



**Athens 2014**  
2ND INTERNATIONAL CONFERENCE  
on Sustainable Solid Waste Management  
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# **“Compositional analysis of food waste from study sites in Greek municipalities”**

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# Objectives



- To develop a methodology for conducting compositional analysis on source separated household biowaste
- To apply the developed methodology in order to investigate differences and similarities to results on biowaste composition derived from Municipalities of Athens and Kifissia of the Attica Region
- To draw conclusions concerning the composition of source separated household biowaste from Greece and compare them with relative from other countries
- To investigate potential limitations and areas for improvements in the developed methodology.



# Introductory remarks

- **'Bio-waste'** includes the biodegradable garden and park waste, **food and kitchen waste from households**, restaurants, caterers and retail premises, and comparable waste from food processing plants (*WFD, 2008/98/EC*)
- **Food waste (FW)** constitutes one of the largest components of the waste stream around the world. Based on EC (2011) the percentage breakdown of EU-27 food waste arisings is: **42% from households**, 39% from manufacturing, 14% from food service/catering sectors and 5% from wholesale/retail
- Experience so far has shown that in order to ensure the quality of the compost produced both from composting and from aerobic treatment of digestate, the organization of **separate collection schemes of bio-waste is necessary**
- **In Greece**, the practice of separate collection has not been yet introduced in practice except from some pilot studies area (ATHENS-BIOWASTE project)
- Diversion of HFW from landfills is reflected in the waste hierarchy of the **WFD** and the **Landfill Directive**.

# ATHENS BIOWASTE project



**Title:** *Integrated Management of biowaste in Greece – The case study of Athens (LIFE10 ENV/GR/605).*



## Main Objective of the project:

*.....the implementation of biowaste separation at source in selected areas of the Municipalities of Athens and Kifissia and the treatment of the collected biowaste in the MBT of EDSNA in order to produce high quality compost.....*

Selection of household  
biowaste from the  
Municipality of Kifissia  
1.743 households

Selection of household  
biowaste from the  
Municipality of Athens  
2.076 households + 70  
restaurants



[www.biowaste.gr](http://www.biowaste.gr);  
[www.facebook.com/athensbiowaste](https://www.facebook.com/athensbiowaste)

