

## Opportunities for Developing an Integrated Municipal Solid Waste Management System in Greece: A Legal and Financial Framework

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**Abstract:** Waste management is a four-stage procedure that includes : a) collection, b) transport, c) recovery and d) disposal of waste. The Greek legal framework follows closely the development of European waste management policy which is laid down in the Waste Framework Directive, adopted in 2008. Local authorities are responsible for waste management in Greece although Prefectures and Regional governments do not act in this field. Through the new NWMP the Greek Government attempted to establish an integrated waste management planning framework in harmonisation with the national and regional land use planning and to rationalise the utility costs. Financial sustainability of solid waste management systems is very difficult to succeed, as authorities most of the times appear unable to cover capital and operating costs and create appropriate motives for people to implement the “waste hierarchy” (reduction, recycling and disposal options). As far as Greece is considered, there are significant gaps in knowledge related to the actual total cost of municipal solid waste management, but Greece could establish a sustainable waste management policy by the reformulation and enforcement of economical instruments (landfill taxes and fees) and the introduction of recycling motives in combination with public awareness and participation through education and information.

**Keywords:** environmental legal framework, municipal solid waste, management, governance,

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### I. Introduction

Although municipal waste management in European countries has focused on disposal methods, over the past ten years “waste hierarchy” has changed the scene in waste management resulting in significant progress. Nevertheless, resource use is still inefficient, and waste is not yet properly managed in all EU countries due to differences in consumption patterns, economic wealth and municipal collection and management waste methods. Greece is not considered to be self-sufficient for disposal of municipal waste and landfilling is the most common method of waste management in Greece.

In this study, we focus on municipal solid waste (MSW) management in Greece. We describe the process of management and the “best practices” being implemented in Greece and their financial cost. Our research is based on the current Greek legislation according to the European Union (EU) legal framework and the European solid waste (SW) strategy. We examine the model and fees of solid waste management, based on the Cost-Benefit Analysis (CBA) and non-market methods by considering both economic and environmental criteria. We conclude that good governance, by implementing accountability, transparency, responsiveness, effectiveness and efficiency, participation, equity will naturally lead to sustainable waste management.

The paper is organized as follows: Section II includes an analysis of the municipal solid waste legislation and management problems in Greece based on the theoretical background and relevant literature. Section III includes analysis of data regarding quantity and composition of solid waste in EU and Greece and a description of methods of integrated waste management. Section IV discusses the economic instruments that are applied and those that should be further applied in EU Countries, including Greece, to implement an integrated financial solid waste management. Finally, this study includes a discussion regarding the use of possible legal and policy instruments as new tools in waste management.

## **II. Solid Waste Management: Theoretical Background**

### **2.1 Definitions**

The World Health Organisation [1] gave in 1976 a definition for solid waste as “waste arising out of man’s domestic, trade, commercial, industrial, agricultural and mining activity which is not free flowing”. In Gilpin’s “Environmental Dictionary” [2], solid waste is defined “as all material of solid and semi solid character that the possessor no longer considers of sufficient value to retain”. According to Gilpin’s [2] definition “solid waste management is a planned system of effectively controlling the production, storage collection, transportation, processing and disposal or utilization of solid waste in a sanitary, aesthetically acceptable and economic manner.”

Waste management is a four-stage procedure that includes: a) collection, b) transport, c) recovery and d) disposal of waste. According to the Eurostat data definitions waste recycling is defined as “... any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes...”. Although recycling is a recovery operation the model of waste recovery represents, in accordance with Eurostat data, “any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function... in the wider economy”. Annex II of the Waste Framework Directive sets out a non-exhaustive list of recovery operations.

Disposal is a stage that can be fulfilled by many methods, such as landfill sites, incineration, energy recovery and composting that submits biodegradable waste to anaerobic or aerobic decomposition. Modern technology, according to theory review, offers different alternatives for MSW management [3] as described below. Apart from illegal dumpsites, there are organised disposal sites - known as sanitary landfills (SAs) - that may not offer recovery or recycling of waste but afford a kind of protection to ground surface as compared to illegal ones. Nevertheless, SAs remain biochemically active for many years and are a source of persistent environmental problems related to land, air, water quality and public health.

Mechanical sorting is another solution to waste management. In this case there is no planning for sorting at the source and these facilities, which have enormous capital and operating costs, produce compost of low quality, rarely reused. As a characteristic example, since 2002 large quantities of mixed MSW compost have been piling up unused at the Kouroupitos facility in Greece [3]. Valorization of waste is an environmentally accepted method that works through sorting at source as almost all the MSW produced can be transformed into useful raw materials or energy. Waste to energy (WTE) constitutes the only method that follows sustainable development as other thermal treatment technologies have significant financial, operating and environmental impact.

