



ΕΡΑΝΕΚ 2014-2020  
OPERATIONAL PROGRAMME  
COMPETITIVENESS • ENTREPRENEURSHIP • INNOVATION



# CORFU 2022

9<sup>th</sup> International Conference on Sustainable Solid Waste Management

## Improving Anaerobic Co-digestion of Sewage Sludge with Solar Dried Food Waste

N. Papastefanakis, A. E. Maragkaki, M. Fountoulakis, C. Tsompanidis, T. Manios



Laboratory of Natural Resources,  
Management & Agricultural Engineering  
Hellenic Mediterranean University,  
Greece



Corfu, June 2022

# Innovation & Aim

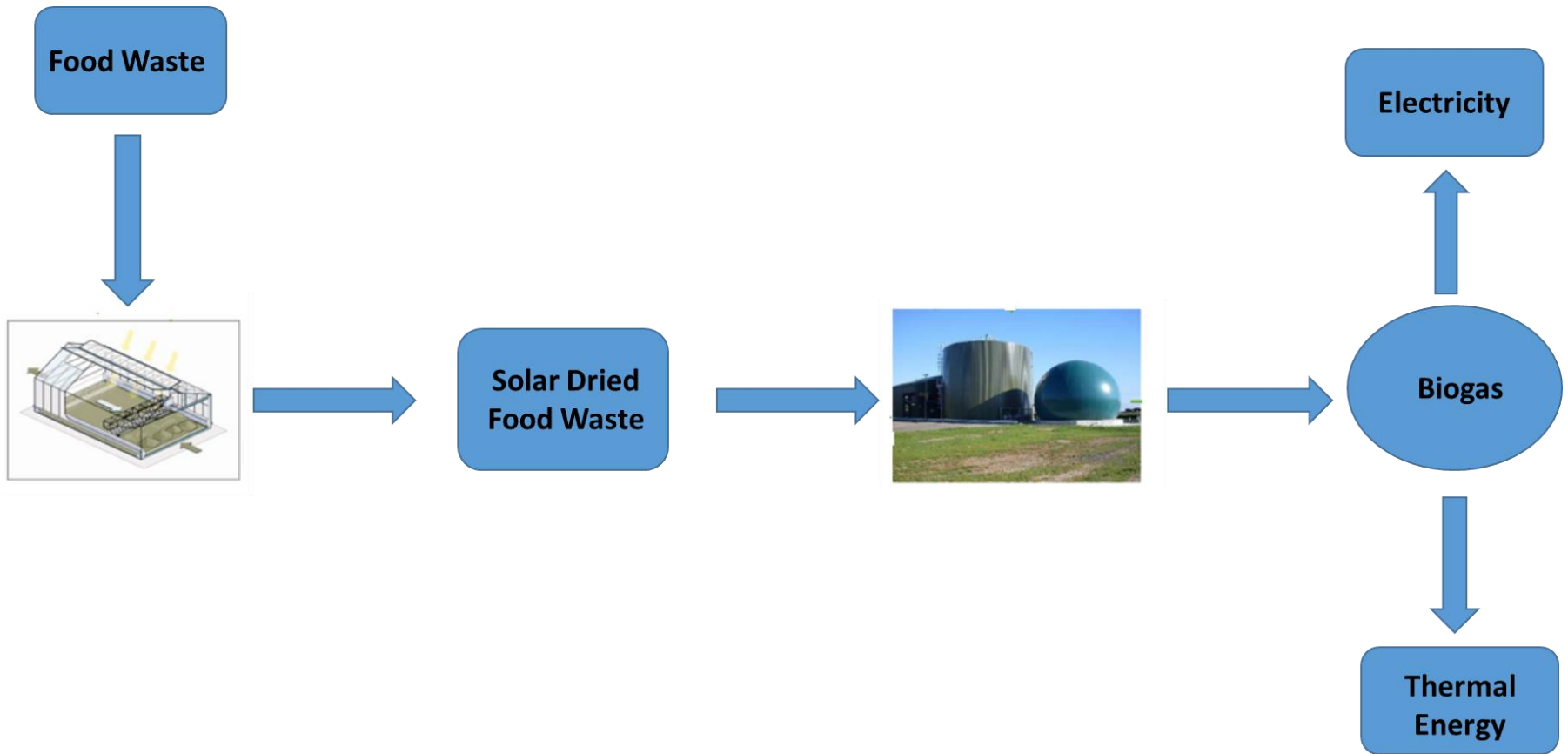
The innovation of this work is the use of solar drying as a pretreatment step for food waste stabilization prior to use in anaerobic digesters. As a result, the solar dried materials will have reduced volumes and weights and could be stored for prolonged periods.