# Pilot areas selected in the Municipality of Kifissia



## NEA KIFISSIA

Population: **1189 inh**

Density: 38 inh/ha

## EKALI

Population: **1108 inh**

Density: 20 inh/ha

## KATO KHFISSIA

Population: **815 inh**

Density: 48 inh/ha

## KASTRI

Population: **409**

Density: 69 inh/ha

## 2<sup>nd</sup> expansion

## STROFILI

Population: **1500**

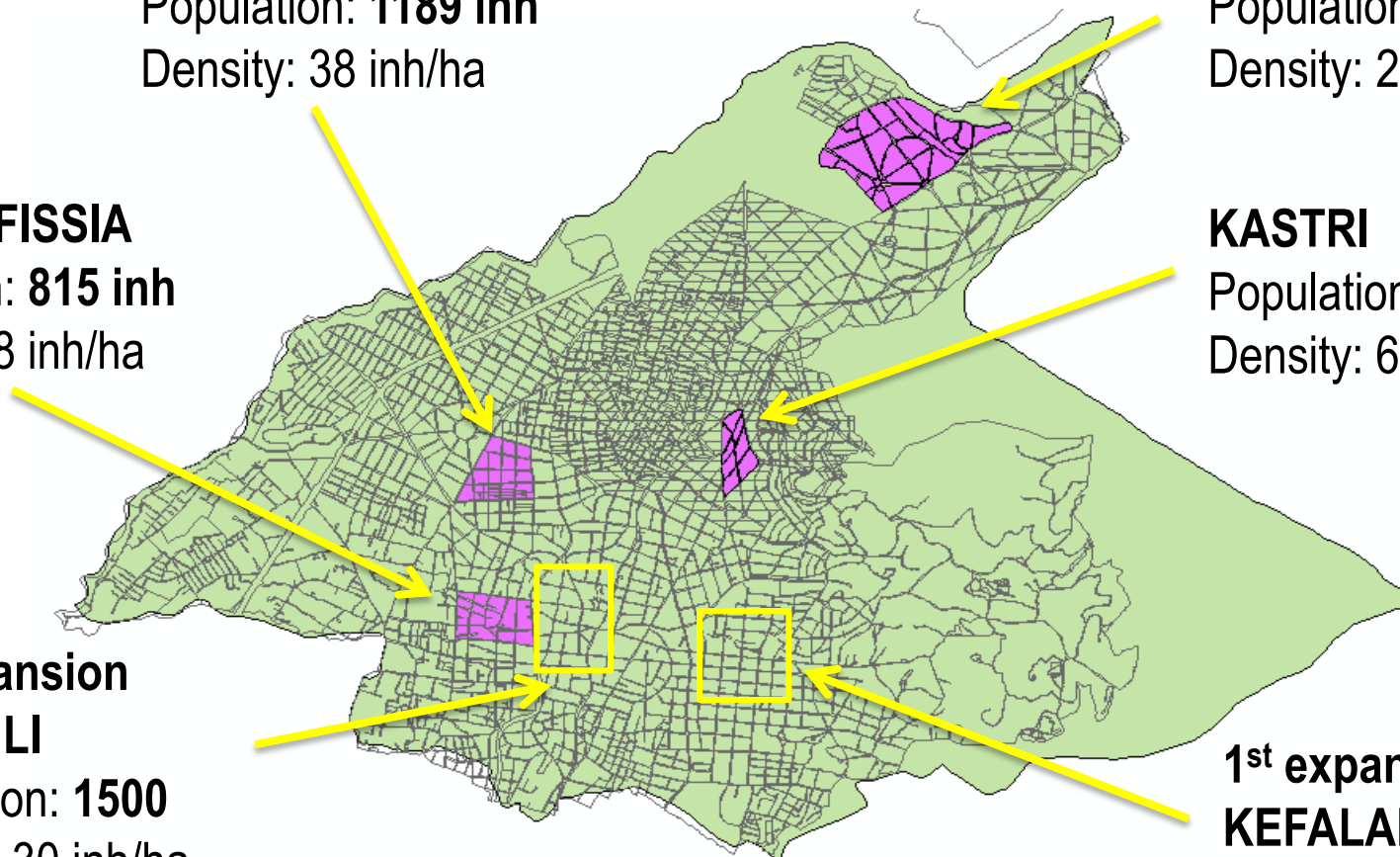
Density: 30 inh/ha

## 1<sup>st</sup> expansion

## KEFALARI

Population: **705**

Density: 41 inh/ha





# Pilot areas selected in the City of Athens



## 1<sup>st</sup> area KYPRIADOU

Population: **2.707** (including 2 Expansions)