This process however should not be approached solely regarding environmental and technical requirements, but should also include sociological aspects concerning stakeholders, and a complete financial analysis of the implementation of the process in order to assure project sustainability and investment [4,5]. Waste management from a financial and investment-related point of view can be described as a cyclical process with three principal components: a) Determine actual current costs b) Estimate future costs c) Set and collect solid waste management fees. A complete analysis of these three components with the use of the appropriate investment appraisal techniques, such as Cost Benefit Analysis (CBA), or the classic approach of Net Present Value (NPV), is crucial for long term financial viability and sustainability of any proposed process and framework [6,7]. The EU waste policy involves a vast number of policies, institutional settings and financial mechanisms concerning municipal waste management [8], as a part of its integrated environmental policy that will be presented in the next section.

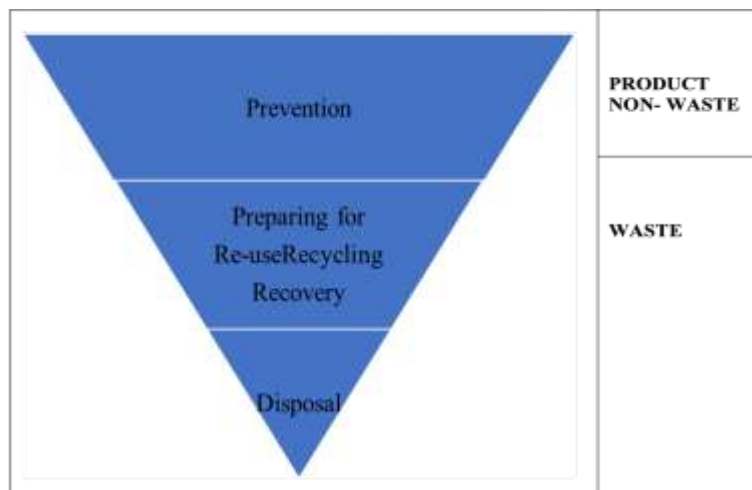
### **2.2. EU waste policy and legislation**

EU’s environmental policy represents one of the most integrated sectors of EU policies. It has been structured upon seven Environmental Action Programmes (EAP) and has established regulations for sectors such as water, waste, air, forests, sea and biodiversity. The first EU waste management strategy was adopted, in the form of a communication, by the Commission in 1989 and reviewed in 1996. EU’s basic target in this sector was to create an energy and resource efficient economy by implementing a sufficient waste policy. In 1975, the Waste Framework Directive 75/442/EEC established the overall framework for management of waste and introduced, for the first time, the waste hierarchy concept and the priority of protection of the environment and human health. The table below summarises the basic framework of EU legislation:

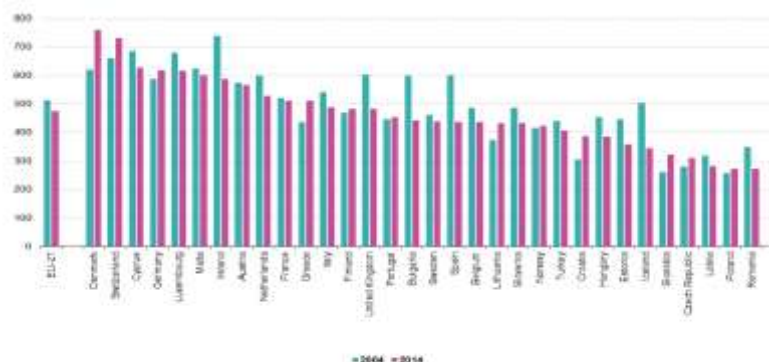
**Table 1: EU solid waste legislation outline**

General Framework	Waste Management Operations	Specific Waste Streams
7 <sup>th</sup> Environmental Action Plan	Landfill Directive	Packaging And Packaging Waste
		Batteries And Accumulators
Waste Framework Directive	Industrial Emissions Directive/Brefs	Sewage Sludge
		End-Of Life-Vehicles
Waste Shipments Regulation		Waste electrical and electronic equipment (WEEEs)
		Plastic (Pcbs/Pcts)

Current EU waste regulations are complex though the general framework is laid down in the Waste Framework Directive (WFD), adopted in 2008. WFD provides the definitions of key concepts such as waste, end-of-waste status, re-use and recycling and suggests a policy to move the EU towards a 'recycling society'. According to the new EU Directive, waste legislation and policy of Member States shall apply as a priority following a five-step waste hierarchy where prevention is the priority, followed by re-use, recycling and other forms of recovery and disposal such as landfill being the last solution. The waste hierarchy is set out at Article 4 of the revised Waste Framework (Directive 2008/98/EC) as presented in Fig. 1 (European Commission Directorate-General Environment 2012).



**Figure 1: Waste hierarchy according to Directive 2008/98/EC**



**Figure 2: Municipal waste generated by country in 2004 and 2014, sorted by 2014 level (kg per capita). Source: Eurostat**

According to data presented in Figure 2 municipal waste generated by country has decreased progressively over the last decade, as Member States work to meet targets set under EU regulations and implement the “Waste Hierarchy” scheme.

