Development and demonstration of an innovative household dryer for the treatment of organic waste

"DRYWASTE LIFE 08 ENV/GR/000566

Layman's Report

Co-ordinate beneficiary
National Technical University of Athens

Associated beneficiary
Papagos- Cholargos Municipality

Total Project Budget: 923,142 €

EU contribution: 453,262 € (49,10%)

Athens, 2014

Environmental Problem Targeted

According to EU, bio-waste is defined as "*biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants*". The total yearly production of bio-waste in the EU amounts to around 88 Mt and it constitutes one of the largest components of Municipal Solid Waste (MSW) i.e. in EU bio-waste is on average 32% w/w, while in the case of Greece it is about 44% w/w. Bio-waste production from households accounts for the largest share (about 38% w/w of MSW) among the different food waste sectors (manufacturing, food service/catering and wholesale/retail). Future trends show that bio-waste is anticipated to increase significantly due to population growth and increasing consumption giving rise to increased environmental impact in cases when unsustainable management techniques are applied (e.g. landfilling). During bio-waste landfilling anaerobic decompositions take place leading to biogas and leachates production. The major problem associated with biogas emissions to the atmosphere is the fact that is acquires high methane content, a chemically active gas which contributes enormously to climate change. It is worth noting, that the estimated quantities of anthropogenic methane emitted globally from the disposal of bio-waste in landfills, amounts to 11% for the year 2010. Therefore, bio-waste diversion from landfills can contribute significantly to reducing the impact on climate change. Besides air pollution caused by landfilling, the organic matter and nutrients of bio-waste is lost and it is no longer available for recycling and reuse. In addition, the life span of landfills is shortened and the need for new landfills is created.

EU bio-waste management policy aims to reduce the environmental and health impacts of bio-waste and improve Europe's resource efficiency. The long-term goal is to turn Europe into a recycling society, avoiding waste and using unavoidable waste as a resource wherever possible. The aim is to achieve much higher levels of recycling and to minimise the extraction of additional natural resources. Proper waste management is a key element in ensuring resource efficiency and the sustainable growth of European economies. The existing bio-waste management options include, in addition to prevention at source, collection (separately or with mixed waste), anaerobic digestion and composting, incineration, and landfilling. Currently bio-waste landfilling remains the predominant waste management option for many EU member states since limited initiative is shown in regard to the application of national policies and technologies for bio-waste management.

DRYWASTE project & objectives

DRYWASTE is a LIFE+ EU project which provides a novel approach in regard to bio-waste management by effectively dehydrating source separated bio-waste at household level through a domestic dryer aiming to enhance and simplify bio-waste management in a sustainable manner. Since bio-waste constitutes a waste stream with increased water content (i.e. 75 to 85 %w/w), its effective removal leads to high mass and volume reduction, while delivering a renewable end product (dried biomass) which can be handled easily and effectively for the production of alternative added- value products. The developed technology is a promising option with encouraging results which can contribute towards the EU and national policies and targets on bio-waste treatment and enhance the diversion of biodegradable organic waste from landfills.

DRYWASTE project objectives

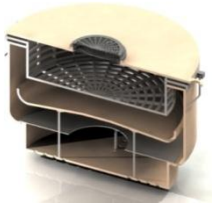
The main objectives of DRYWASTE project are:

- **to promote the dissemination of an innovative and environmental promising bio-waste treatment technology, aiming to the reduction of organic waste mass and volume at source,**
- **to design, develop, test, optimize, evaluate and demonstrate an innovative household dryer for the drying of bio-waste in order to significantly reduce its mass and volume at source, to lead to the production of a "final dry organic waste product" (after the drying process) with very little water content, which can be further processed in alternative environmentally friendly ways,**
- **to research the positive and negative impact of the use of this technology at environmental and socioeconomic level and**
- **to provide suggestions on how this technology could be applied at a larger scale in the future,**
- **to provide a well-documented and effective option for the management and treatment of organic household waste at source**
- **to disseminate and communicate the projects findings and results through appropriate informative activities to relevant stakeholders and target groups**

