, with the aim of determine the quantity and quality of biogas due to the organic load of bio-boosters.

SOLARGAS - Experiments

- Group C, will consist of the base substrate to which the substrate mixture will be added in solid form (diluted in the base substrate mixture prior to introduction in the bio-reactor) again in an amount that will achieve an increase in VS concentration by 1%, 3% and 5% of the substrate VS.
- The combination of the results of the three groups will give a precise estimation on the effect of bio-booster.
- Finally the produced digestate from the pilot – scale anaerobic digester together with the digestate from an anaerobic sludge plant (Municipal Sewage Treatment Plant of Heraklion) and agro-industrial and livestock residues (Sychem SA, Industrial Area Heraklion) will produce mixtures.
- These mixtures will be used in composting tests and also in studies which will examine their thermal content to produce energy and / or gas synthesis (syngas).

SOLARGAS- EXPECTED RESULTS

- A functional, economical and environmental upgrade of anaerobic digestion and energy generation units through its automated coupling with solar drying units.
- A new production process, that of bio-booster, that could lead to a side-by-side economic activity of anaerobic units, with potential buyers even outside Greece, such as Germany, with more than 10,000 anaerobic units.
- An integrated effluent / digestion management, which will ensure both the effective recovery of nutrients through high-quality compost or the production of fuel (and even more energy), solving one of the major barriers to anaerobic digestion.

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Thank you for your attention!!!!

Acknowledgments

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