**The key definitions about waste given in Directive 2008/98/EC are:**

**Waste:** Any substance or object which the holder discards or intends to, or is required to discard. The terms ‘substance’ and ‘object’ are not to be understood in the sense of EU chemicals legislation, but as autonomous terms of waste legislation which are to be read broadly. Any substance or object is either waste or non-waste.

**Waste management:** Collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, including actions taken as a dealer or broker.

**Collection:** Gathering of waste, including preliminary sorting and storage of waste for the purposes of transport to a waste treatment facility.

**Separate collection:** Collection where a waste stream is kept separately by type and nature so as to facilitate specific treatment options.

**Treatment:** Recovery or disposal operations, including preparation prior to recovery or disposal.

**Prevention:** Measures taken before a substance, material or product become waste.

**Re-use:** Any operation by which products or components that are not waste are used again for the same purposes for which they were conceived. Preparing for re-use: Checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing.

**Recovery:** Any operation the principal result of which, is waste serving a useful purpose.

**Recycling:** Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.

**Disposal:** Any operation different to recovery even when the operation has, as a secondary consequence, the reclamation of substances or energy.

The Directive also introduces the public and stakeholders participation to engage them in the transposition and implementation processes. It incorporates the "polluter pays principle" and the "extended producer responsibility" and requires that Member States adopt waste management plans and prevention programmes.

### **2.3 Waste Policy and legislation in Greece**

The Greek legal framework in the waste sector follows closely the development of European waste management policy and relevant EU Directives.

Nowadays, waste legislation in Greece is divided into three basic categories:

1. Greek Framework Legislation on Solid Waste,
2. Greek Legislation on Waste Management Operations and
3. Greek Legislation on Packaging waste and on specific streams such as packaging material, used tyres, end-of-life vehicles (ELVs), used lubricants, batteries and accumulators, waste of electric and electronic equipment (WEEEs) etc.

The core legislation of the Greek environmental protection - based on article 24 of the Greek Constitution – incorporates: i. Law 1650/1986 (OG 160A/18-10-1986) on the protection of the environment as amended by Law 2742/1999 (OG 207A/07-10-1999) and ii. Law 3010/2002 (OG 91A/25-4-2002), which provides, in Article 12, the basic regulation of waste management. The first piece of legislation (currently outdated) in the field of waste management was the Sanitary Ordinance E1b/301/1964 which set technical specifications on collection, transport and disposal of wastes. The first integrated legal framework for solid waste management in Greece in compliance with EU legislation is the Joint Ministerial Decision (JMD) 50910/2727/2003 (GG B’ 1909/2003) “Measures and Conditions for Solid Waste Management - National and Regional Planning Management in compliance with the provisions of the Directive 91/156/EEC”, that describes the basic rules, principles and targets for national and regional management and planning [9]. This JMD in conjunction with Law 2939/2001, sets the objectives of solid waste management, provides for relevant bodies engaged in managing solid waste (FoSDA) and outlines respective measures for the rehabilitation and usage of disposal sites.

Article 5, par. 1 defines the guidelines for management of solid waste throughout the country and suggests appropriate measures that promote the use of waste as an energy source. Article 11 also provides for the obligations of wasteholders, in accordance to Law 2939/2001 (Official Gazette A’ 179/2001), a National Waste Management Plan, into which a catalogue of waste types, a detailed description of the current situation and measures to be applied, are annexed to it. According to the Ministerial Decision 50910/2727/2003 the national waste plan had to be revised every five years - or earlier if necessary – however, until 2012 no revision had been made [10].

This JMD was an attempt to transpose the Council Directive of July 15th, 1975 on waste (75/442/EEC) - as it was further revised by the Waste Framework Directive (WFD) (91/156/EEC) - into Greek national legislation. Despite adopting the first WFD, the Greek Government displayed significant delays in transposing both the Directive 2008/98/EC of the European Parliament and that of the European Council of 19 November 2008 on waste as well as repealing certain other Directives (Text with EEA relevance) from the Greek law.

The new framework Law 4042/2012 (Official Gazette A' 24/2012) "Protection of the environment through criminal law - Transposition into national law of Directive 2008/99/EC – Framework for the production and the treatment of waste - Transposition into national law of Directive 2008/98/EC– Arrangement of issues related to the Ministry of Environment, Energy and Climate Change" which transposes the Waste Framework Directive 98/2008/EC and the Directive 99/2008/EC, establishes measures to protect the environment and human health by preventing or reducing the adverse effects of waste production and waste management and reducing the overall impact deriving from the use of resources. The adoption of Law 4042/2012, combined with Law 3854/2010 (GG A' 94/2010), related to alternative management of specific waste streams, provides a comprehensive legal framework for waste management.