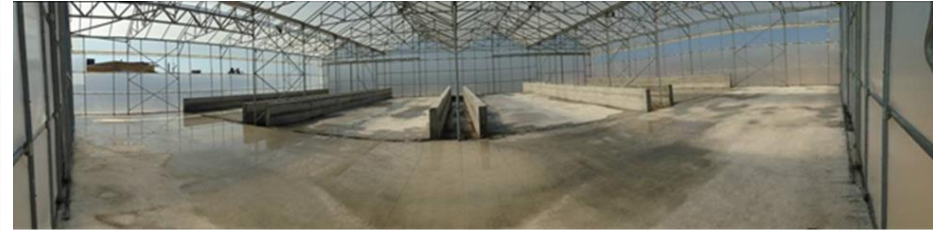
Main Aim:

**The use of dried material in small concentrations in order to improve biogas production in existing digesters at Wastewater Treatment Plants which operate only with sewage sludge**

# Flow Chart



# Solar Drying Process

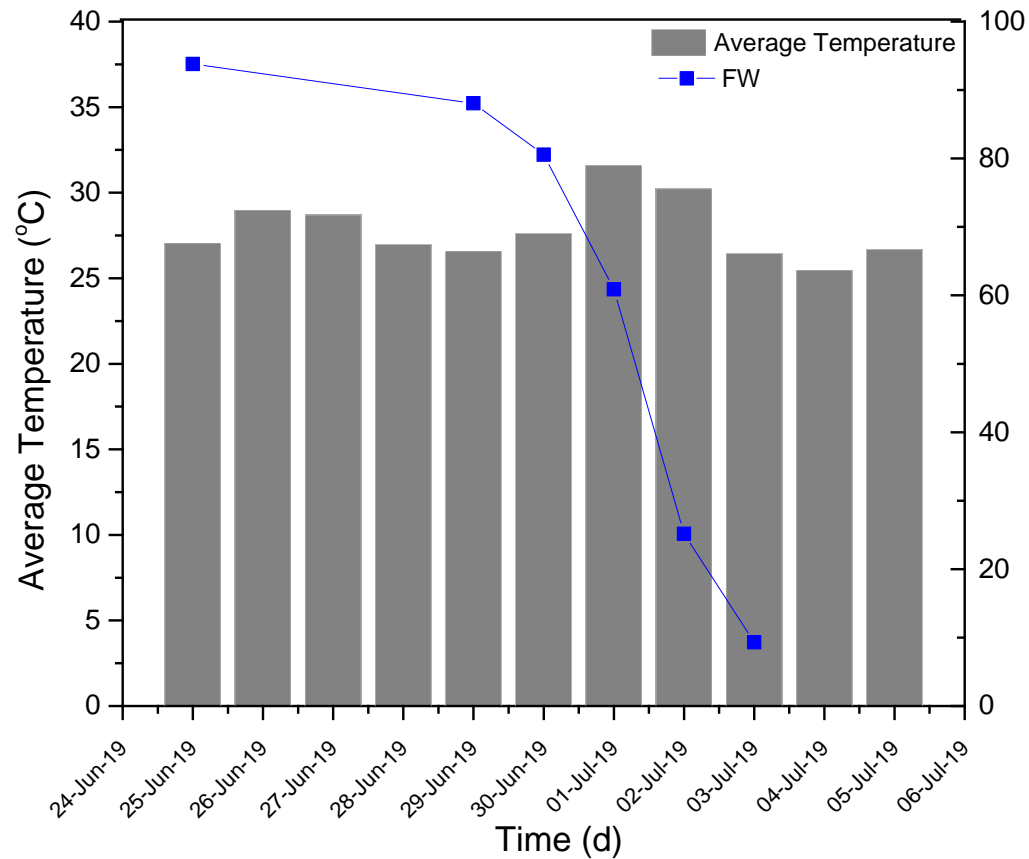


Greenhouse Solar Drying Unit



Solar Dried Material

# Solar Drying



- The experiment took place during summer (June)
- The examined wet materials were dried in far **less than 2 weeks**
- The moisture content decreased from 93.8% to 9.3% on the 9<sup>th</sup> day

