DEVELOPMENT & APPLICATION OF SEPARATE COLLECTION AND MANAGEMENT SCHEME FOR BIOWASTE IN GREECE: THE CASES OF ATHENS & KIFISSIA

K. Moustakas*, D. Malamis**, A. Bourka***, C. Venetis**, O. Skiadi***, S. Giannaki****, V. Xipolitas*****

*Unit of Environmental Science & Technology, School of Chemical Engineering, National Technical University of Athens, 9 Heroon Polytechniou str., Zographou Campus, Greece, konmoust@central.ntua.gr
**EPTA SA, 16 Iniochou str., Halandri 15238, Greece, abourka@epta.gr
***Association of Municipalities in the Attica Region–Solid Waste Management (EDSNA), 6 Andersen str., 11525 Athens, Greece, oskiadi@yahoo.com
****Municipality of Athens, Direction of Sanitation & Recycling, 151 Iera Odos, 122 41 Egaleo, sgiannaki@cityofathens.gr
*****Municipality of Kifissia, 2 Myrsinis str., 14563 Kifissia, Greece, v.xipolitas@gmail.com

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Abstract
Separate collection and composting of biowaste from municipal waste (mainly kitchen waste) has been initiated for the first time in Greece with two case study Municipalities in Attica Regions, Athens and Kifissia. This scheme is crucial for building a contemporary biowaste management system according to the framework Directive on waste (2008/98/EC) and the Greek Law 4042/2012, which sets specific targets on biowaste collection. The first batch of compost is expected to be produced in July 2013 and its quality will be correlated with EU Eco-Label and other standards. The success of a biowaste management system is twofold and includes planning of a separate collection scheme with high capture rates and optimising treatment processes to achieve high quality compost.

INTRODUCTION
Sustainable waste management is an important objective for all European countries, the key to which is the separation of biowaste at source (EC 2008). The Framework Directive on waste (2008/98/EC) contains specific provisions for the management of biowaste, including the promotion of bio-waste separation at source. Moreover, according to recent studies at European level, the separation of biowaste at source is considered a prerequisite for ensuring efficient allocation and utilization of the produced compost market. Apart from the diversion of the organic fraction of municipal solid waste from landfills, which is achieved by the separation at source of biowaste (compliance with EU Directive 1999/31/EC on landfill), separation of biowaste at source also improves the calorific value of the remaining municipal solid waste and creates a cleaner stream of biowaste, allowing the production of high quality compost. In recent years, there has been a significant increase in separation at source programs of biowaste in many regions of the EU members and it is regarded as a successful option for waste management.

Kerbside collection and waste treatment in Greece
In the majority of the municipalities in Greece, municipal solid waste is collected in two kerbside collection streams: packaging waste and residual waste. Packaging waste is collected by local authorities in cooperation with the Hellenic Recovery & Recycling Corporation
and ends up at Recycling Materials’ Sorting Centres, while the remaining residual waste, also collected by local authorities, ends up in landfills or units of Mechanical and Biological Treatment (MBE). In Athens, there is one MBE unit (Mechanical Recycling and Composting Plant – EMAK) in Ano Liossia, which treats approximately 20% of the total waste generated in the area, producing RDF (waste derived secondary fuel) and low-quality compost.

**Necessity for an integrated biowaste management**

The biowaste is on average 32% w/w in the EU, while in the case of Greece the same percentage composition is about 40% w/w. Currently, apart from some home composting initiatives, municipal biowaste is directed to landfills. The Regional Solid Waste Management Plan (PESDA) of Attica and the action plan of the Association of Municipalities of Attica (EDSNA) provide for the construction of three new composting facilities in the greater Athens area (Fyli, Grammatiko and Keratea), which will treat pre-sorted organic waste. Therefore, the separation of biowaste at source is essential and should be applied taking into consideration all specific characterizations of the areas under examination (Favoino 2000; Favoino et al. 2004; Favoino 2011; Joachim 2010; Ventosa et al. 2008).

From the environmental perspective, the importance of integrated biowaste management, with the integration of separation systems, lies in diverting them from landfills (EEA 2009) and in their exploitation. During the deposition of this stream of waste in landfills, conditions of anaerobic biodegradation occur, with consequent emission of significant quantities of biogas and the generation of leachates with high organic and inorganic load. This process takes place for several years after disposal. The major problem regarding the burial of bio-waste is the emission of biogas with high methane content, which is one of the chemically active gases contributing 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, diverting them from landfills can contribute significantly to reducing the impact on climate change. Besides air pollution resulting from disposal of this stream of solid waste in landfills, its content in organic matter and nutrients 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 (Gibbs & Hogg 2008).