The Ministry of Environment and Energy (former YPEKA) is responsible for policy making, national planning, technical matters, as well as licensing and regulating financing of large waste treatment and disposal facilities. According to the National Solid Waste Management Plan (NSWMP), the integrated management of solid waste including transfer, temporary storage, operation of transfer stations, belongs to Waste Management Authorities (WMA) i.e Local Authorities according to the administrative reform plan "Kallikratis", while the Ministry of Interior Affairs is responsible for the establishment of an official registry of WMAs. The 13 Administrative Regions that represent the second level of local self-government are responsible for licensing and elaborating waste-related master plans. According to the 'polluter pays' principle - introduced in 2003 for waste streams other than MSW -, management responsibilities lie within the producers.

As local authorities (Waste Collection Authorities) are responsible for waste management, Prefectures and Regional governments do not act in this field. According to the data given in Section 2 of this study, many Greek Local Authorities deliver wastes to illegal dumping sites despite that similar actions contradict sustainable development guidelines and EU legislation. This is mainly due to the absence of suitable sanitary facilities (Landfill Directive), and cost related issues [11] The execution of NSWMP involves stakeholders and a collaboration with the public. Despite initiatives taken by stakeholders, the objectives of NSWMP failed to materialise. One of the major constraints is weak governance among stakeholders with regards to the NSWMP implementation.

### III. Empirical Analysis Of Current Data

#### 3.1 Municipal Solid Waste (MSW) quantity and composition in Greece

Although municipal waste management in European countries was focused on disposal methods, over the past ten years "waste hierarchy" has changed the scene in waste management resulting in significant progress. Nevertheless, resource use is still inefficient, and waste is not yet properly managed in all EU countries due to differences in consumption patterns, economic wealth and municipal collection and management waste methods

Tables 2,3,4 illustrate data given by the New National Waste Management Plan, regarding overall current waste production, current waste production per Prefecture and current waste management with respect to relevant data from 2011.

Type of waste	Abbreviation	Non-hazardous waste (Kt)*	Hazardous waste (Kt)	Total waste (Kt)
<b>I. MUNICIPAL TYPE WASTE</b>	<b>MTW</b>	<b>5743</b>	<b>6,5</b>	<b>5749</b>
1. Municipal solid waste	MSW	5569	6,5	5575
Bio-waste	BIO	2470		2470
Packaging waste	PAC	866		866
Rest of recyclable material	REST RM	1860		1860
Waste of electric / electronic equipment of household origin	WEEE	66	1,1	67

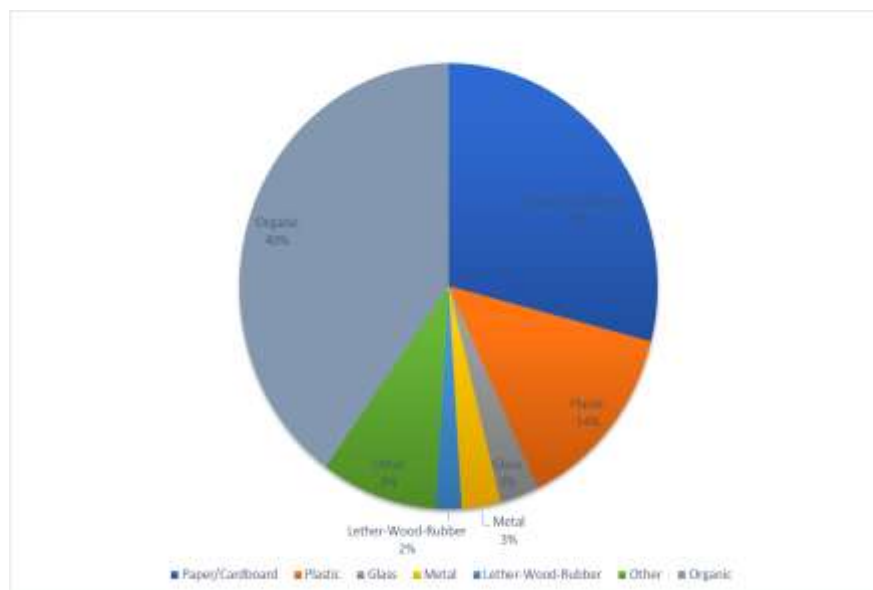
Waste batteries and accumulators	WBA		1,1	1,1
Rest of MSW	REST	307	4,3	311
*Kt: Thousands of tonnes				