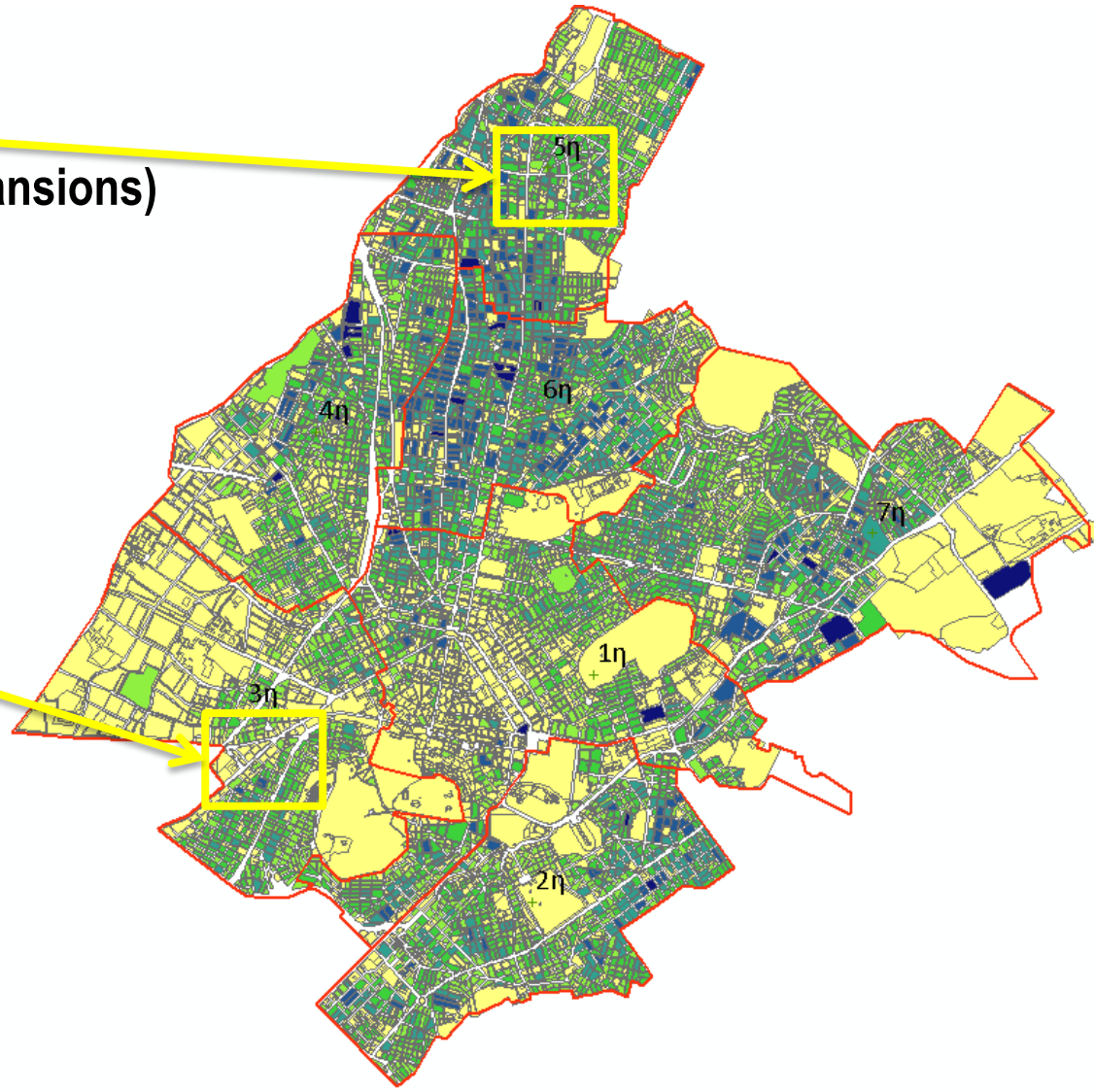
Density: 208 inh/ha

## 2<sup>nd</sup> area GAZI

Population: **1.447**

Density : 54 inh/ha

≈ 80 restaurant, bars etc





# Waste Compositional Analysis (I/III)

- **What is this?** *Waste Compositional Analysis is the study of synthesis of a representative waste sample through categorization in proportions to distinct waste components depending on the reasons for executing the analysis*
- **How can it be implemented?**
  - waste analysis campaigns (WAC) undertaken by the interested party
  - kitchen diaries kept by the consumers
  - estimations from statistical data on food supply and nutrition
  - questionnaire surveys etc
- **Who is interested in?**
  - National and local authorities
  - Waste management companies
  - Researchers and Scientists
  - The public



# Waste Compositional Analysis (II/III)

## ■ *Why is it important?*

- define current situation of waste composition,
- prioritize waste management needs,
- determine preventing measures at national, regional and local level and benchmarking the progress towards their implementation,
- determine the degree and nature of the presence of impurities in source separation, inform food-waste reduction activities
- plan waste collection and treatment

## ■ *Problems related to performance of compositional analysis?*

- There is not a standardized methodology for executing compositional analysis on source separated household biowaste
- Waste samples are highly heterogeneous and changes due to state of degradation





