HERAKLION2019

7th International Conference on Sustainable Solid Waste Management 26-29 June 2019

The experience of the NTUA Unit of Environmental Science & Technology in projects

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Heraklion, 27th June 2019

National Technical University of Athens (NTUA)

NTUA (<u>www.ntua.gr</u>) was founded in 1836 and is the oldest and most prestigious educational institution of Greece in the field of technology.

NTUA in numbers:

- 9 Faculties, 1350 personnel
- 700 academic staff
- 140 scientific assistants
- 260 administrative & technical staff
- 8500 Undergraduate students
- -1500 graduate students



Unit of Environmental Science & Technology (UEST)



UEST Laboratory – ISO 9001:2000 & 17025:2005 certified



30 years: we implemented over 150 projects



Industry 82





OTHER EU 30 (H2020, FP7, EUROPEAID, INTERREG,TWINNING)

Waste & natural resources

Each year in the European Union:

- 7.3 billion tonnes of resources are consumed
- 2.7 billion tonnes of waste are generated,
- 40% is being re-used or recycled, the rest ends up at landfill or is partly incinerated.

Waste & natural resources

- If this quantity of waste was recycled then:
 - the equivalent of 148 million tonnes of CO₂ emissions could be avoided annually;
 - Around 5.25 billion euro would be saved from the recovery of recyclables such as paper, glass, plastics, aluminum and steel per year.
 - 500,000 new jobs at least would be created.



EU-27 physical trade balance with the rest of

the world 2011



From Linear to Circular Economy: The future economic model



ENERGY FROM RENEWABLE SOURCES





«Closing the loop»: an ambitious package for Circular Economy in EU



On 2nd December **2015** the EU approved an ambitious set of measures for Circular Economy:

- 1. The value of products, materials and resources is maintained in economy as much as possible
- 2. Waste generation is minimized.
- 3. Economy and competitiveness are strengthened creating new business opportunities and introducing innovative products and services
- 4. Economic, social and environmental benefits

Long-term Benefits – Targets & Expectations



It is estimated that **3.4 million new jobs** in circular economy, e.g. in the fields of: repairing, waste management, recycling, renting and leasing in EU until 2030



Reduction of the total annual emissions of greenhouse gases by **2-4%**



Development and new jobs – Up to + 7% of GDP



Safety & stability of the supply of raw/secondary materials in supply chains



Savings of up to **600 billion Euro** - **8% of the annual turnover** for companies in EU

The EU Action Plan for Circular Economy

Key Action Areas



WASTE MANAGEMENT

> Objectives

- Improve waste management in line with the EU waste hierarchy
- Address existing implementation gaps
- Provide long-term vision and targets to guide investments

Key Actions

- Legislative proposals on waste
- Work with Member States to improve waste management plans, including to avoid overcapacity in residual waste treatment (incineration and mechanicalbiological treatment)
- Ensure coherence between waste investments under EU Cohesion Policy and the waste hierarchy

THE WASTE HIERARCHY

Avoid	1	Maximimum conservation of resources
Reuse	2	Reusing materials
Recycle	3	recycling & reprocessing materials
Waste to energy	4	energy recovery prior to disposal
Disposal of waste	5	zero conservation of resources

New recycling targets for MSW

EU LEGISLATION REVISION

New targets



% Prep. For reuse and recycling

- ✓ Bio-waste separate collection
- ✓ One calculation method until 2025
- ✓ Extension for achieving the recycling targets for 7 Member States recycling less than 20% (2013 data)
- \checkmark Revision in 2025 for setting higher targets

EU LEGISLATION REVISION

New targets







IN A LEGISLATIVE PROPOSAL THE EUROPEAN COMMISSION CALLS ON MEMBER STATES TO STRIVE TO REDUCE FOOD WASTE BY AT LEAST 30% BY 2025.