**Table 3: Current waste production per Prefecture (year 2011)**

<b>PREFECTURE PRDUCTION 2011 (Kt)</b>	<b>Non-hazardous waste (Kt)*</b>	<b>Hazardous waste (Kt)</b>	<b>Total waste (Kt)</b>	<b>% total waste production</b>
East Macedonia & Thrace	1699	9	1708	5%
Central Macedonia	3344	46	3390	10%
West Macedonia	9888	5	9893	28%
Epirus	1162	4	1166	3%
Thessaly	2408	26	2434	7%
Ionian Islands	358	2	360	1%
West Greece	1469	15	1484	4%
Central Greece	4320	37	4357	12%
Attica	3927	103	4030	11%
Peloponnese	3427	12	3438	10%
North Aegean	485	4	489	1%
South Aegean	659	6	664	2%
Crete	1871	12	1883	5%
<b>Total</b>	<b>35016</b>	<b>280</b>	<b>35296</b>	<b>100%</b>
*Kt: Thousands of tonnes				

**Table 4: Current waste management (year 2011)**

<b>Type of waste</b>	<b>Recovery (R) (Kt)*</b>	<b>Disposal (D) (Kt)</b>	<b>Storage (S) (Kt)</b>	<b>Unrecorded management (Kt)</b>
<b>NON-HAZARDOUS WASTE</b>				
<b>I. MUNICIPAL TYPE WASTE</b>	<b>1068</b>	<b>4609</b>	<b>22</b>	<b>44</b>
1. Municipal solid waste	1004	4565		
Bio-waste	175	4565		
Recyclable materials (incl. packaging waste)	787			
Waste of electric / electronic equipment of household origin	43			
Rest of ASA				
*Kt: Thousands of tonnes				



**Figure 3:** Municipal waste composition in Greece

### 3.2. Methods of Integrated Waste management

Quantity and composition of municipal solid waste are key parameters for designing an integrated waste management of solid waste including transportation, treatment and disposal installations, recycling, management costs estimation and development of national management plans.

The main provisions of the Integrated Solid Waste Management concept are:

- to apply integrated variations on conditions of joint use of production – technological, organisational/administrative, research and educational measures and
- to allow ISWM planners flexibility to choose among different elements of waste management options, that will result in minimal energy use, minimal environmental impact and minimal landfill space at a cost affordable to the community [12].

Waste management has been recognized as one of the most pressing problems in Greece over the past years, as it was not organised according to EU Laws and it was primarily relying on semi-controlled landfills. Nevertheless, during the last 15 years solid waste management in Greece has been upgraded and re-organized as an integrated policy with specific environmental and financial goals [13]. Waste Management plan in Greece is presented in the new National Waste Management Plan. The priority targets of the New NWMP for 2020 to reduce costs and increase profits for the communities are:

- re-allocation of waste management and responsibility for separation at source and recycling to the municipal level
- preservation of the public nature of waste management,
- transfer of, privately run, alternative waste management under public control
- investment into more advanced waste management techniques
- encouragement of public participation,

Through the new NWMP the Greek Government attempted to establish an integrated waste management planning framework in harmonisation with the national and regional land use planning and to rationalise the utility costs of waste management. To succeed, the NWMP proposed the revision of all regional waste management plans by the respective municipalities. The main goal of the NWMP was to ensure higher standards of environmental protection and human health and to establish the implementation of separation at source and recycling, as the most appropriate means of collection. Regarding appropriate waste treatment methods, the NWMP recommended Energy Recovery as an acceptable method that produces secondary gas or liquid fuels - as opposed to thermal methods for energy recovery from secondary fossil fuels currently considered as a method with adverse environmental consequences. According to the latest official data taken from the Greek Ministry of Environment –YPEKA and presented below, 90 illegal landfill sites were operating in 2011, a number that was significantly reduced to 63 in 2012. 332 sites were reported as closed but not rehabilitated, but 255 of them had submitted proposals for financing closure and restoration. Since the beginning

of 2013, 94 sites have been restored, restoration works for another 89 have been commissioned, whereas the restoration of 202 sites is pending.

Greece is among those EU countries that still maintain landfilling as a method of disposal waste. The amount of MSW landfilled in 2010 was, according to data of the Working Paper of the European Environment Agency, 4.2 million tonnes - equivalent to 81 % of the total generated MSW. These quantities were similar for almost 10 years, despite an increase in recycling, especially after 2007 where it peaked at approximately 20% of total generated MSW. Composting as a MSW treatment is not used in Greece since less than 2% of MSW is being composted. This method was introduced to practice after the operation of two large MBT plants in two regions of Greece [14]. The European Commission referred Greece to the European Court of Justice for violation of EU solid waste legislation several times [15]

#### **IV. Towards Financial Sustainability And Integrated Financial Solid Waste Management**

European Union's environmental policy was based to the "command and control" approach that involves direct regulation along with monitoring and enforcement systems, as the government agencies desired to impose a legal framework to control and eliminate possible environmental impacts. Following this approach, government agencies developed a set of rules, regulations and strategies that had to be implemented. Gradually, environmental policy shifted towards a market-based approach by adopting new tools such as economic instruments. Nowadays, according to the new environmental policy, it is not simply a question of choosing between Economic Instruments (EIs) and Command and Control Strategies (CACs) but adopting measures by using both. Good governance is a tool to enhance solid waste management services towards sustainability.

