

Recycling in the Municipality of Vari-Voula-Vouliagmeni - The beginning of the Circular Economy Application

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Abstract: The main goal of the new recycling **methodology** for the collection of solid waste in the city of Vari - Voula - Vouliagmeni (VVV), is the matching of the waste producer with the generation of waste for which she/he is responsible. The **aim** is to strengthen the participation of citizens, businesses and organizations in the activities of the Municipality which implement and expand the circular economy. It is estimated that the philosophy of positive reward will have significant effects and will be a bridge between the current situation and the future, where, on the basis of the European waste strategy, the 'polluter pays' principle should be applied.

The **result** of increasing of the waste quantities that pre-selected / recycled / composted, will lead to a decrease of quantities of unprocessed waste, that are currently be leaded to burial. There are also obvious economic benefits, resulting from the saving/reduction of landfill taxes and fines. Main objectives of this new methodology are

- Creation of local strategies, action plans and tools in order to increase the proportion of sorting in the waste source in order to promote reuse and recycling.
- Strengthening citizen participation in recycling systems and in circular economy.
- Improving citizens' income through active participation in local recycling activities under the moto 'Benefit As you Save'.
- Sharing best practices and transferring knowledge to innovative solid waste management in local level.

In **conclusion** 24,95%, or 11.047,87 tones of municipal solid waste were diverted from landfill in 2019, 8.412,52 tones more than 2016, a year in which we did not apply this new methodology.

Keywords: waste management, circular economy, recycle, compost, source separation, matching

1. Introduction

Since the end of 2018 [1], a methodology to separate waste in source and matching the waste generation has been systematically implemented in Vari – Voula - Vouliagmeni. (VVV). The Mechanical Treatment Facility is working on the separation of the biodegradable fraction from the rest of heterogeneous waste mixture and the recyclable fraction (paper/cardboard, plastic, glass metals) is also passed through a series of sorting methods, which recovering these materials at source.

The new, innovative idea for Greece, which we have begun to implement in the VVV Municipality, concerns the development of a set of processes and tools that identify the waste producer, locally and in time. Thus the VVV Municipality will be able to apply the ‘polluter pays’ principle reliably and reward those citizens that sort waste at source, applying ‘Benefit As you Save’ procedures and supply the local circular economy with recycled materials.

VVV Municipality collects Biodegradable waste / Greens (pruning) (code 20 02 01, [2] & [3]) from sidewalks with open vehicles, with or without grab, and loaders. In addition, the Municipality distributes free of charge and places special brown bins for organic waste, equipped with Radio-Frequency Identification (RFID) tags, in order to collect the organic, also biodegradable, waste (code 20 01 08[2] & [3]). When the garbage collector collects waste from these bins, a municipal database is automatically updated on the quantity, location and time of collection. Every waste producer that separates its organic waste is credited with assigned benefit points. Under the scientific supervision of the National and Kapodistrian University of Athens - Department of Chemistry (Prof. K. Chassapis) we produce biocatalytic peat alternative soil substrates, VITA GREEN and VITA GREEN plus [4]. These soil conditioners, which are first-class soil conditioners (A + and A), suitable for use in organic farming in accordance with the requirements of Reg. (EC) 834/2007 & 889/2008, as attested by 28056-6 / 19 CERTIFICATION OF CONFORMITY of DIO, Inspection and Certification Organization of Organic Products.

Since the beginning of 2019, the Municipality of VVV distribute to the citizens bags with QRcode, different for paper (code 20 01 01 [2] & [3]) and different for PMD (Plastic – Metal – Drinkable packaging, code 15 01 06. [2] & [3]). The citizens fill the bags with recyclable materials that be collected by Municipality door to door. The QRcodes are uploaded on a platform that identifies the person who is the owner of the bags and benefit points are assigned. (<http://www.3v-bas.gr/#/landing>).

2. Methodology

The key-point of our methodology is the change of the behavior of the entire population of the Municipality of VVV, with a step-by-step approach, which is called ‘Benefit As you Save’. It concerns the registration of all households, businesses and buildings in the related area in order to receive appropriate material, i.e bins and bags to be able to separate the waste they produce. The next step of ‘Benefit As you Save’ approach is to reward these citizens with various benefits.

