Interreg
Balkan-Mediterranean
BIOWASTE

UTILIZING "PAY AS YOU THROW SYSTEMS AND AUTONOMOUS COMPOSTING UNITS FOR BIO-WASTES MANAGEMENT IN TOURISTIC AREAS - BIOWASTE"

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ABOUT THE PROJECT

The main objective of the "Pay as You Throw" project is the application of a procedure for separating solid municipal waste from organic waste at the site of generation, mainly aiming at "Biomass" (solid food residues and plant residues). This procedure is particularly applicable for the catering sector as well as for smaller suburbs, located further from the center of the settlement.

The only way to achieve the main objective (separating organic from solid municipal waste) is to find an appropriate way to calculate the waste disposal fee created by the economic entities and households and transported to the landfill.

Determining the amount of solid waste disposal fee requires complex procedures, such as measuring the amount of waste that Public Utilitiy Company (PUC) vehicles take from households, measuring the path the waste vehicle passes in the waste disposal procedure, amount of fuel consumed during transportation, number of employees participating in the waste disposal process in the Public Utilities vehicle etc. For this purpose, the "Pay As You Throw" procure special equipment to measure the quantity of waste which are located in the container in which households and business entities dispose of waste generated. The equipment consists of a GPRS device for tracking the movement of the vehicle during waste collection, solid waste municipal bin with integrated chip, chip reader, as well as a special vehicle device that measures the weight of the waste disposal vessel.

What about the organic waste?

The project envisions separating organic from solid municipal waste. Put simply, the project is making an effort to get catering establishments and the population to begin using a waste separation procedure (solid food waste) and solid waste that will be subject to further selection before being taken to landfill. Separate waste stored in separate containers (for which the project also provided procurement) is then processed into Autonomous Composting Units, which undergoes composting and getting compost, which it will then be used to feed on a public communal area (parks, etc.). This procedure contributes to the direct reduction of waste quantities, which at this point ends up in landfill. This, given the smaller amounts of waste generated, reduces the cost of transporting it itself.

Both procedures, "Pay as You Throw Systems" and "Autonomous Composting Units", are considered the latest technology in the waste treatment process, applying innovative technology.

The need for the application of the above arises from the EU Environmental Directive, in particular the Waste Framework Directive 98/2008. A separate section of these documents requires that by 2020, 10% of organic waste from each settlement to be obtained by separation from the now mixed municipal waste structure. Introducing waste separation on the spot where it is generated, and selecting target groups that are the largest organic waste generators, is one of the possible tools to achieve the stated objective and achieve the provisions in the directives, with less resources and means than to a generally applicable scheme of major cities is applied. Like all other waste disposal methods, this project is more or less socially responsible as it relies on the voluntary participation of target groups (households and catering establishments).

This pilot project and its activities are being implemented for the first time in the municipality of Probistip, and have the potential to be replicated in other settlements, giving an increased dimension to the social and economic development of society. As a result, efforts to unify several procedures will yield a better effect than any other, individually applied procedure, providing a significant amount of data from which planning can be replicated in other settlements.

The project is based on 5 work packages: management, visibility, application of Pay as You Throw Systems, use of Autonomous Composting Units, development of Economic Efficiency and Environmental Impact Assessment studies, and Preview for possible replication of the approach and results of the project to other urban communities in Probistip.

Within the third and fourth work packages, was procured equipment for a total value of €208.388,00 whereby, for the needs of the target groups, the following were purchased: 2 containers with built-in waste chip with volume of 1.100 L, 80 containers with built-in waste chip with a capacity of 80 L, 80 containers for organic waste with a capacity of 10 L. At the same time, the equipment of the vehicle for collecting waste from the Public Utility Company has been upgraded by installing a GPRS device for monitoring the movement and measuring the fuel quantities, and thus with the amount of greenhouse gas emissions. A chip reader has been set up in the waste containers, so the system automatically detects which user generated the waste, according to which the exact amount of money it has to pay for waste disposal can be calculated.