##### **4.1 Economic Instruments in Solid Waste management**

In this section, we introduce the economic instruments that must be applied in European Countries and Greece to implement an integrated financial solid waste management.

Economic instruments can be used in solid waste management as a tool to [16]:

- reduce the amount of waste generated
- reduce the proportion of hazardous waste in total waste production
- encourage recovery, reuse and recycling of wastes
- support cost-effective solid waste collection, transport, treatment and disposal systems
- minimize adverse environmental effects related to solid waste collection, transport, treatment and disposal systems, and
- generate revenues to cover costs

Financial sustainability of solid waste management systems is very difficult to succeed, as authorities frequently fail to cover capital and operating costs and encourage implementation of the "waste hierarchy" principle (reduction, recycling and disposal options). The use of economic instruments in solid waste aim primarily at covering waste management costs, improving service delivery for citizens and avoid negative impacts by minimising waste disposal and finally, strengthen resource recovery and recycling.

Although literature divides Economic Instruments (EIs) in many sub-categories for this study we will adopt the taxonomy of the Inter-American Development Bank, that groups EIs into three main categories: a) revenue-raising, b) revenue-providing and c) non-revenue instruments. The first category includes user-related charges such as levies and taxes, for the provision of waste management (collection, transportation and disposal) characterised as revenue-raising instruments.

Revenue providing instruments include varied subsidies to reward an environmentally friendly attitude (recycling, recovery) that results in the reduction of solid waste disposed in landfills. Subsidies are used instead of sanctions and they are usually related to tax or other charges reduction, preferential access to credit, or provision of land or other resources. The third category of non-revenue instruments is a combination of the aforementioned categories and includes legal- and information-based instruments that influence the financial condition of a waste producer thereby affecting public standing, and provide public education to alter the demand for environmentally improved waste management. According to the above Inter-American Development Bank's classification the most ordinary instruments of the three categories are presented in Table 5.



**Table 5:** Inter-American Development Bank’s classification of the most ordinary instruments

Revenue raising instruments	Revenue providing instruments	Non-revenue economic instruments
<ul style="list-style-type: none"> <li>- pollution charges, based on pollutant loading</li> <li>- waste generation charges, based on waste quantities and degree of waste hazard</li> <li>- waste user charges, based on collection and disposal services received;</li> <li>- waste tipping charges, to unload at transfer or disposal facilities</li> <li>- product charges or fees to handle disposal of specific products, such as batteries, tyres and refrigerators</li> <li>- disposal taxes, added to disposal charges to influence disposal choices - pollution taxes, added to user charges to influence choices for pollution reduction</li> <li>- eco-taxes, added to non-renewable energy production or fuels to influence energy demand and fuel choices</li> <li>-presumptive taxes, based on presumed levels of pollution; and</li> <li>- renewable resource taxes, on virgin materials to influence demand for their use and motivate recycling of secondary materials</li> </ul>	<ul style="list-style-type: none"> <li>-tax credits and tax relief, allowances on property taxes, customs duties, or sales taxes to motivate investment in waste management improvements</li> <li>-charge reduction, based on proof of recycling or re-use in reducing wastes requiring collection or disposal</li> <li>- tax rebates, for pollution savings or energy efficiencies</li> <li>-Environmental improvement funds, established to support pollution reduction, resource protection, energy efficiency</li> <li>- research grants, to stimulate technology development;</li> </ul>	<ul style="list-style-type: none"> <li>- Product life cycle assessment, which predicts overall environmental burden of products and can be used in certification programmes</li> <li>-Deposit-refund, deposit paid and refund given upon product return for re-use</li> <li>-Take-back systems, where manufacturers take back used products or packaging; Procurement preferences, evaluation criteria adding points for products with recycled content or reduced resource demand</li> <li>- Eco-labelling, which notes product’s recyclable content and whether product is recyclable</li> <li>- Recycled content requirements, laws and procurement specifications noting the precise recycled content required</li> <li>- Product stewardship, which encourages product designs that reduce pollution, include the full cost of solid waste recycling and disposal, reduce wastes and encourage recycling</li> <li>- Disclosure requirement, in which waste generators are required to disclose their pollution</li> <li>-Manifest systems, precise cradle-to-grave tracking of hazardous wastes</li> <li>- Blacklists of polluters, published lists enable consumers to consider whether to buy from polluting companies;</li> <li>-Liability insurance, liability assurances by contractors and private operators</li> <li>-Bonds and sureties, guarantees for performance by contractors and private operators</li> <li>- Performance-based management contracting where oversight contractors commit to overall service improvements and</li> <li>-Clean City competitions which reward neighbourhoods and cities that have improved cleanliness</li> </ul>

