RECOVERY OPTIONS OF ORGANIC WASTE IN HELLAS: AN OPORTUNITY FOR REDUCING GREENHOUSE GAS EMISSIONS THROUGH RESIDENTIAL WASTE MANAGEMENT

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ABSTRACT

Following the international trend and due to the global financial crisis, waste management policy in Hellas appears to be in transition. The persistence in old fashioned and non-environmental friendly waste management schemes seems to be bended by new rational systems started being promoted in the recent past in the country. The revised national waste management plan and the Hellenic Association of Business Composting Companies are focused on organic waste.

The aim of this paper is to present the produced amount of compost from organic waste in Hellas during the years 2010 and 2011 through the implementation of recovery options as: a) mechanical – biological treatment facilities, b) home composting schemes and c) biodegradable waste diversion in households located in agricultural areas. Furthermore, the decrease of greenhouse gases due to the current status and future compost recovery targets in accordance with Landfill Directive and EU Packaging Directive, will be estimated for each aforementioned recovery option.

Keywords*:* residential waste, waste management, home composting, mechanical – biological treatment, greenhouse gases.

1. Introduction

According to the Directive 1999/31/EC on landfill of waste, Member States of European Union must reduce the amount of biodegradable Municipal Solid Waste (MSW) going to landfill to 35% of their total amount generated in 1995 by 2016 (EEA, 2009). Hellas, and other EU countries have applied for a prolongation of the time limits not exceeding four years because they were landfilling more than 80% of their MSW in 1995. The generation of MSW in Hellas in 1995 and 2007 was 270 and 420 kg per capita, while the percentage of MSW landfilled in Hellas in 1995 and 2007 was 100% and 84% respectively (Figure 1).

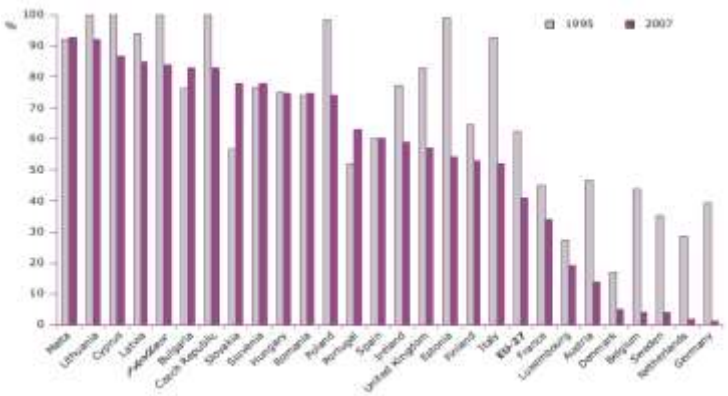

Figure 1: Percentage of MSW landfilled in the EU-27, in 1995 and 2007 (EEA, 2009).

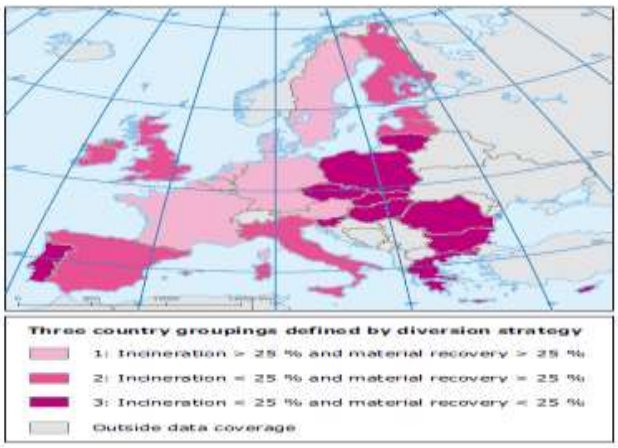

Figure 2: Three country groupings defined by waste diversion strategy.

Member States were categorized under three waste management 'groupings', according to their strategies for diverting MSW from landfilling and their relative shares of landfilling, material recovery (mainly recycling and composting) and incineration (EEA, 2007) (Figure 2). Hellas was included in the third group because waste recovery and incineration levels were both low, while its dependence on landfill was relatively high.