The distribution of households in buildings is important, because of the different specifications and sizes of waste bins, of the quantities of waste bags and of the methodology of identifying waste producers as the municipality vehicles move from single-family buildings to buildings with 10, 20 or more families.

Table 1. Population data

The permanent population of the Municipality (Hellenic Statistical Authority, 2011, [5])

City	Population
Vari	15.855
Voula	28.364
Vouliagmeni	4.180
Total	48.399

Table 2. Number of households in buildings [5]

Type	Buildings	Households	% in total
Buildings with 1 household	5.164	5.164	15,40%
Buildings with 2 households	1.953	3.906	11,65%
Buildings with 3-5 households	2.191	8.764	26,14%
Buildings with 6-9 households	842	6.315	18,83%
Buildings with 10-19 households	486	7.290	21,74%
Buildings with more than 20 households	91	2.093	6,24%
Total	10.727	33.532	100,00%

The VVV Municipality, in the coming few years, will distribute 10,727 bins equipped with RFID tags, aiming at the participation in the reward platforms of at least 33,532 residents (household representatives). Since 2018 we focus on an area called Pigadakia and on 66 businesses throughout the city. About 500

brown bins were placed, equipped with RFID tags, which identify each household/business.

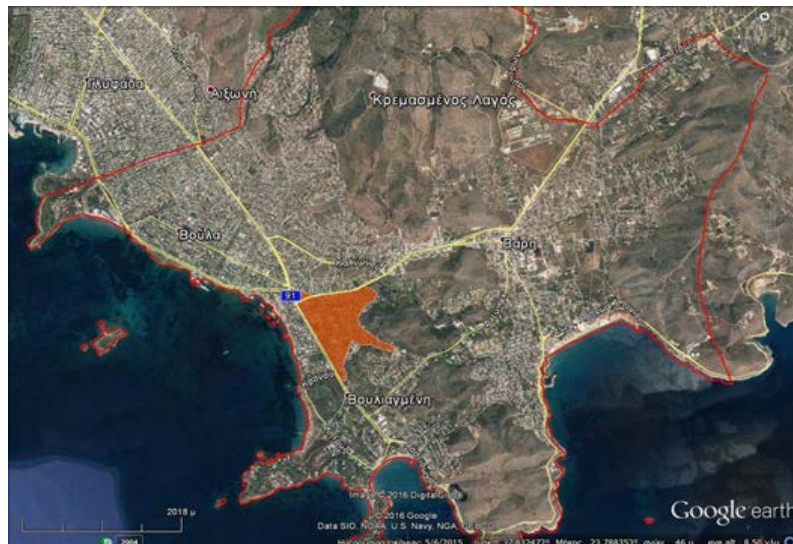


Figure 1. Municipality of Vari – Voula – Vouliagmeni

In Figure 1 the boundaries of the Municipality are marked with the red line and the Pigadakia area is orange.

At Pigadakia area there are 1248 households in 663 buildings [6]. In each building, a brown bin (120 or 240 liters) is placed to separate organic waste at source. Municipal vehicles collect the content of the brown bins, weigh and identify each bin and transfer this information to a municipality database.



Figure 2



Figure 3

VVV municipality also collects from sidewalks biodegradable waste / greens (prunings). The NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS - DEPARTMENT OF CHEMISTRY (Prof. Dinos Chassapis) is the scientific advisor of VVV in order to produce biocatalytic peat alternative soil substrate, named VITA-GREEN (only from greens) and VITA-GREEN plus (from greens and organics). 400 citizens have already use VITA-GREEN and 200 citizens have already use VITA-GREEN plus.



Figure 4



Figure 5

The daily results of brown bins collection and weighing are available now in the municipal database.