Bio-waste drying system

The prototype household drying system aims to dehydrate the source segregated bio-waste at household level by effectively removing the moisture content of the substrate operating on a continuous basis. The system is a ceramic in–vessel cylindrical batch reactor with a daily feeding capacity of around 4 kg of bio-waste. The main components of the system are the following:

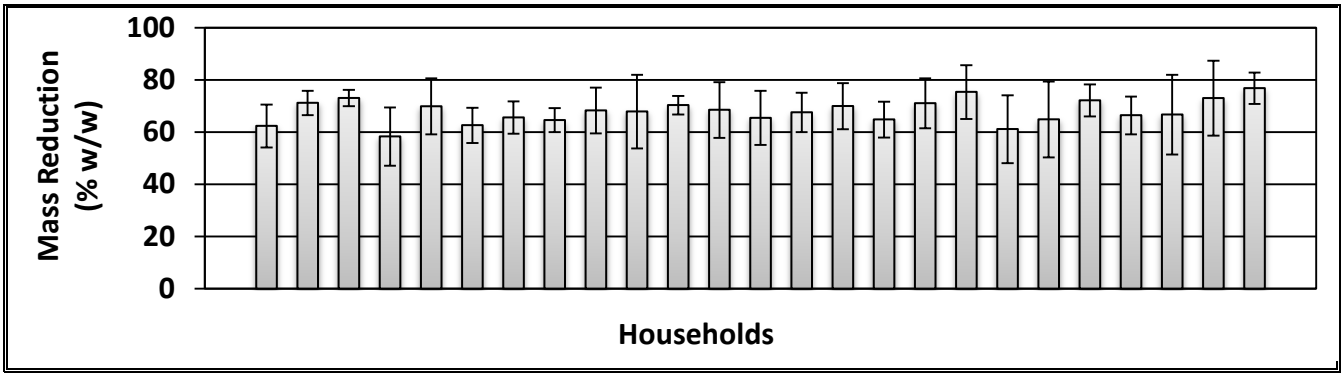
- **The chamber and the base of the system in which all the components of the system are positioned.**
- **The bio-waste basket in which the separately collected bio-waste are placed by the user. The perforated cylindrical basket has a capacity of approximately 8L with larger diameter in comparison to the basket's height in order to increase the surface area of the substrate and thus to enhance the efficiency of the drying process of organic solids.**
- **The thermal plate and the thermostat are the main components that provide the necessary thermal energy in order to achieve the desirable temperature level for the drying of bio-waste (≈70oC).**
- **The centrifugal fun for the active aeration of the substrate.**
- **The water vapor & leachate collector which is positioned below the bio-waste basket for the collection of the produced water vapor and leachate during biowaste drying.**
- **The lid and the activated carbon filter which are positioned at the top part of the drier in order to ensure the absence of odors release outside the system and to prevent potential nuisance, but also to keep the thermal load within the chamber.**

Bio-waste dryer components			
 Chamber and Base	 Bio-waste Basket	 Thermal plate	 Household dryer
 Water vapor & leachate collector	 Lid	 Activated carbon filter	 Household dryer (cross-section)

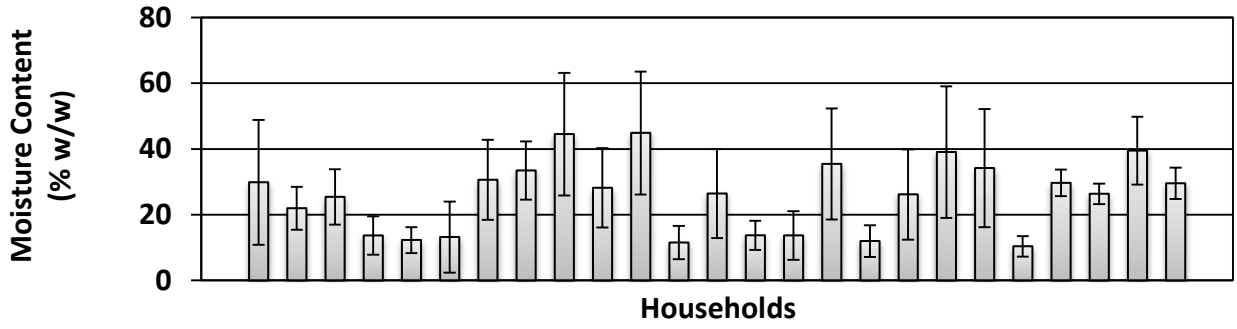
Pilot scale application of the bio-waste dryer