# Waste Compositional Analysis (III/III)

## Identified methods for solid waste component analysis based on physical sampling

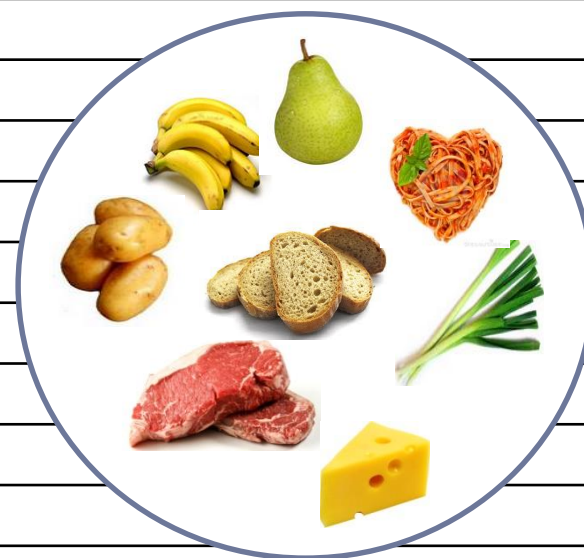
Reference	Method	Institution
ADEME (1998)	A method for characterization of domestic waste	MODECOM™, France
ASTM International (2003)	Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste	American Society for Testing and Materials
Burnley et al. (2007)	Assessing the composition of municipal solid waste. Method developed from the Environment Agency of England and Wales	Department of Environmental and Mechanical Engineering, The Open University, Milton Keynes, United Kingdom
CIWMB (1999)	Uniform waste disposal characterization method	California Integrated Waste Management Board
Cornelissen and Otte (1995)	Physical investigation of the composition of household waste in the Netherlands	RIVM (The Netherlands National Institute of Public Health and Environmental Protection)
European Commission (2004)	SWA-tool, Methodology for the analysis of solid waste	5th Framework Program, Vienna, Austria
Gustafson and Johansson (1981)	Hushållsavfall. Genereringstakt och sammansättning/Household waste. Generation rate and composition	Luleå University of Technology (LTU), Sweden
Maystre and Viret (1995)	A goal-oriented characterization of urban waste	Institute of Environmental Engineering, Lausanne, Switzerland
Mbande (2003)	Appropriate approach in measuring waste generation, composition and density in developing areas	South African Institution of Civil Engineering
Nordtest (1995)	Solid waste, municipal: sampling and characterization	Nordtest, Finland
Ohlsson (1998)	Plockanalys av hushållsavfall. Metoder och trender/Household waste composition studies. Methods and trends	Luleå University of Technology (LTU), Sweden
Petersen (2004)	Waste component analysis as a planning tool	Dalarna University College, Sweden
Reinhart and McCauley-Bell (1996)	Methodology for conducting composition study for discarded solid waste	University of Central Florida, US
Rugg (1997)	Solid waste/characterization methods	Environmental Engineers' Handbook, US
RVF (2005a)	NSR solid waste characterization method	NSR Research, Sweden
RVF (2005b)	Municipal solid waste composition analysis manual	The Swedish Association of Waste Management (RVF)
SAEFL (2004)	A survey of the composition of household waste	Swiss Agency for the Environment, Forests and Landscape
Scott (1995)	Work in harmonising sampling and analytical protocols related to municipal solid waste conversion to energy	International Energy Agency (IEA)

# Methodology (I/III)



The primary **waste components** which were selected are presented in **Table 1**.

No.	Waste component category
1	Vegetables and Salads
2	Fruits
3	Bread and Bakery
4	Meals (homemade and preprepared)
5	Spaghetti /Rice/Flour/Cereals
6	Meat and Fish
7	Dairy and Eggs
8	Cake, Desserts, Confectionery and Snacks
9	Drinks (Coffee and tea bags )
10	Paper
11	Garden Waste
12	Rest biowaste: <i>organic material which do not fit into another category because (a) it is not possible to be integrated in a category and / or (b) have a size less than 13mm</i>
13	Impurities: <i>i.e. plastics, metals, glass, plastic bags etc.</i>



# Methodology (II/III)



**Step 1:** Weight and record the mass of the total collected load of household from each municipality.

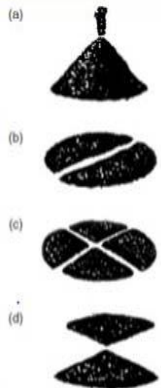
**Step 2:** Prepare appropriate areas (load-discharge area, surface for opening bags, sorting table)



**Step 3:** Unload waste from collection vehicle to the load discharge area at MBT facility.

**Step 4:** Select between 300-500kg, then open all bags and empty the contents to the prepared area.

**Step 5:** Mix, cone and quarter biowaste and then select about 50kg of representative sample for laboratory analysis.



# Methodology (II/III)



**Step 6:** Weight the remain biowaste and transfer it to the sorting table



**Step 7:**

Manually sort to predefined waste components until the maximum particle size < 13mm