**Legislation regarding biowaste management**


In addition, the newly issued Law 4042/2012 “Framework for the production and the treatment of waste - Transposition into national law of Directive 2008/98/EC” defines that until 2015, the percentage of biowaste separate collection must ascend at least up to 5% of biowaste total amount by weight and until 2020 up to 10% of biowaste total amount by
weight (article 41). Furthermore, starting 2014, everyone who sends biowaste to landfills without pre-treatment will have to pay an additional gate fee of 35 €/tn, which will increase annually by 5 € with a maximum fee of 60 € (article 43).

The national strategies of biowaste management must follow these guidelines. Summing up, the aims are a) to divert as much biowaste from landfill as possible and b) to promote biowaste separate collection.

**The case of the two Municipalities in Greece**

The implementation of these strategies at national level counts as innovation. A first step to test their implementation is the project “Integrated management of bio-waste in Greece: The case studies of Athens & Kifissia” with acronym “ATHENS BIOWASTE”. ATHENS-BIOWASTE (LIFE10/ENV/GR/000605) is a co-financed project by the European financial instrument for the Environment (LIFE+). The project is implemented in two municipalities in Attica Region, namely the Municipality of Athens (MoA) and the Municipality of Kifissia (MoK). The City of Athens is the capital city and most populous municipality in Greece with 789,000 inhabitants and an area of 3.895 ha., while Kifissia is located north of Athens with a population of 64,000 inhabitants and an area of 3.510 ha.

**METHODOLOGY**

**Identification and description of case study areas in the municipalities of Athens and Kifissia**

The aim of this activity was to identify and evaluate the pilot areas, where the separate collection of biowaste takes place. During the current Activity, the work that has been implemented is divided in three phases:

**Phase A: Main Characteristics of the Municipalities and Preparation of Digital Maps**

At the first phase, a profile of the two participating Municipalities has been created so as to facilitate discussions and further analysis.

The main characteristics of Athens are its high population density, its high variety on living standards (very high and very low cost areas) and the abundance of multi-family building arrangements.

The population density in Kifissia is 20 inh/ha. The Municipality has been formed under the Law 3852/2010 (Kallikratis) by the former Municipalities of Kifissia, Ekali and N. Erythraia. Main characteristic of Kifissia is the high living standard and the detached houses.

In order to filter these areas and conclude to a smaller area of 3,000 inhabitants, required for the pilot system, digital maps have been prepared with the use of GIS.

**Phase B: Development and Application of Criteria for the Selection of the Pilot Areas**

The second phase included the development of certain criteria for their application in the framework of the GIS model. Each Municipality decided on the criteria to be applied taking into account that the areas to be selected in Athens and Kifissia had to be significantly different in order to allow evaluation on how these characteristics influence the implementation of the biowaste source separation scheme.
As a result, for the Municipality of Athens, the following were agreed:
- To select two pilot areas within the municipality
- The 1st area to be representative of the municipality, i.e. to have an average population density and an average living standard.
- The 2nd area to have significant biowaste producers, such as restaurants.

After the application of the aforementioned criteria with the use of the GIS model, two neighborhoods were selected: Kypriadou kai Gazi. Kypriadou, is a high density residential area in Athens and Gazi is a low density area in Athens with many restaurants and other catering facilities with high production of biowaste (figures 1 & 2)

![Figure 1: Map of Kypriadou](image1)

![Figure 2: Map of Gazi](image2)

Respectively, for Kifissia, it was agreed that at least one area should be selected from the former municipalities, i.e. Kifissia, Ekali and Erythraia. In addition, among these areas, one area at least should have a very low building co-efficient (≈0.4) so as to test a door-to-door collection system and one with a mixed housing system and a relevant high living standard.

After the application of the aforementioned criteria with the use of the GIS model, four neighborhoods were selected: Kato Kifisia, Nea Kifisia, Kato Ekali, Kastri. Kato Kifissia is a medium density area with flats and detached houses, Nea Kifissia is similar to Kato Kifissia, Kato Ekali is a low density residential area with big houses with yard and Kastri combines characteristics from Kato Kifissia, Nea Kifissia and Kato Ekali and is considered to be a relative low density residential area (figures 3, 4, 5 & 6). It must be noted that only part of the neighborhoods was selected, in order to avoid a very large number of population.
Regarding the case study areas within the MoA that have already been presented above, it should be noted that two more specific points have been added in the pilot scheme. In fact, these two points were the outcome of the high impact of the ATHENS-BIOWASTE dissemination activities. More specifically, the Ministry of Defense expressed the willingness to take part in the separation of the biowaste at source and most specifically the Club (restaurant) of Officers located at Vasilisis Sofias Avenue in the center of Athens. Additionally, the Agricultural University of Athens expressed the willingness to take part in the separation of the biowaste at source using the food waste from its restaurant and part of its green waste. The separation of biowaste at source has started in both these specific points generating large quantities of biowaste. Two extra pilot areas were also added for the case of the MoK (Strofuli & Kefalari).