In the fourth work package, two organic waste composting machines were purchased. One is located adjacent to the city market and will serve to recycle organic waste from the first target group - catering facilities. Thus, the remnants of

dishes served in catering establishments near this device will be collected and subjected to a composting process. In order to increase the efficiency of the machine, plant residues from the City Market will also be subject to composting, as before, instead of ending up in landfill. The second machine is set up in the decentralized Urban Community "Kalniste" in order to serve the needs of the inhabitants of this neighborhood. A total of 80 families participate in the project activity. External experts from UGD and Probistip municipality, in cooperation with the technical staff of both project teams, delivered training to the target group (80 families), familiarizing them with the project objectives, its importance, methods of operation, procedures for separation of organic waste. in households, as well as the way in which organic waste is introduced into the composting machine.

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MUNICIPAL WASTE IN THE REPUBLIC OF NORTH MACEDONIA

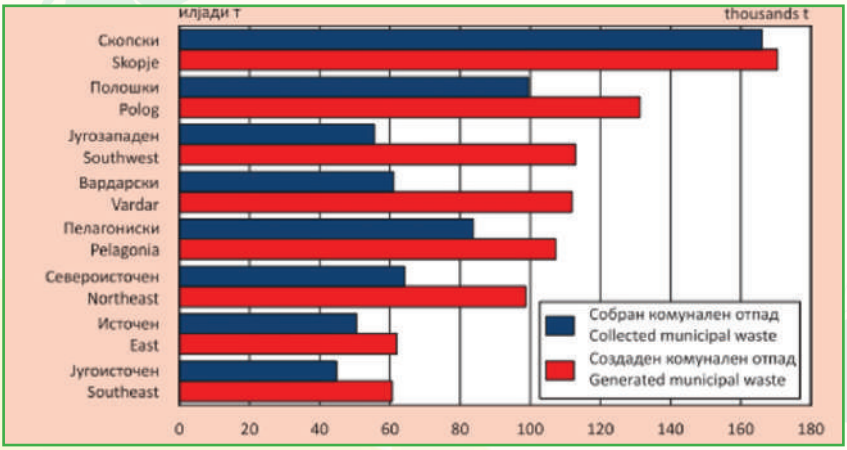
Waste is any substance or object that the creator or possessor discards, intends to discard or is required to discard. Generally, waste is divided into hazardous and non-hazardous, where there are many subcategories in the group of non-hazardous waste, and municipal waste is one of them.

Municipal waste is waste generated by individuals from households (household waste) and commercial waste. Household waste is the waste collected daily from households, as well as specially collected hazardous household waste, bulk waste, garden waste and the like. Commercial waste is any other waste generated by legal and natural persons in the performance of commercial, industrial, craft, service, administrative and similar activities, which by its nature or composition is similar to that of household waste.

Municipal solid waste is one of the main waste streams generated. About 77% of the country's population is involved in the public municipal waste collection system organized by municipalities and municipal public utilities. The waste ends up at municipal non-standard (non-sanitary) landfills throughout the country. The rest of the population (23%) that does not use utilities is mostly concentrated in rural areas, and this part of the waste ends up in smaller landfills around the country.

According to the State Statistical Office data, the total annual amount of municipal waste generated in the Republic of North Macedonia in 2018 is 854.865 tons, of which 625.386

tons are collected by municipal utilities. The annual amount of municipal waste generated in 2018 is 412 kg or 1,13 kg/day. The following figure shows the rate of generation and collection of municipal waste by regions.



Source: State Statistical Office

The largest amount of municipal waste was collected in the Skopje Region, and the smallest amount in the Southeast Region. The same is the situation with the amount of municipal waste generated.

Regarding the quantities of generated municipal waste, waste quantities can be expected to grow by 1,7% annually over the next 10-12 years, and changes in the quantities of waste from production/services/agriculture depend on the dynamics of economic development. of the state.

Municipal waste management

Waste management is one of the most serious environmental problems in Macedonia. The general waste management policy, in order to overcome the existing situation and establish a

sustainable waste management system, was formulated in the Law on Environment, in the National Environmental Action Plans (NEAP 1996/2007) and in particular in the Law on Environment. The Law on Waste Management introduces new documents in the waste management policy: Waste Management Strategy, National Waste Management Plan and Waste Management Programs.