**Step 8:** Weight and record the waste category. Re-weight is necessary

**Step 9:** Clean the load-discharge area, the surface for mixing and the sorting table.

**Step 10:** Calculate mass fraction and percentage of waste component



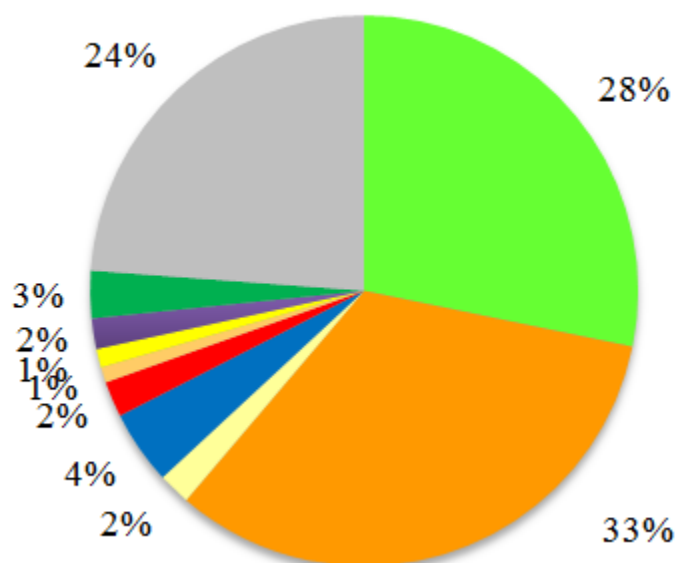
# More indicative photos



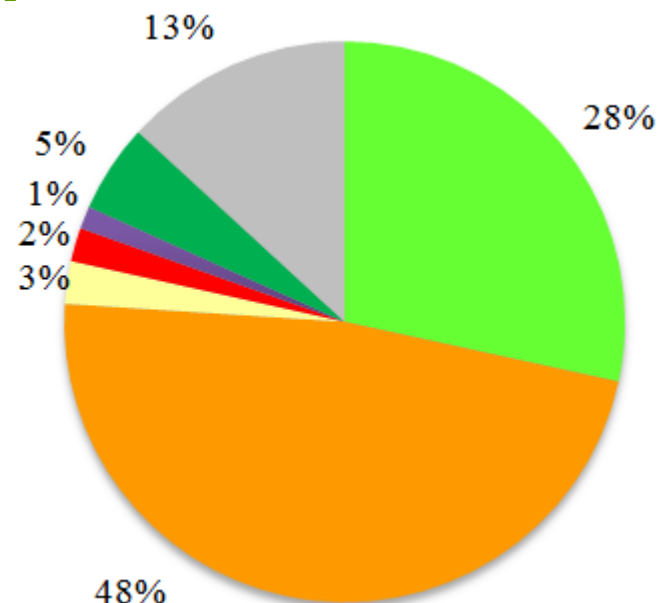
# Results and Discussion (I/VII)



## Kifissia



1<sup>st</sup> WAC\*, 28.03.2013



2<sup>nd</sup> WAC, 31.05.2013

Vegetables and Salads

Meals (homemade and preprepared)

Dairy and Eggs

Paper

Fruits

Pasta/Rice/Flour/Cereals

Cake, Desserts, Confectionery and Snacks

Garden Waste

Bread and Bakery

Meat and Fish

Drinks (Coffee and tea bags)

Rest biowaste

\*WAC: Waste Analysis Campaigns

\*\* Impurities are not considered



# Results and Discussion (III/VII)

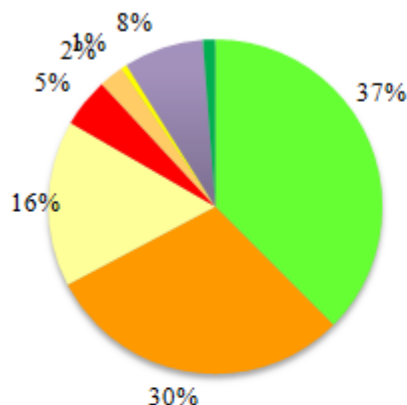


- The **largest amounts** of household biowaste of Kifissia are '**Fruit**' waste (33% and 48% from 1st WAC and 2nd WAC, respectively)
- The **second largest** component are '**Vegetables and salads**' (28% in both WACs).
- Percentages of '**Rest biowaste**' recorded **high values** especially during the 1st WAC (24 %), while during the 2nd the percentage fell to 13%.
- The figures for '**Meat and Fish**' and '**Bread and Bakery**' food waste categories remained **constant at around 2%**, both for the 1st & 2nd WAC in Kifissia.
- The percentages of '**Paper**' were **low enough** (2% and 1% from 1st WAC and 2nd WAC, respectively), while '**Garden Waste**' was in the range of **3% and 5%** from 1st WAC and 2nd WAC, respectively.