Phase C: Description and Analysis of the Pilot Areas

The third phase included the detailed analysis of the pilot areas in terms of:
- Determination of the pilot area border by applying the GIS model to the selected neighborhoods and assessing the detailed population number
- Recording street addresses and numbers
- Identification of other facilities (schools, supermarkets, etc.) covered by the areas
- Aerial photos of the areas
- Site visits
- Registration of existing infrastructures and bins

**Selection and planning of separate collection method for the case study areas**

The aim of this activity was to select and plan the separate collection system in the pilot areas. More specifically, the current activity included the following four phases:

**Phase A: Consultation on the separate collection method to be applied in each pilot area**

At this phase several meetings took place in order to decide on the separate collection methods to be applied in each area. Following this procedure, it was decided that the MoA will implement a collection with road containers/bins, while the MoK will promote door to door collection, wherever possible, in combination with collection with road containers/bins.

In more detail, the following methods were decided (figure 7):

<table>
<thead>
<tr>
<th>All households of the pilot areas were provided with:</th>
</tr>
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<tbody>
<tr>
<td>- small kitchen caddies of 7-10 lt</td>
</tr>
<tr>
<td>- biodegradable - compostable bags (certified to EN 13432)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>The MoA is equipped with:</th>
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<tr>
<td>- Bins (brown in colour) on the kerbside, beside the bins for residual waste. Four wheel metallic bins of 660 lt were decided for the Kypriadou pilot area as in the city of Athens any smaller bin is likely to be stolen and damaged. As for the Gazi pilot area, the Officers’ Club and the Agricultural University of Athens, four wheel metallic 1.100 lt. bins were chosen for their capacity.</td>
</tr>
<tr>
<td>- Bins of 30 or 50 lt for the interior of bars &amp; restaurants in Gazi</td>
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<table>
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<tr>
<th>The MoK was equipped with:</th>
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<tbody>
<tr>
<td>- Bins of 35-50 lt for detached houses, where door-to-door collection will take place</td>
</tr>
<tr>
<td>- Plastic two wheel bins (brown in colour) which were placed on the kerbside beside the bins for residual waste or on the open area of the buildings. The size of the bins differ between 120 lt, 240 lt and 360 lt.</td>
</tr>
</tbody>
</table>

**Figure 7**: The separate collection methods for the MoA and the MoK
The aforementioned methods for the two case studies are illustrated below (figure 8):

**Municipality of Athens**

![Diagram showing waste collection methods for Athens](image)

**Municipality of Kifissia**

![Diagram showing waste collection methods for Kifissia](image)

**Figure 8:** Illustration of the proposed separate collection methods for Athens & Kifissia

The collection and transport of biowaste to the recycling plant of EDSNA at Ano Liosia takes place with the existing collection vehicles of the Municipalities. More specifically:

- One vehicle has been dedicated for the collection of biowaste in each municipality (Photos 1 & 2). A special livery was designed on the vehicle so as to be easily identifiable and to further disseminate the scheme to the citizens.
- An online fleet management system has been placed and operates in the vehicles so as to allow monitoring of biowaste collection.

**Photo 1:** MoA vehicle  **Photo 2:** MoK Vehicle
Phase B: Household Database and Estimation of the required bins (quantity)
This phase included the estimation of the required bins in the selected areas through the estimation of the number of households that participate in the collection scheme. According to this analysis, the number of households per area was estimated as following:

- Selected Areas in Athens: **2,084 households** which correspond to a population of 3.500-4.500 inhabitants. The pilot collection areas in Athens include also around **70 businesses** (restaurants, bars, etc.) that generate food waste.
- Selected Areas in Kifissia: **1,743 households** which correspond to a population of 3.000-4.000 inhabitants

Planning of the awareness campaign
All of the equipment/consumables have the LIFE logo stamped or printed (figure 9).