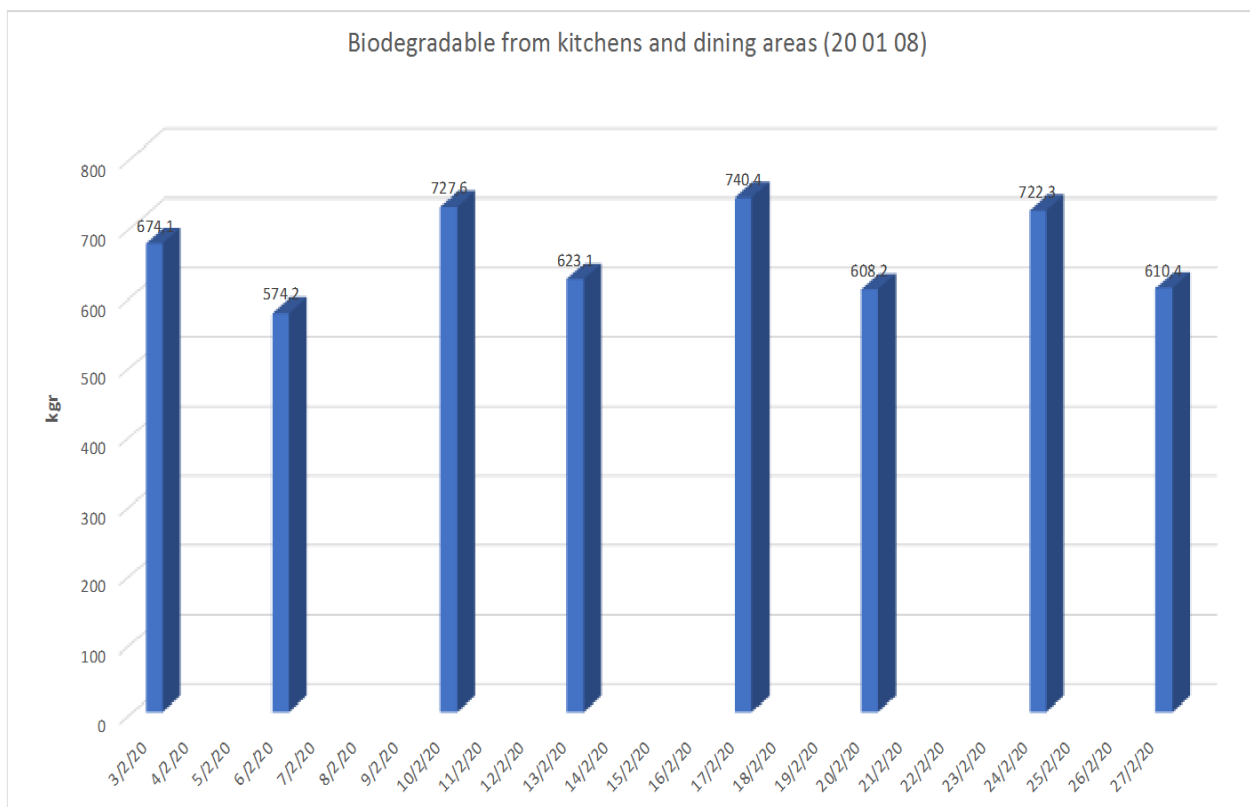


Figure 6 . Biodegradable from kitchens and dining areas (20 01 08) at Pigadakia area on February 2020

More detailed data, for each household/businesses, are also available in the municipal database. For example

Table 3. Biodegradable from kitchens and dining areas (20 01 08) of four households

Date	Household 1 (Kgr)	Household 2 (Kgr)	Household 3 (Kgr)	Household 4 (Kgr)
2020-02-03	15,00	0,00	0,00	14,00
2020-02-06	11,40	10,60	5,30	0,00
2020-02-10	7,10	9,10	16,50	0,00
2020-02-13	4,30	2,90	2,40	2,60
2020-02-17	1,70	0,00	7,30	5,50
2020-02-20	4,20	0,00	0,00	1,20
2020-02-24	3,60	9,80	13,00	3,60
2020-02-27	2,50	0,00	3,90	0,80
Total	49,80	32,40	48,40	31,00

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Additionally, since the beginning of 2019 the Municipality of VVV, distributes to the citizens at Pigadakia, bags with QRcode, different colour for paper (code 20 01 01) and different colour for PMD (Plastic – Metal – Drinkable packaging, code 15 01 06). The citizens fill the bags and Municipality collects them door to door. The QRcodes are uploaded on a platform that identifies the person who is the owner of the bags and benefit points are assigned. <http://www.3v-bas.gr/#/landing>



Figure 7



Figure 8

The points credited today by the platform to each participant ((household or businnes representative) are rewarded currently with a 50 liter VITA GREEN or VITA GREEN plus free bag (Figure 5). The matching methodology of the waste producer with the generation of waste, has started to yield results over than ten months now.