# Solar Drying

Composition of food waste (FW) before and after the solar drying process

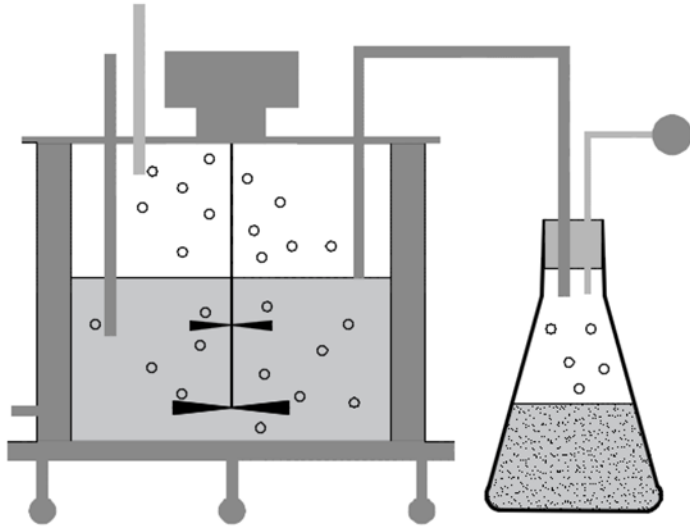
Parameters	FW (Before solar drying)	FW <sub>dry</sub> (After solar drying)	Decrease
pH	5.0 ± 0.2	4.8 ± 0.1	4 %
VS (g/kg)	945.5 ± 0.9	831 ± 0.6	12%
TOC (g/kg)	614.3 ± 29.8	578.7 ± 36.9	6%
TKN (g/kg)	35.9 ± 1.8	34.8 ± 0.2	3%

# Experimental procedure

- ✓ 4 type of feedstock:
  - ❖ **D1:** 100% sewage sludge (**SS**)(v/v)
  - ❖ **D2:** **SS + FW** (20% increase of VS in D1 influent)
  - ❖ **D3:** **SS + FW** (30% increase of VS in D1 influent)
  - ❖ **D4:** **SS + FW** (40% increase of VS in D1 influent) **Mesophilic AD, 37°C**, HRT = 24 days
- ✓ Influent & effluent samples analyzed TS, VS, pH, TCOD, d-COD and methane content in biogas

Digester number	Digester working volume (L)	HRT (days)	Time (days)	Feedstock	OLR (kg VS m <sup>-3</sup> d <sup>-1</sup> )
1	3	24	1 – 72	SS (100%)	1.38
2	3	24	1 – 72	SS+FW (20% VS increase)	1.65
3	3	24	1 – 72	SS+FW (30% VS increase)	1.82
4	3	24	1 – 72	SS+FW (40% VS increase)	1.98