![Figure 9: The ATHENS-BIOWASTE logo](image)

The aim of this activity was the preparation of the biowaste scheme awareness campaign, targeting directly in the citizens and professionals of the selected areas. It includes three basic phases:

1. **Awareness Phase before the start-date of the pilot scheme**: At this phase a letter was sent via post or door-to-door service, by each Mayor/Vice Mayor to all the participating households, accompanied with an Informational Leaflet for Biowaste Collection at Source. This phase started 1 month before the pilot scheme, i.e. October 2012 for the case of Kifissia.

2. **Awareness Phase at the start-date of the pilot scheme**: At this phase, the citizens were approached door-to-door and were provided with the kitchen caddies, the biodegradable bags and **one-page instructions** on how to start collection at source. In addition, a dedicated telephone help line is used for information and enquiries by the citizens. Each Municipality has already created one helpline and a separate email address.

3. **Awareness Phase during the implementation of the pilot scheme**: This phase aims at reminding the citizens about biowaste collection and promoting higher collection rates. For this purpose, each Municipality organizes its own events. All events take place inside the pilot areas or in close distance from them.

The awareness campaign includes the participation of a number of people with specific ATHENS-BIOWASTE appearance, comprising of municipality staff (and volunteers for the case of MoA). More specifically, a press conference and several information days in each pilot area and animation workshops in schools of the area dedicated to composting have been planned.
Implementation of the separate collection program in the selected areas

The implementation phase includes:

1. Implementation of the awareness campaign
2. Implementation of separation at source
3. Laboratory analysis of collected samples

The implementation of the biowaste separation at source requires:

- The involvement of citizens in the areas of application of the separation at source program
- The distribution of biowaste collection bins in the pilot areas
- Recovery of biowaste through the implementation of the separation at source program in the application areas
- Laboratory analysis of materials (e.g. waste composition, moisture content) collected from areas of the separation at source system in order to evaluate the success of the separation (Krutwagen et al. 2008; Mills and Andrews 2009; Miniwaste 2010).

Composting of the collected material and analysis of the final product

This phase includes

- Design and implementation of the process of composting
- Laboratory analysis of the produced compost
- Development of software to link the quality of compost to the collection and processing of biowaste.

The collected biowaste from the two municipalities is treated at a separate channel of the composting unit of the Mechanical and Biological Treatment Plant (EMAK) of EDSNA (Photos 3 & 4) in order to produce high quality compost. Furthermore, in order to evaluate the initial input and the final product, a series of laboratory tests to characterize quality of the produced compost (containing impurities plastics, metals, etc., pH, heavy metals, pathogens) is carried out. The measurements and analyses are made by the certified (ISO 9001:2008 and ELOT EN ISO/IEC 17025:2005) lab of the NTUA Unit of Environmental Science & Technology.

![Photo 3: Inlet of the biowaste in the composting unit](image)

![Photo 4: The separate channel](image)

A primary composition of the input biowaste is given in Figure 10. Such sampling and analysis takes place on monthly basis, while it is the first relevant data for Greece.
Dissemination

The working team has given emphasis on this Action, since the high dissemination impact is a necessary precondition for the success of the ATHENS-BIOWASTE activities.

With regard to dissemination activities the main means used include:

- Webpage available at www.biowaste.gr in both English and Greek
- A Facebook account (www.facebook.com/athensbiowaste)
- Information desk in each of the participating Municipalities,
- Newsletters,
- Press conferences,
- A large number of press releases in numerous national newspapers, local newspapers, news websites, etc
- TV coverage at national level and radio coverage.

The relevant dissemination activities became more intense a couple of weeks before and after the starting point of the implementation of the separation at source in the two Municipalities.

RESULTS

The first batch of compost is expected to be produced in summer 2013 and its quality will be correlated with EU Eco-Label and other standards. A software will also be developed to correlate compost quality to biowaste collection and treatment methods and supplement the extensive monitoring procedures which have been planned with special attention using tools, such as GIS (Figure 11). The monitoring procedures include the quantification of indicators like biowaste separate collection (per inhabitant), biowaste separate collection (per household), participation level (per buildings, per households, per Municipality), etc.
Regarding the investment costs arising from the collection system organised, these are summarized in Figure 12.

![Figure 12: Investment Costs per inhabitant](image)

**CONCLUSIONS & FINDINGS**

The success of a biowaste management system is twofold and includes planning of a separate collection scheme with high capture rates and optimising treatment processes to achieve high quality compost. The monitoring and dissemination actions constitute significant tools for the successful implementation of effective biowaste management schemes.

**References**


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