The basic national legislation on waste management consists of the Law on Waste Management, which is a basic legal act and prescribes the general rules that apply to the basic issues related to waste and hazardous waste. The Law on Waste Management has important links with other legal acts that regulate the tasks and responsibilities regarding the organizational and operational issues in the field of waste management, in particular the Law on Environment, which contains basic provisions on environmental permits, environmental impact assessment, greenhouse gas emissions. Certain waste streams are regulated by separate laws.

Competences

The tasks and responsibilities of the Ministry of Environment and Physical Planning (MoEPP) for waste management, in addition to the preparation and adoption of legal instruments, are generally institutional: planning and policy development; registration, licensing; monitoring, data collection/management, database maintenance and reporting, and implementation monitoring.

With the decentralization process in the country, many responsibilities were delegated to municipalities. Municipalities are responsible for the management of municipal and other types of non-hazardous waste: the organization of the collection,

transportation and disposal of municipal waste; overseeing the transportation and disposal of industrial non-hazardous waste, making decisions on the location of waste management facilities, adopting local waste management regulations, financing and overseeing the closure of illegal landfills, and closing waste management facilities.

Establishing landfills for non-hazardous and inert waste is also the responsibility of municipalities; however, the issuance of permits, inspection and monitoring on environmental issues, with the exception of inert waste landfills, is the responsibility of the MoEPP.

Only a few municipalities have established waste management departments or appointments in their administrative structure.

With the waste management legislation and policy adopted, a regional waste management approach is in place. Regional municipal waste management systems are a link between state and local institutions and undertake most of their responsibilities and tasks, such as planning, investment management, public relations and the organization of other municipal waste management activities initially belonged to the municipalities, on behalf of the affiliated municipalities and their citizens, with the consent and participation of the MoEPP.

From an administrative/organizational and financial point of view, such systems will be managed by inter-municipal boards as politically representative bodies of affiliated municipalities and by the board of directors of regional waste management firms that perform municipal management, collection, remediation and disposal waste activities, and can also function as a central regional agency that will perform various professional tasks, such as planning, investment, local

regulation, organization, return, costs and financing executed in the field of waste management and environmental monitoring.

Year	Total generated municipal watse (tons)	Total municipal waste generated pre capita (kg/y.)
2014	765 156	370
2015	786 182	380
2016	796 585	384
2017	786 881	379

Table Total generated municipal waste in the Republic of North Macedonia

According to the current legislation in the field of waste management, the Mayors of municipalities are obliged to submit an annual report on non-hazardous waste management in the respective municipality to the Ministry of Environment and Physical Planning. The total amount of collected, transported municipal and other non-hazardous waste reported by the Mayors of 26 municipalities, including the City of Skopje, is 475.685,57 tons for a population of 1.197.777 citizens. Estimated on average per capita for 2018 from reported values each resident of North Macedonia generated 251 kg of municipal and other non-hazardous waste. 472.556,2 tons or 99.3% of municipal waste. Processing, including recycling, reported 2.383,97 tonnes or 0,5%, while 745,5 tonnes or 0,2% were composted. Dominant way of managing municipal and other types of non-hazardous waste is the disposal, i.e. disposal of waste at legal landfills which is 99,3%.

Only 0,7% of processed municipal and other types of non-hazardous waste are reported compared to the total generated and transported municipal and other non-hazardous waste in 2018.