2. Municipal solid waste in Hellas

The composition of the total generated MSW in Hellas is presented in Figure 3. According to the analysis conducted in national level in 1997, organic waste were reduced, whereas packaging materials (mainly plastics and paper–cardboard) were increased.

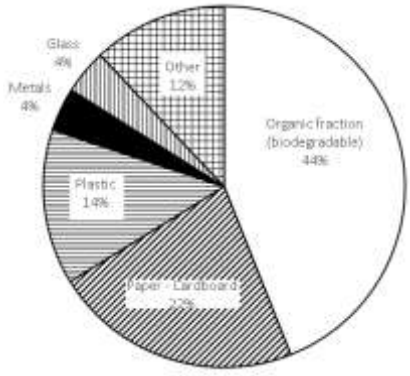

Figure 3: Mean value of composition of urban solid waste in Hellas in 2011.

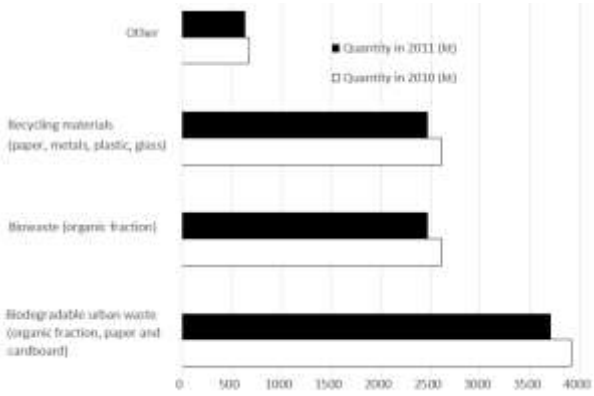

Figure 4: Quantities of biodegradable waste and recycling materials in MSW in Hellas for the years 2010 and 2011.

Quantities of biodegradable and recycling waste (paper, metal, plastic, glass) were estimated in national level for the years 2010 and 2012 and are presented in Figure 4.

The greater part of waste was directed for landfilling (82%), 15% went to recycling centers, while a small percentage (3%) was led for composting and energy recovery in 2011 (Table 1).

Table 1: Estimated production and management of urban solid waste in Hellas (t).

Urban waste	**2010**		**2011**	
Production	5,891,668	100.00%	5,574,757	100.00 %
Landfill	4,877,638	82.8 %	4,569,877	82.0 %
Sanitary	4,563,638	77.5 %	4,304,203	77.2 %
Uncontrolled	314,000	5.3 %	265,674	4,8 %
Packaging recycling	871,174	14.8 %	829,733	14.9 %
Organics recovery	141,856	2.4 %	175,147	3.1 %
Composting	141,856	2.4 %	159,283	2.8 %
Energy recovery	-	-	15,864	0.3 %

On the other hand, 37% of organic waste in 2010 and 39% in 2011 was converted to compost (Table 2), while Shredded Refuse Fuel (SRF) was produced in Mechanical and Biological Treatment (MBT) facilities.

Table 2: Quantities that were diverted to recover the organic waste in Hellas (t).

Organics recovery (biodegradable waste)	**2010**		**2011**	
Composting	141,856		159,283	
Composting / recovery in MBT facilities	52,746	37 %	68,139	38.9 %
Home composting (Bins)	10,000	7 %	10,000	5.7 %
Diversion of organic waste from agricultural areas in household level	79,380	56 %	81,144	46.3 %
Recovery for energy	-	-	15,864	-
Recovery of used vegetable oils, fried oils and animal fat for producing biodiesel fuel	-	0 %	15,864	9.1 %
Total	141,856	100 %	175,147	100 %

The main MBT facility in Hellas was located in the Municipality of Ano Liossia and it was part of Attica's MSW management plan, where organic waste was converted to compost and SRF was produced as well, whereas residual waste was disposed in landfill.

3. Assessment of climate change in terms of greenhouse gases

The assessment of climate change in terms on net fluxes of greenhouse gases from MSW management options was studied by Smith et al. (2001). It was stated that the net greenhouse gas flux could be assessed as the sum of positive and negative fluxes. of Methane emissions from landfilling biodegradable waste and emissions of fossil-derived carbon dioxide from collection and transportation of waste from the fuel used lead to positive greenhouse gas fluxes. On the other hand, a number of processes lead to negative fluxes including waste incineration, recycling and use of compost. Furthermore, source segregation of MSW followed by recycling and composting and anaerobic digestion gave the lowest net flux of greenhouse gases. In comparison to landfilling, composting and anaerobic digestion and paper recycling produced the greatest reduction in net flux of greenhouse gases.