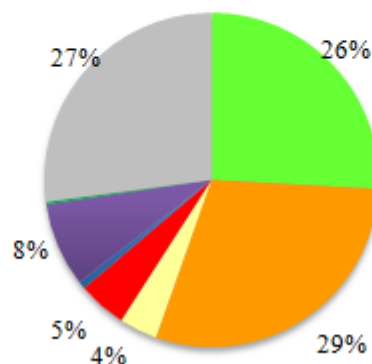
# Results and Discussion (III/VII)



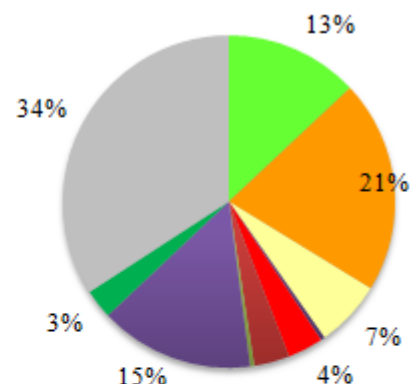
## Athens



*Kypriadou area*  
**1<sup>st</sup> WAC\***  
**05.11.2013**



*Kypriadou area*  
**3<sup>rd</sup> WAC,**  
**17.02.2014**



*Kypriadou and Gazi areas*  
**2<sup>nd</sup> WAC,**  
**11.12.2013**

- Vegetables and Salads
- Fruits
- Bread and Bakery
- Meals (homemade and preprepared)
- Pasta/Rice/Flour/Cereals
- Meat and Fish
- Dairy and Eggs
- Cake, Desserts, Confectionery and Snacks
- Drinks (Coffee and tea bags)
- Paper
- Garden Waste
- Rest biowaste