The prototype household dryer was applied at pilot scale for 8.5 months in selected households in Papagos – Cholargos municipality, which had agreed to participate to the scheme on a voluntary basis. For the implementation of the bio-waste household drying scheme, the following equipment was distributed to each participating household: (i) the bio-waste dryer, (ii) an electricity meter to monitor the amount of electricity consumed during the operation of the dryer, (iii) a weighing scale for measuring bio-waste quantity (iv) bags for storing the dried organic product. Furthermore physicochemical analysis of the characteristics of the final dry product were performed (Mass reduction, Ph, heavy metals, LOI, VS, TOC, calorific value, carbohydrate content and biomethane potential). The main findings are given below:

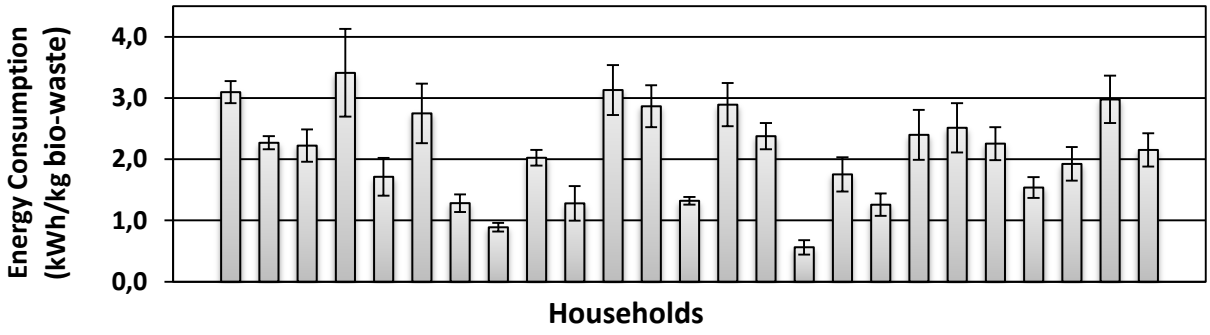
- **The use of the dryer enhances the effectiveness of bio-waste source separation. This is evident by the increased purity levels (>99 % w/w) of the product that has been collected from households. The increased purity of the resulting biomass is of paramount importance in terms of its exploitation and utilization for the production of added value products.**
- **The use of the bio-waste drying unit can effectively reduce the mass of source separated bio-waste at household level by 67.44 % w/w. This was measured through the measurement of the wet mass that was inserted inside the waste dryer (the measurement was conducted by the civilians) and the measurement of the dry mass that was received by the DRYWASTE project team. The mass reduction is related to the moisture content removal from bio-waste when using the dryer. It is therefore evident that the mass reduction of bio-waste at source (i.e. household level) contributes positively throughout the MSW management chain (i.e. collection, transportation, treatment, reuse and disposal) in terms of environmental, economic and social impact**



- **At the end of bio-waste process time, the remaining moisture content is reduced effectively to 25.86 % w/w. At the achieved moisture content level the biological decomposition rate of bio-waste (and any other fermentable organic substrate) is inhibited. The inhibition of degradation and the physical stabilization of bio-waste are desirable since (i) potential odor nuisance to the users is prevented, (ii) longer bio-waste temporal storage periods are allowed at household level and (iii) the putrescible fraction of MSW is transformed to a less problematic and easier to handle material (i.e. dried biomass).**



- **The electricity needed for the operation of the dryer and the processing of source segregated bio-waste has been recorded at 1.87 kWhe/kg bio-waste, which costs around 1.17 € per month and household.**



- **The results of a survey questionnaire performed to the participating households were very positive and encouraging, showing that the participants were satisfied by the overall performance of the bio-waste drying system (potential of integrating the dryer to the waste management plan of the municipality, easiness in use, handling of bio-waste, reduction of bio-waste mass and volume, nuisance during the operation, willingness to buy the system etc.)**