**4.2 Economic instruments implemented to waste management in Greece**

According to the EEB Country Factsheet for Greece and the provisions of Law 4042/2012 the economic and fiscal instruments applied to scale-up waste hierarchy are:

**Landfill Tax:** Even though article 43 of Law 4042/2012, transposing the WFD, imposes a landfill tax, implementation of this provision was postponed until December 31st, 2016 and has not been applied yet. In order to implement the provision of article 43 the Greek Government stated that, organizations/enterprises that disposed un-treated municipal waste into landfills would be eligible to pay a landfill tax of 35€/t - sought to be enforced in 2014 - that would be raised annually by 5€/t up to the amount of 60€/t. However, no systems to favour prevention and participation to separate collection (PAYT schemes) are in place and no deposits were refunded [17].

**Landfill gate fees:** Current landfill gate fees are low (i.e. 10-48,5€/t). This sum covers the operational cost of municipal waste landfilling and is charged back to the waste producers (households, commercial sector etc.) being calculated based on property surface owned by each citizen (flat rate). This is a system that abolishes any connection between fees paid and the amount of waste that someone produces in contrast to the ‘polluter-

pays' principle. In addition to this, relevant fees calculation is remote from the 'waste hierarchy' concept and gives no incentives for recovery and recycling. The Greek Government is planning to amend this fee system mainly due to the operation of new waste treatment facilities constructed and operated via Public Private Partnerships which will increase fees. Currently, it is considered to amend the tariff system and set fees directly based on the amount of waste produced [18].

**Pay as you throw schemes (PAYT):** Pay as you throw (PAYT), is a unit-based pricing that charges customers according to the amount of solid waste discarded. This strategy for charging local solid waste collection and disposal services - analogous to that used by local utilities for electricity, water, and heating services, forces citizens to pay for the amount they dispose. Under the HEC – PAYT LIFE+ Environment Policy and Governance Project "Development of Pay as You Throw Systems in Hellas, Estonia and Cyprus" [19] a pilot PAYT scheme is being developed in the municipality of Elefsina, Attica. The project covers 1,500 households and the scheme is based on a partial reimbursement of municipality taxes for those participating under the scheme.

**Deposit refund systems:** These systems do not apply in Greek solid waste management.

**Subsidies:** Investment Incentives Law (Development Law) 3908/2011 (Official Gazette A' 8/2011) [20] responds to the diverse needs of investors and establishes priorities and policies that mandate an investment process characterized by speed, transparency, and effectiveness. The Development Law introduces measures to improve technological development and promote green economy and environmental investments.

**Packaging scheme:** In the sector of packaging, waste management systems are created by the economic operators to organise and participate in collective (or individual) systems of alternative waste management. Based on the "polluter pays" and the "extended producer responsibility" principles, producers pay a fee proportional to the annual quantities of the relevant product put on the market, the environmental impact of each material and the cost-benefit analysis of the recovery/recycling process followed. The systems organise the whole process of collection, transport, storage and treatment by cooperating with authorised facilities and provide information to direct citizens behaviour towards alternative waste management.

The Hellenic Recovery-Recycling Corporation SA(HERRCo) was founded in December 2001 by industrial and commercial enterprises which, either supply packaged products to the Greek market, or manufacture different packaging items. The Central Union of Municipalities in Greece (KEDE) has a shareholding of 35% in the System's capital. In compliance with the provisions of Law 2939/01 and in seeking to fulfil the obligations of packaging operators in an effective and cost-efficient way by ensuring that packaging materials and other products are recycled (material) or recovered (energy) in an environmentally sound manner, HE.R.R.Co has developed and implemented the Collective Alternative Management System – "RECYCLING" (C.A.M.S. – RECYCLING) in Greece.

#### **4.3 Proposed tools for establishing financial sustainability in solid waste management in Greece**

The main objective of this study was to make a proposal for decision-makers and authorities to establish financial sustainability in solid waste management. After having analysed the legal framework, the quantity and quality in solid waste in Greece and EU, the models and strategies of waste management from collection to disposal and finally the economic instruments for covering waste management costs and improving service delivery it is possible to focus on the 6 steps that must be followed to provide effective and affordable solutions in waste management.

1) Firstly, real costs, current and future, of solid waste management must be determined by using the Full Cost Accounting (FCA) method. To achieve this, different costs, such as capital costs, annual operating costs and cost projection for the future years, linked to management in local level, should be calculated. Tailor-made Microsoft Excel spreadsheet models for specific countries (e.g. Costa Rica, Philippines) appear to be a reliable method to use [21].

Until the late 1980s, cost accounting for MSW management was confined to collection and disposal costs. The necessity for using special tools such as the FCA methodology [22], has been determined by the process of active transition to the integrated solid waste management (ISWM) concept. FCA is defined as: "...a systematic approach for identifying, summing, and reporting the actual costs of solid waste management. It considers past and future outlays, overhead costs, and operating costs."