\*WAC: Waste Analysis Campaigns, \*\* Impurities are not considered

# Results and Discussion (IV/VII)

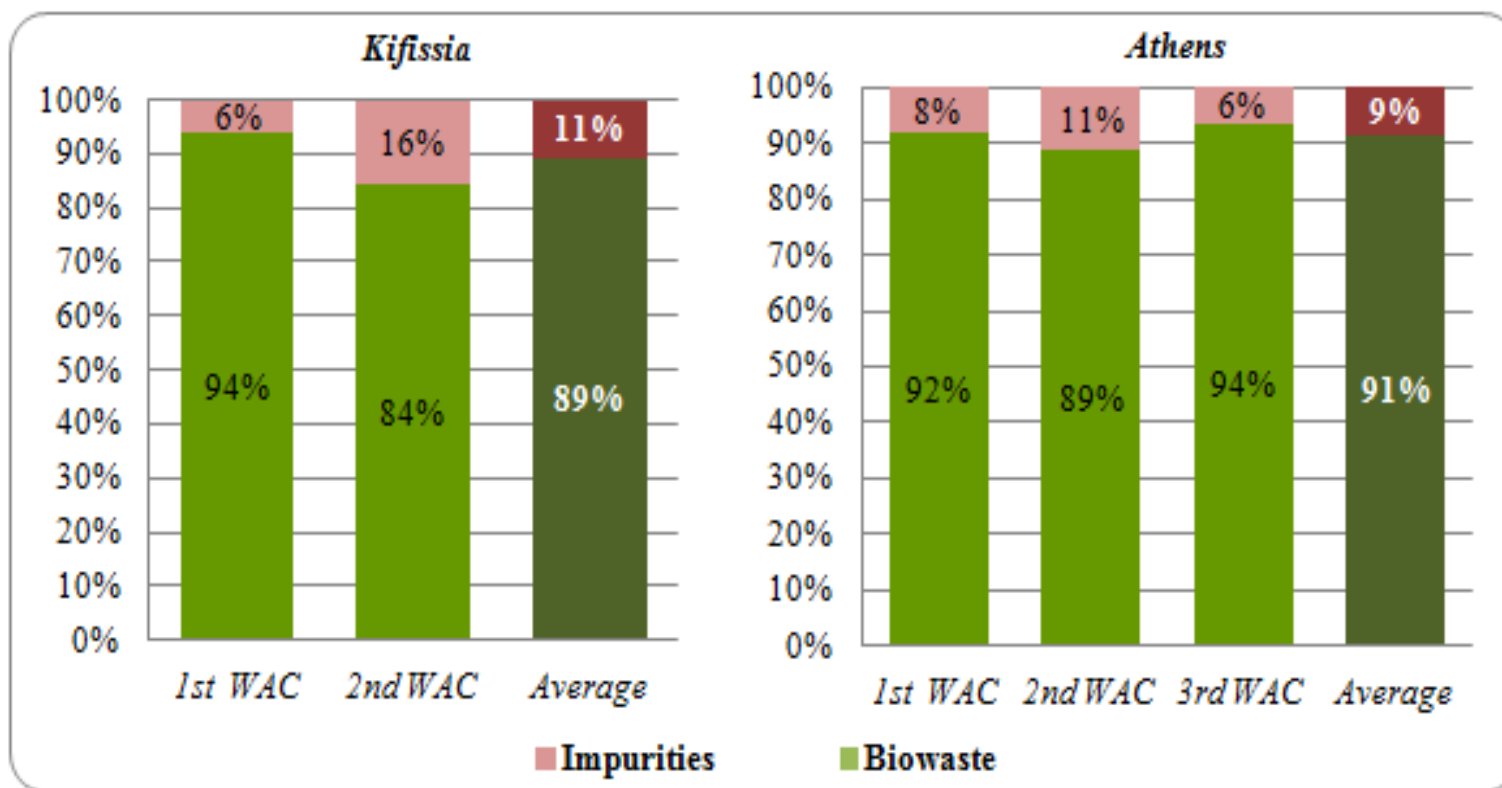


- As in the case of Kifissia, '**Fruit**', '**Vegetable and Salads**' and '**Rest Biowaste**' represented the **greatest amounts** in each WAC for the Municipality of Athens.
- The figures for '**Meat and Fish**' are slightly higher (4%, 3% and 5% from 1<sup>st</sup> WAC, 2<sup>nd</sup> WAC and 3<sup>rd</sup> WAC, respectively) than those recorded for Kifissia; albeit the increase is rather small.
- During the 2<sup>nd</sup> WAC, a **percentage of 15%** was observed for the '**Paper**', which can be attributed to the fact that during this campaign biowaste originated from Gazi area was also sorted.
- Low enough is the contribution of '**Green waste**' to overall waste composition (1%, 3% and <1 % from 1<sup>st</sup> WAC, 2<sup>nd</sup> WAC and 3<sup>rd</sup> WAC, respectively), which is in line with the fact that the Municipality of Athens is more urbanised than Municipality of Kifissia.

# Results and Discussion (V/VII)



## *Percentage of impurities*

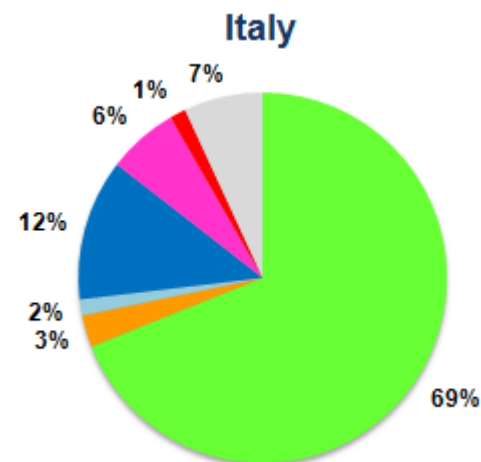
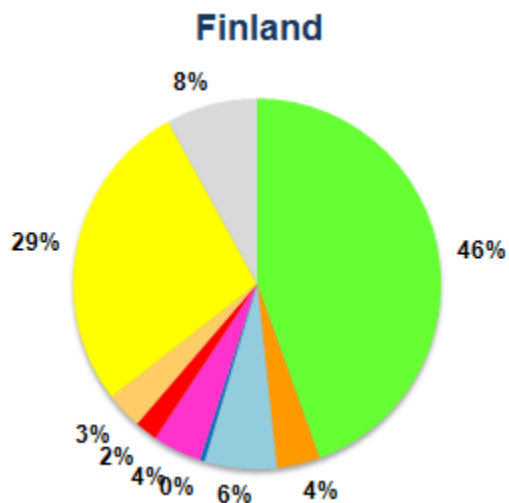
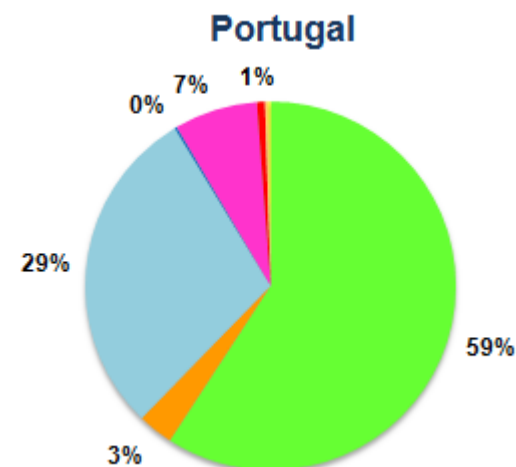
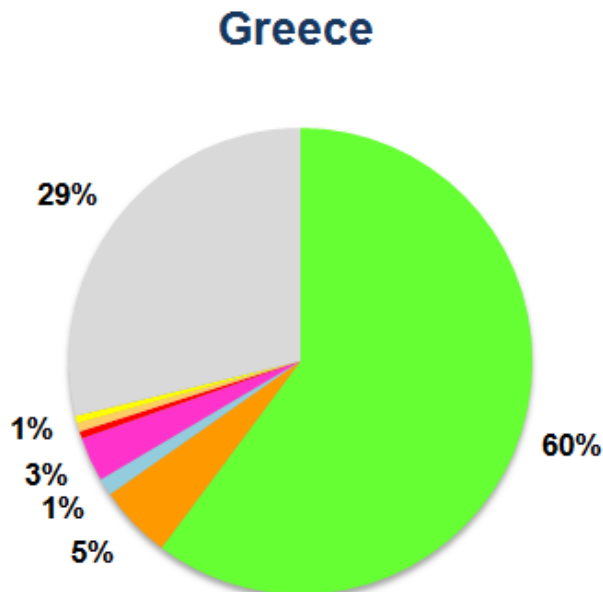
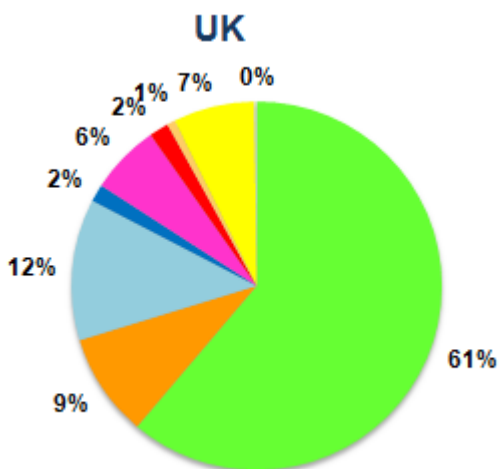