# Lab scale digester



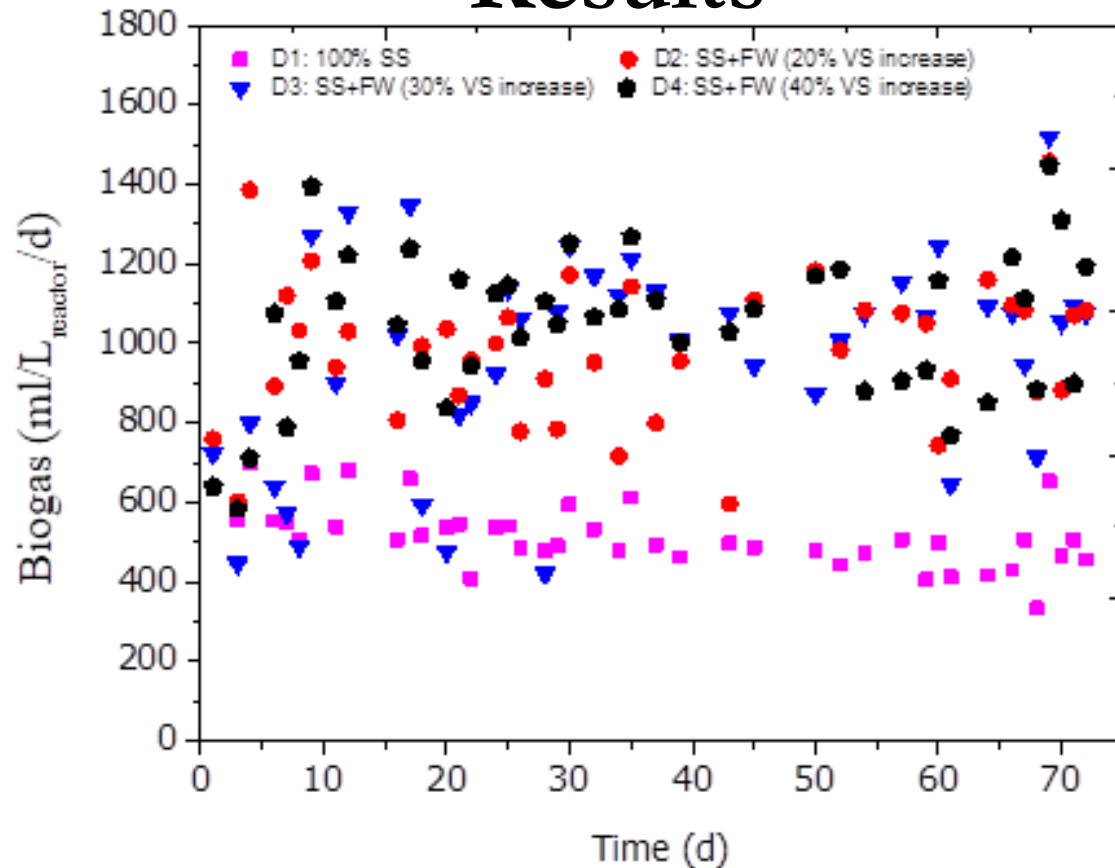


# Feedstock

## Characteristics of experimental materials as feedstock

Parameters	D1	D2	D3	D4
pH	$6.1 \pm 0.3$	$5.9 \pm 0.2$	$5.9 \pm 0.2$	$5.8 \pm 0.3$
TS (g/L)	$47.6 \pm 7.0$	$55 \pm 7.6$	$60.9 \pm 8.6$	$65.6 \pm 9.4$
VS (g/L)	$33.2 \pm 3.7$	$39.6 \pm 5$	$43.6 \pm 4.5$	$47.5 \pm 5.6$
TCOD (g/L)	$57.6 \pm 12.6$	$72.9 \pm 12.6$	$74.9 \pm 13.9$	$78.0 \pm 17.2$
d-COD (g/L)	$5.1 \pm 2.5$	$10 \pm 2.8$	$12.3 \pm 3.2$	$14.7 \pm 3.7$
TKN (g/L)	$1.9 \pm 0.1$	$2.4 \pm 0.3$	$2.6 \pm 0.2$	$2.5 \pm 0.4$