The main role of FCA in waste management is as:

- > An information support tool for decision making in integrated waste management;
- > A tool for rational planning of SWM activity; i.e., the budgeting of a project;
- > A tool for balanced analysis of elements of the whole SWM scheme including collection, recycling, composting, etc.
- > A tool for efficiency evaluation of a SWM scheme and its attending services; and
- > A tool for calculation of competitive rates for services, charges for pollution and prices of solid waste facilities

2) Secondly, it is very important to determine the cost recovery policy and objectives and ensure that total system costs are covered including operation and maintenance costs, capital costs and aftercare costs. To succeed in the design of this policy, funding sources should be evaluated and revenues generated from the sale of products derived from waste streams must be analysed. Alongside, decision makers must seek for additional funding sources (eg. Tourist tax, fee from private generators) otherwise further user-related charges must be enforced.

3) The third step is the designing of a charging system that is fair and structured on social scaling tariffs, low-cost and simple to administer, efficient, understandable and convenient for users and legally enforceable in line with the “polluter pays” principle.

4) One very important step that is following the new approach to adoption and implementation of EU environmental policy is consultation with the public- otherwise known as public participation. In order to apply a model of financial management of waste, public should accept the charging regime as a result of consultation meetings and information supplied by campaigns, TV spots, newspaper and leaflets. During the last decade environmental policy is changing from a “command and control” approach to a new policy type based on education, public participation and voluntary measures.

Education is a very important tool that encourages understanding, creates values and norms for behaviour and makes easier for public to accept and implement an environmental policy. Supplementary to education is the information that provides facts intended to change behaviours. In both cases, consultation with the public and public participation is of profound significance. ‘Public participation in decision-making’ is one of three rights guaranteed to the public in the field of Environment by the Aarhus Convention which was signed in 1998 by the EU under the auspices of UNECE (United Nations Economic Commission for Europe) and later ratified by it. The other two rights are: the right of access to environmental information held by public authorities (e.g. on environmental issues related to human health), and the right of access to justice in cases where the other two rights have been disregarded. Public participation is imposed in Article 31 of Greek Law 4042/2012, transposing the WFD (article 31).

5) The last step before the implementation of a new charging system is the modification of existing legislation to be officially adopted by decision- makers.

6) Finally, the implementation and monitor of the new system is a pre-condition to achieve financial sustainability in solid waste management.

As far as Greece is considered, there are significant gaps in knowledge related to the actual total cost of municipal solid waste (MSW) management [23]. The prediction of the quality and quantity of MSW is crucial for designing and programming municipal solid waste management system but predicting the amount of generated waste is a difficult task as it is being affected by various parameters. Several methods for estimating waste generation that have been applied in Greece so far, have demonstrated high correlations between the generation of Municipal Solid Waste and total GDP, per capita income, and population [24].

During the past decade, several municipal solid waste management facilities (MSWMF) were constructed and operated in Greece and many investments have been made, e.g the operation of two new state-of-the-art MBT plants, one in the greater Athens area and one in the island of Crete. Moreover, two additional MBT plants, one in Heraklio (island of Crete) and the other in the Ionian island of Cephalonia begun operating in 2010 [8], while 6 more MBT plants became operational by 2014. According to Pires *et al.* [8], several plants mainly based on MBT technology are in the planning or construction stage, that contribute to an increase in material recovery and recycling.

Although Greece has a strategy and aims to implementing an integrated solid waste management system, there is still a lot to be done. Decision-makers, including Government and municipal authorities, must amend the current tariff system and set fees directly based on the amount of waste generated. They also should implement without further delay the requirements for the introduction of a landfill tax, recently been adopted by Law 4042/2012, transposing the WFD [25].

## **V. Conclusion**

Despite the current economic situation in Greece significant steps have been made to adopt a legal framework, propose a policy and implement an integrated solid waste management system. The Greek Waste Prevention Plan is a coherent tool for Integrated Waste policy and a significant step to organise a Prevention Strategy in Greece. Nevertheless, significant roadblocks in disposal and treatment must be overcome, namely because of the high number of active illegal landfills and the fact that current policies of waste prevention, reduction, recycling and recovery do not follow the ‘Waste Hierarchy’ in accordance to EU goals and provisions. Our study suggests that, in order to apply a framework of ‘good waste governance’ there is a need for the system to be: a) inclusive, providing transparent spaces for stakeholders to contribute as users, b) financially sustainable, which means cost-effective and affordable; and c) rest on a base of sound institutions and pro-active policies. The big steps that must be taken are the reformulation and enforcement of economical

instruments (landfill taxes and fees) and the introduction of recycling motives in combination with public awareness and participation through education and information disperse. The main objective should be the establishment of financial sustainability in solid waste management through an integrated policy aiming gradually to a zero-waste society.

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