Benefits from the application of the household bio-waste dryer

- **The bio-waste drying scheme contributes to the achievement of the quantitative national targets concerning the diversion of the biodegradable organics from landfilling**
- **The drying unit contributes to the setup of bio-waste source separation schemes which are considered the most effective technique in terms of MSW sustainable and resource efficient management.**
- **The bio-waste drying scheme contributes to raising the environmental awareness of the public – to the increase of public sensitivity on environmental issues – to good environmental practices among the daily activities of the householders.**
- **The separation and drying of bio-waste at source offers the opportunity of a high-quality "clean" feedstock for a variety of different treatment methods.**
- **The physicochemical characterization of the produced dried bio-waste has shown that the resulting renewable biomass has the potential to be used as feedstock for delivering added value products. More specifically the end product can be used as input material for the production of compost, pellets, biofuels and green energy through anaerobic digestion, biomass to biofuel conversion processes and thermal treatment.**
- **The application of bio-waste drying scheme at large scale gives rise to increased positive environmental impacts especially in terms of global warming and human toxicity.**
- **The application of bio-waste drying scheme reduces the number of vehicle routes for the collection and transportation of bio-waste leading to significant improvement potential of the existing MSW collection and transportation system. This is especially important consideration in Southern European and other Mediterranean countries where climatic conditions demand more frequent collection of easily degraded waste.**
- **The cost for the collection and transportation of MSW is reduced as a result of the decrease of the number of vehicle routes required for this purpose (lower quantity of waste must be collected and disposed).**
- **The cost for the disposal of mixed waste (disposal fees paid by the Municipalities to the operator of the landfill site) is reduced, since the level of this expense is proportional to the quantity of waste that is disposed.**
- **Based on a cost-benefit analysis the bio-waste drying large scale application is considered a viable and promising option for the effective and sustainable management of bio-waste.**
- **The final dry product may be used for the production of bioethanol, biogas through anaerobic digestion and compost. It may also be used for the production of thermal energy through thermal treatment due to the fact that the calorific value of the final dry product equals to that of wood.**

Project impact to actors related to waste management

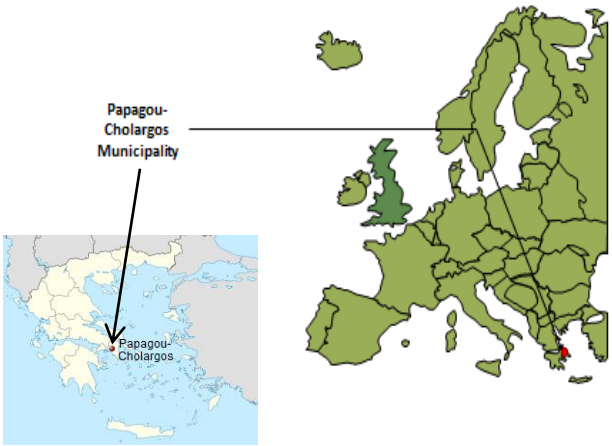
i. citizens/householders: Their environmental awareness is increased, they take more initiatives and make more efforts to protect the environment, they include the practice of simultaneous separation and drying of bio-waste as a common daily activity, they produce a product with added value originated from the waste that they generate, they participate actively in material recycling schemes, they possess a sense of responsibility for their waste, etc.

ii. Local Authorities: They are provided with an effective tool in order to re-organize and optimize the existing practices that are applied for the management of the household wastes generated at their localities, which is based on the principles and the priorities of the European and national environmental policy and legislation. This, results in i) cost saving (from the reduction in costs for the collection and transfer of the mixed municipal wastes to the landfills as well as from the utilization of the end product (biomass), ii) limitation of nuisance during the collection and transfer of waste to the landfill sites iii) improvement of the entire environmental profile of the Municipality/Community.

iii. Private companies: Private companies that deal with biomass can use the renewable material for the production of value added products.

iv. Public Authorities/decision and policy makers: The large scale application of the household dryer, will contribute to the achievement of the quantitative national targets concerning the diversion of the biodegradable organics from landfills and the initiation of bio-waste source separation. In addition, by incorporating this practice in the existing solid waste management schemes the principles and the priorities of the European and national environmental policy and legislation are actually enforced by providing tangible results.

The Project was implemented in Papagos-Cholargos Municipality, Greece



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