Table 4. Solid Waste in VVV Municipality
(National Electronic Waste Register, Years 2016 & 2017 [7])

Kind (Code)	Quantity (tn) (2017)	% (2017)	Quantity (tn) (2016)	% (2016)
Mixed packaging of recyclable materials (15 01 06)	1.588,59	4,32%	1.624,89	4,31%
Biodegradable waste / Greens (pruning) (20 02 01)	1.145,18	3,11%	266,74	0,71%
Mixed urban waste (20 03 01)	33.210,87	90,23%	35.090,64	93,01%
Others (13 02 05, 15 01 07, 16 01 03, 16 01 04, 17 01 07, 17 09 04, 20 01 10, 20 01 35, 20 01 36)	862,89	2,24%	743,72	1,97%
Total	<u>36.807,53</u>	<u>100,00%</u>	<u>37.725,99</u>	<u>100,00%</u>

Since 2018 we have started to have separate measurements for paper and cardboard and biodegradable from kitchens and dining areas (organics).

Table 5. Solid Waste in VVV Municipality
(National Electronic Waste Register, Years 2019 & 2018, [7])

Kind (Code)	Quantity (tn) (2019)	% (2019)	Quantity (tn) (2018)	% (2018)
Mixed packaging of recyclable materials (15 01 06)	1.739,16	3,93 %	1.598,32	4,13%
Paper and cardboard (20 01 01)	18,00	0,04%	2,63	0,01%
Biodegradable from kitchens and dining areas (20 01 08)	1.505,78	3,40%	14,65	0,04%
Biodegradable waste / Greens (pruning) (20 02 01)	6.732,15	15,20%	4.937,52	12,75%
Mixed urban waste (20 03 01)	33.230,66	75,05%	30.711,87	79,28%
Others (13 02 05, 15 01 07, 16 01 03, 16 01 04, 17 01 07, 17 09 04, 20 01 10, 20 01 35, 20 01 36)	1.052,78	2,38%	1.466,80	3,79%
Total	<u>44.728,53</u>	<u>100,00%</u>	<u>38.731,79</u>	<u>100,00%</u>

Table 6. Buried Solid Waste in VVV Municipality
(National Electronic Waste Register, Years 2019, 2018, 2017 & 2016, [7])

Buried/ Non Buried Waste	2019	2018	2017	2016
Percentage of buried waste	75,05%	79,20%	90,23%	93,01%
Percentage of non-buried waste	24,95%	20,71%	9,77%	6,99%
Total	100,00 %	100,00 %	100,00 %	100,00 %

The percentage of waste disposed of landfill increased from 2016 to 2019 by 17,97%. More spectacular results are expected next years as the distribution of brown bins with RFID and recycling bags with QRcode will be increased. The target is to cover 10,727 buildings and 33,532 households, by the end of

the year 2028.

3. Conclusions

The new methodology, the matching of waste producer with solid waste generation in the city of Vari – Voula – Vouliagmeni (VVV), increases the waste quantities that have been pre-selected / recycled –/ composted, with a lot of economic benefits. The obvious result is the reduction of landfill taxes and fines because of the decrease of quantities of unprocessed waste led to burial. 24,95 %, or 11.047,87 tones of waste were diverted from landfill in 2019, 8.412,52 tones more than 2016, a year in which we did not apply this methodology.

The environmental footprint of this effort is positive. The participation of citizens, businesses and organizations in the Municipality's activities under the philosophy of positive reward, has already significant effects and will be a bridge between the current situation and the future where, on the basis of the European waste strategy, the diversion from the landfill is a one-way street. By the year 2035, the european target is less than 10% of the solid urban waste be buried.

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