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Priority SECTORS



We create value





The size of the food waste problem - WORLD

GLOBALLY:

- Every year 1/3 of the world production of food ends up in the trash
- 1.3 billion tons of food still perfectly edible are lost or wasted, enough to feed 3 billion people
- 3.3 Giga-tonnes of GHG emissions is the carbon footprint of FW (8% of global GHG emissions)
- 3 times the water volume of Lake Geneva is used to produce food that is lost/wasted
- 20% of world's paricultural land is

If global food waste was a country, it would be the third largest greenhouse gas emitter after the US and China



 Increase in food prices: The more food we waste, the higher the demand on the global market, which drives up prices.

The size of the food waste problem – EU-wide

IN



 53% of EU FW comes from households: OUR OWN kitchen is the guilty!

- Every year 88 million tonnes of food (or 173 kg FW per person per year) ends up in the trash – could feed 200 million people.
 This number is expected to rise to approx. 126 million tonnes by 2020 if no action is taken.
- 20% of EU food production is lost or wasted
- 170 Million tonnes of CO₂
 emissions emitted from production and disposal of EU food waste
- 143 billion euros related costs

ATHENS-BIOWASTE LIFE+ project and acronym: «Integrated management of bio-waste in

Greece – The case study of Athens, ATHENS-BIOWASTE»

- **PROJECT LOCATION:** Athens, Greece
- **BUDGET INFO:** 1,339,930.00 € (50% EC Co-funding)
- DURATION: Start: 01/09/11- End: 31/08/2014
- **PROJECT'S IMPLEMENTORS:**
 - Coordinating Beneficiary: National Technical University of Athens
 - Associated Beneficiaries:
 - •Association of Communities and Municipalities in the Attica Region
 - •EPTA Environmental Engineers Consultants
 - •Municipality of Athens
 - •Municipality of Kifissia

ATHENS-BIOWASTE BACKGROUND and AIMS

- ATHENS-BIOWASTE aims to establish and promote sustainable biowaste management in Greece using the municipalities of Athens and Kifissia as case study areas.
 - Separate collection systems in the Municipalities of Athens and Kifissia
 - Collection and compositing of biowaste at the MBT facility of EDSNA
 - Developing appropriate bio-waste management software tool
 - Drafting recommendations for the amendment of the current technical specifications included in Greek legislation
 - Raising environmental awareness and knowledge in citizens and other stakeholders regarding

Selection and planning of separate collection methods for the case study areas

Criteria considered for the selection of the pilot areas in Athens & Kifissia municipalities



Pilot areas selected in Kifissia Municipality



Kifissia Municipality Biowaste



35-50L for single-family detached residents

Pilot areas selected in Athens Municipality



Further biowaste collection points in Athens Municipality



Armed Forces Officers Club (Restaurant - Food waste)



Agricultural University of Athens (Restaurant – Food waste)



Agricultural Floricultural Nurseries Cooperative of Attica (Green waste)

Athens Municipality Biowaste <u>kerbside</u> collection system

10L bin per household (including biobags)

30-50L bin per bar restaurant etc.(including biobags)



Planning of the awareness campaign



Implementation of the separate collection program in the selected areas

Distribution of bins and biodegradable bags to households



Implementation of the separate collection program in the selected areas

Collection and Transportation of source separated biowaste







Compositing of the collected material and analysis of the final product

Mechanical and Biological (Composting) Treatment plant in Attica Region



Composting process at the

Biowaste weighting



Biowaste unloading





Biowaste composting



Biowaste feeding



Biowaste mixing (Food & Green waste)



LIFE+ DRYWASTE



- Project title and acronym: «Development and demonstration of an innovative household waste dryer for the treatment of organic waste, DRYWASTE» (LIFE 08 ENV/GR/000566)
- **PROJECT LOCATION:** Athens, Greece
- PROJECT BUDGET
 - **Total amount:** 969,850.00 €
 - % EC Co-funding: 49.10%
- **DURATION:** Start: 01/01/10 End: 30/06/2012
- **PROJECT PARTNERS**:
 - Coordinating Beneficiary: National Technical University of Athens
 - Associated Beneficiary: Cholargos-Papagos Municipality