4. Produced organic waste

The produced biodegradable waste was 3,917 kt in 2010 and 3,707 kt in 2011, while the produced biowaste (organic fraction) was 2,610 kt and 2,470 kt respectively. The organic recovery through composting was 142 kt in 2010 and 159 kt in 2011. Energy recovery was achieved through the management of 16 kt of organics in 2011. Thus, the amount of disposed organic waste in landfills was 2,468 kt and 2,295 kt in 2010 and 2011 respectively. According to

the revised national waste management plans, 2,934 kt of biodegradable waste should be diverted from landfills in 2020 (Table 3).

Table 3: Targets for biodegradable waste diversion from landfills in Hellas (Ministry of Reconstruction of Production, Environment & Energy, 2015).

Target year	2020	
	kt	%
Total target for diverting biodegrade waste	2,934	
Individual targets		
Separate collection networks		
Diversion from biowaste network	530	18%
Diversion of paper (packaging and printed paper)	648	22%
Total diversion of biodegradable waste in separate collection systems	1,178	40%
Remaining networks for mixed municipal solid waste		
Diversion of biodegradable waste from mixed remaining MSW	4,756	60%

In order to calculate the GHG total net flux (kt CO2 eq.), the equation 1 was used.

$$TNF_i = EF_{LF}*LF_i*+EF_{RM}*RM+ EF_{RO}*RO \quad (1)$$

where i = number of year
TNF_i = Net greenhouse gas flux (kt CO2 eq.) during year i.
EF_{LF} = Greenhouse gas emission factor of landfilling the waste (kt CO_2 eq./t of MSW).
LFi = Disposal of waste by landfilling (t/y) during year i.
EF_{RM}= Greenhouse gas emission factor of recycling (kt CO_2 eq./t of materials).
RM_i = Recycled packaging material (t/y) during year i.
EF_{RO}= Greenhouse gas emission from organic waste recovery (kt CO_2 eq./t of waste).
RO = Recovery of organic waste (t/y) during year i.

The amount of 4,877 kt of MSW landfilled in Hellas in 2010 produced 1,595 kt CO_2 eq., which was the higher greenhouse gas flux as calculated by equation 1. The amount of greenhouse gases from landfilling was decreased to 1,494 kt CO_2 eq. due to the fact that the organic waste recovery was increased from 142 kt in 2010 to 175 kt in 2011.

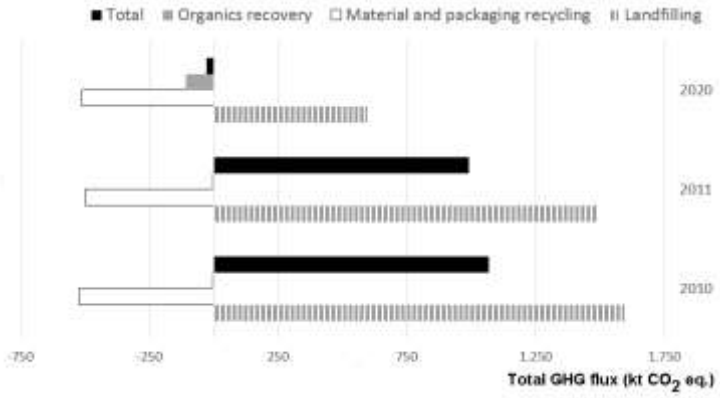

Figure 5: Total greenhouse gas flux for the years 2010, 2011 and 2020.

5. Conclusions

The aim of this study was the calculation of the compost production in Hellas through the implementation of multiple technologies as well as the estimation of the of greenhouse gases decrease in terms of the current status and of the future compost recovery targets. Hellas, needs to focus more on waste composting schemes due to the fact that almost half of the total generated waste are organics, while it still insists in waste landfilling. According to the research

results, Hellas can achieve a great decrease of the greenhouse gases emission by adopting waste composting schemes and diverting in that way a significant percentage of MSW from being landfilled.

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