# Results



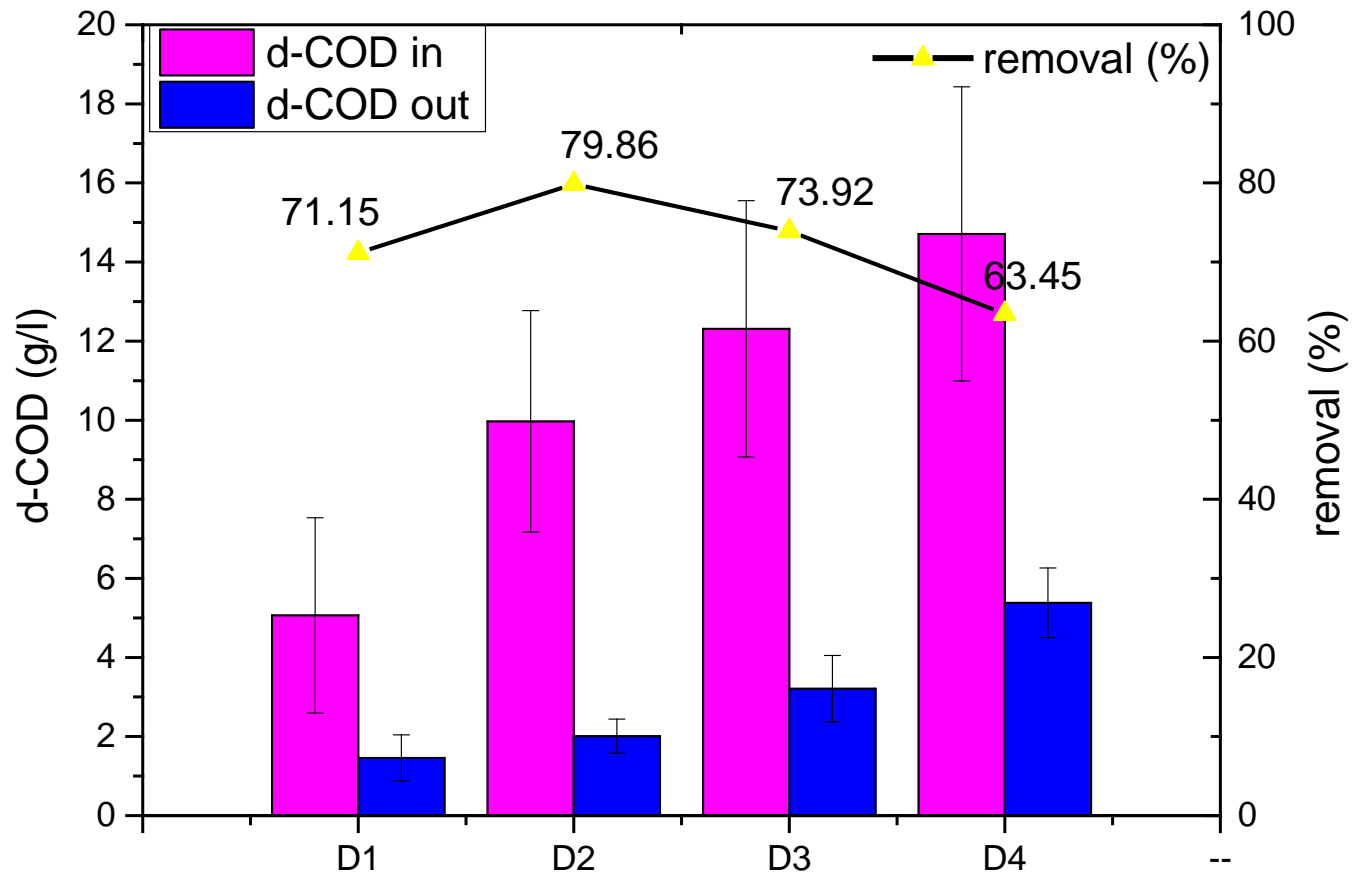
100% SS  $\rightarrow 517 \pm 80$  ml/l<sub>reactor</sub>/d

SS + FW (20% VS increase)  $\rightarrow 964 \pm 264$  ml/l<sub>reactor</sub>/d 86%

SS + FW (30% VS increase)  $\rightarrow 991 \pm 184$  ml/l<sub>reactor</sub>/d 91%

SS + FW (40% VS increase)  $\rightarrow 1045 \pm 190$  ml/l<sub>reactor</sub>/d 102%