LIFE+ DRYWASTE



• LIFE+ DRYWASTE

- Designed, constructed, tested, optimized, demonstrated and evaluated a household drying system in order to reduce food waste at source, through moisture content removal.
- Produced a "dried food wastr could be further used in alternation
 Before Atter produced in alternation
 Waste dryer basket Atter produced in alternation
 Waste dryer basket Waste dryer basket Waste dryer bottom base

Evaluation of the demonstration action



- The <u>purity level</u> of the end product is approximately 100%, since the presence of contaminants (non biodegradable materials) was negligible
- Increased level of acceptance since nearly all participants operated the system
- Food waste <u>mass reduction</u> range 64.17 78.11% w/w due to moisture removal
- The final dried product is almost odourless, easily handled and stored without any decomposition to be observed (due to low moisture content levels)
- Producing <u>physically stabilized biomass</u> characterized by a high organic content (contains soluble sugars, starches, lipids, proteins, cellulose and other compounds) that make it a <u>source of potential fermentative substrates and subsequent conversion to added value products</u>.

LIFE+ Waste2Bio



- Project title and acronym: «Development and demonstration of an innovative method of converting waste into bioethanol», Waste2Bio (LIFE 11 ENV/GR/000949)
 - Project Budget
 Total Project Budget: 1,490,350€
 EC Funding: 745,175€ (50% of Total Project Budget)
 - Start Date: 01/09/2012 & End Date: 31/10/2016
 - Project partners:

Coordinating Beneficiary: (1) National Technical University of Athens

Associated Beneficiaries: (2)

s: (2) Municipality of Papagos-Cholargos(3) Municipality of Aspropirgos


LIFE+ Waste2Bio



- Implemented biowaste source separation schemes in selected pilot areas Papagos-Cholargos and Aspropirgos Municipalities (200 households)
- Designed, developed, optimized and demonstrated the bioconversion scheme of biowaste to bioethanol
- Reduced biowaste disposal at landfills
- Produced a high added value final product (bioethanol) that can be used primarily as an alternative renewable fuel (biofuel)
- Assessed the large scale application of the innovative biowaste management scheme









Current RESEARCH



What are the main products that can be produced from petroleum and lignocellulosic biomass?



An Example of a Flow-Chart for Products from **Petroleum**based Feedstocks

Figure 2 – An Example of a Flow-Chart for Products from Petroleum-based Feedstocks

Analogous Model of a Bio-based Product Flow-chart for Biomass Feedstocks



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Biorefinery: the alternative concept to petroleum-based processes and products



Biorefinery: Is the alternative concept to today's fuelbased refineries which produces fuels, chemicals, energy etc.

Source: GREEN CHEMISTRY: PROESA ® Technology to convert Biomass into Bio-based Chemicals Guido Ghisolfi (2016)

Food waste biorefineries for added-value bio-based products



Not Yet Commercial

Commercial Stage



Yet barriers exist...



- Costs for up-scaled and demonstration facilities
- Regulatory/licensing costs
 - Access and
 competitiveness to funding
 for transnational research

Enhanced Skills

- Technical
- Entrepreneurial
 Business
- Interdisciplinary training

Social acceptance

- Little demand for bio-based products
 - Low level of
 - awareness/information about benefits of using biobased products

Investments

- Low return over long
 timescales
- Not understanding biobased sector
- Emerging, innovative technologies are seen as highly risky

'Good practice' examples of implementing **CIRCULAR ECONOMY** on waste management





The 'ISWM TINOS' LIFE+ project

SCOPE: 'ISWM-TINOS' project aimed to promote and demonstrate an Integrated Solid Waste Management (ISWM) system to a selected remote area of the Municipality of Tinos for the sustainable management of MSW in line with the Waste Framework











ISWM scheme for BioWaste







Decentralised composting of BioWaste

Compact prototype biowaste composting unit



- ✓ The capacity ranges between 70 to 200 tn yr⁻¹ (residence time 15 to 60d)
- Automated hydration, aeration and deodorization systems
- ✓ Biofilter for the treatment of emitted
- ✓ Collection and recirculation of leach
- ✓ No mechanical agitation is needed