\*WAC: Waste Analysis Campaigns

# Results and Discussion (VI/VII)



## Comparison to other countries



- Fruits & Vegetables
- Bread & Bakery
- Meals
- Spaghetti/rice/flour/cereals
- Meat & Fish
- Dairy & Eggs
- Cake, Desserts, Confectionery & Snacks
- Drinks (Coffee, tea bags)
- Rest food

*Impurities are not considered*

# Results and Discussion (VII/VII)



- The percentages of food waste components are in line with those observed in other countries except for the '*Rest food*'.
- This can be attributed to the condition of the raw material delivered to the MBT facility which was in some cases spoiled up to the point in which it was not easy to distinguish between different waste components. Moreover, it can also be attributed to the mixing that it had undergone during transport to the vehicles.
- Despite the aforementioned differentiation, the Greek compositional data agreed with the general observation from compositional analysis from other countries that '*Fruit and vegetable*' waste constitutes the largest proportion (60%).
- The percentage of '*Bread and bakery*' products was in the same range with those from other countries, while the proportion of '*Meat & Fish*' was a little lower than other countries.
- In all other categories the recorded percentages for Greece were slightly lower than those of other countries.



# General Conclusions (I/II)



- The developed methodology for executing biowaste household compositional analysis provided useful information concerning the composition of waste in specific waste categories.
- The results obtained from the performance of the methodology revealed similarities, since fruit and vegetable waste constitute the main household biowaste stream in both municipalities.
- However, it also showed differentiations between municipalities mainly considering bread and bakery waste, paper and green waste which can be attributed to the most urbanised character of the City of Athens

# General Conclusions (II/II)



- In line with data derived from other countries, in Greece 'Fruit and Vegetable' waste constitutes the main part of biowaste household waste.
- The proportion of 'Rest waste' was relevantly high, which indicates that in order to improve the procedure of compositional analysis and to obtain more representative results, the waste load for sorting should be fresh and to be transported with waste collection vehicles without compacting.
- Results from compositional analysis can also be considered as a promising technique for recording the degree and nature of contamination on the performance of a source segregated schemes.
- Despite that, the revealed information from a waste analysis campaign can be utilized so as to determine the appropriateness of household biowaste or household food waste as a feedstock for biological processes, such as anaerobic digestion, composting or ethanol production.

# Thank you for your attention

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