# Results – d-COD



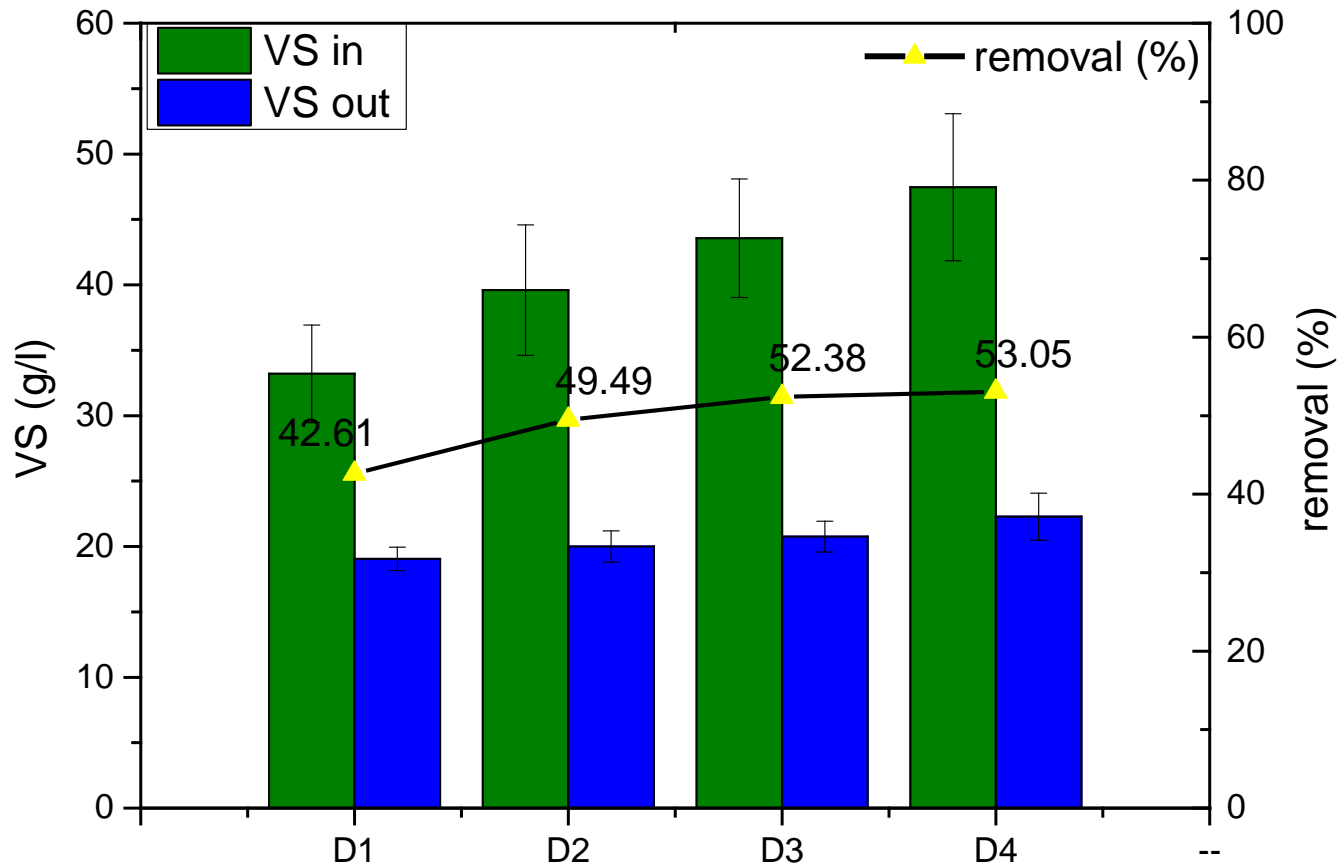
**D1: 100% SS → 71.15%**

**D2: SS+FW (20% VS increase in D1 influent) → 79.86%**

**D3: SS+FW (30% VS increase in D1 influent) → 73.92%**

**D4: SS+FW (40% VS increase in D1 influent) → 63.45%**

# Results - VS



**D1: 100% SS → 42.61%**

**D2: SS+FW (20% VS increase in D1 influent) → 49.49%**

**D3: SS+FW (30% VS increase in D1 influent) → 52.38%**

**D4: SS+FW (40% VS increase in D1 influent) → 53.05%**

# Conclusions

- ✓ Solar drying process could be used as a pretreatment step for food waste stabilization prior to use in anaerobic digestion.
- ✓ The process had small effect on pH, TKN and TOC (4%, 6% and 3% respectively) and bigger effect on VS (12% decrease)
- ✓ Co-digestion process of sewage sludge with a small amounts of dried FW can be a promising perspective in existing wastewater treatment plants
- ✓ After the supplementation of dried FW in the feed compared to sewage sludge the biogas production is improved by 1.8 – 2 times

# Acknowledgments

This research has been co-financed by the European Union and Greek national funds through the Action 1.b.2 "Business Partnerships with Research and Dissemination Organizations, in sectors of RIS3Crete", of the Operational Program "Crete" 2014 – 2020 (project code: KPHP1-0028938).

# Thank you for your attention



Laboratory of Natural Resources,  
Management & Agricultural  
Engineering  
Hellenic Mediterranean University,  
Greece



European Union  
European Regional  
Development Fund

ΕΡΑΝΕΚ 2014-2020  
OPERATIONAL PROGRAMME  
COMPETITIVENESS • ENTREPRENEURSHIP • INNOVATION

ΕΣΠΑ  
2014-2020  
ανάπτυξη • εργασία • αλληλεγγύη  
Partnership Agreement  
2014 - 2020