Overview of the ISWM scheme





The 'PAVEtheWAySTE' LIFE PAVE project WAYSTE OVERALL SCOPE:

This project aims to facilitate the implementation of the Waste Framework Directive in remote areas, by enabling local and regional authorities to improve their municipal waste recycling performa over the bare the bare the way to high resource effic

'PAVEtheWAySTE' MSW management scheme (1)

1. Source separation in 5 main streams













'PAVEtheWAySTE' MSW management scheme (2)

2. Further separation in sub streasting Printed Paper



Valos

Δήμος Νάξου και Μικρών Κυκλάδω









The 'PAVEtheWAySTE' recycling system

- 1. Reception area of 5 pre-sorted waste streams (plastic, glass, metal, paper & special waste streams)
- 2. Fine separation area of pre-sorted waste into subcategories (PET, HDPE, LDPE, Aluminium, paperboard, etc.) by the system operator
- 3. Processing of fine separated materials (compression/ crushing, baling)

ΡΟΣ ΑΠΟΘΗΚΕΥΣΗΣ ΥΓΡΩΙ

ΚΑΙ ΕΥΑΙΣΘΗΤΟΝ ΥΛΙΚΟΝ

T03

ПΦ

T03

T04

ΧΟΡΟΣ ΠΑΡΑΛΑΒΗΣ

ΧΩΡΟΣ ΕΠΕΞΕΡΓΑΣΙΑΣ ΥΛΙΚΩΝ

ανοιγόμενο ανακλινόμενο κούφωμα αλουμινίου, ηλεκτροστατικά βαμμένο, μι τημα θερμοδιακοπής τύπου Alumil M9660

4_{System}ragearea of baled materials

space arrangement of **20m³ container**,

(6.06m x 2.59m x 2.44m)





The 'PAVEtheWAySTE' recycling system (photos)







'PAVEtheWAySTE' MSW management scheme



SOL-BRINE Project

SOL-BRINE: Partners



Municipality of Tinos Island (Project Coordinator)



National Technical University of Athens (NTUA) School of Chemical Engineering Unit of Environmental Science and Technology (<u>UEST</u>)



Culligan Hellas S.A.

SOL-BRINE: Main aim

"The main objective of this project was the development of an innovative, energy autonomous system for the treatment of brine from seawater desalination plants "

SOL-BRINE: Concept



Methodology Construction Design of the prototype Literature Review **Operation**& Optimization **Overall** evaluation Suggestions for (LCA, economic full scale etc.) implementation

Innovative aspects of the project

- Total brine elimination. The system has been designed in line with the Zero Liquid Discharge principle
- ✤ Water Recovery (>90%)
- Production of useful end-products. Through the operation of the prototype system the following two products are produced: (a) distilled water of high quality and (b) dry salt. These products have potential market opportunities.

Innovative aspects of the project

- Energy autonomous operation. Solar thermal collectors are used for delivering hot water (10 KW_{th} at approximately 70°C) and a photovoltaic generator (10 kW_{el}) for electricity. All energy requirements are covered exclusively through the use of solar energy
- Use of state-of the art technology: the evaporation of water is realized through custom designed vacuum evaporation technology (evaporator and crystallizer) and solar dryer



Mass Balance



Evaporator unit



igure: View of the evaporator (installed on site)

Crystallizer unit



Figure: View of the crystallizer (installed on site)

Dryer unit



Figure: View of the dryer (installed on site)






Photo from the constructed prototype brine treatment system!

Project awards



SYNERGIES



Indicative Tips & Suggestions

- Brainstorming for many months deal with actual problems (emphasis on the priority topics of calls) think of effective & feasible solutions
- Innovation
- Close to market
- Work on the comments of the reviewers
- Strong (not big) Partnership -beneficiaries from other MS
- Financial Part: Be as specific as possible, use actual rates, time
- Collaboration with a large number of reliable beneficiaries the role of conferences –networking – info days
- The role of local authorities & the private sector
- The role of mass media
- Keep your projects alive next steps emphasis on after-life, feasibility study

THANK YOU FOR YOUR



ATTENTION NOT SCHOOL OF CHARTER O

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