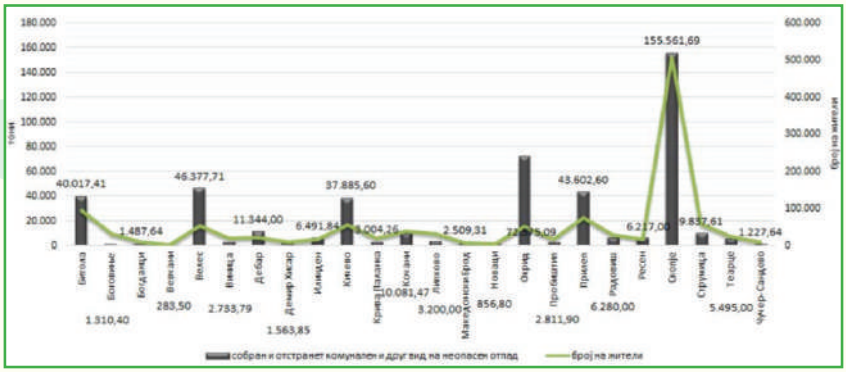


Chart-Reported, collected and transported municipal and other non-hazardous waste in certain municipalities in 2018

Collection and transportation of the waste

Collection of municipal waste is done mainly by public companies. Public utility companies in the municipalities are responsible for organizing the collection, transport and disposal of municipal waste, monitoring the transport and disposal of industrial non-hazardous waste, identifying appropriate locations for waste management facilities, issuing local regulations, financing and monitoring landfill closures. Public utilities are the main waste service providers that collect and dispose of waste. Some municipalities have established public-private partnerships with local municipal waste collection and recycling companies. Only a small proportion of waste collectors are private enterprises, usually those working with waste in rural areas. About 70% of the total population uses waste collection services, but only 10% of them in rural areas. Collection, selection and transportation of waste is insufficient in several areas to achieve compliance with existing regulations. Much of the waste is leaking, and the waste collection vehicles are very old, low capacity and often corrupt. Service users collect

mixed industrial and municipal waste, including hazardous waste fractions. Day-to-day activities are usually characterized by low productive practices and inappropriate utilization of existing resources, which does not encourage cost-effective service provision. Separate collection of municipal waste is not carried out, except for a certain amount of bulk waste in Skopje and organic waste in the municipality of Zrnovci.

Waste collection equipment and service levels are not in accordance with current requirements. Collection of non-separated fractions of municipal and non-hazardous industrial waste as well as non-hazardous and hazardous waste fractions is common practice. There are no officially licensed hazardous waste collectors and transporters.

Municipal waste selection

Most of the municipal solid waste and other collected waste is disposed of without pre-treatment of municipal landfills; Various types of non-hazardous and hazardous waste, such as scrap tires, car batteries, oil car components and other waste are disposed of at "illegal" landfills. Landfills operate without a work permit, with one exception, without any landfill techniques and without regular environmental impact monitoring. There is no record of the delivered waste, and no visual inspection of the characteristics of the waste to be disposed of. Disposal of combined hazardous and non-hazardous waste and incineration of municipal waste, plant tissue waste and outdoor plastic waste represent the most serious environmental risks and consequences. One third of the existing 51 landfills are categorized in the highest risk class according to their environmental risk assessment and their closure or remediation is a priority.

Recycling and recycling activities for municipal waste are very limited and without any organized access. Generally speaking, utilizing many types/ingredients of recyclable materials is financially unprofitable under existing conditions. By collecting and recycling materials with potential for recycling, such as metals, paper, plastics, car batteries, waste oils, and so on, the informal sector and private companies, for the most part, deal with waste placards with potential negative impacts on environment and public health.

Municipal waste not collected by official collection companies is disposed of at illegal landfills. Construction waste and rubbish are also largely disposed of in landfills; there is no separation and landfill disposal capacity for this type of waste. It is estimated that the number of illegal landfills, especially in rural municipalities, is around 1.000.

An additional problem is the traditional incineration of municipal waste, waste from plant tissue, as well as plastics from plantation or forced outdoor production; this kind of waste incineration can cause 43/106 the synthesis of highly toxic and bio-accumulative organic constituents, and uncontrolled air emissions cause ambient air pollution and long-term pollution of agricultural soils and plants.

Composition of waste municipal waste

The average waste composition in Republic of North Macedonia according to the field surveys conducted for the preparation of the National Waste Management Plan of the Republic of North Macedonia is:

Type of waste	%
Organic waste (garden and kitchen waste)	45.3
Paper	7.6
Cardboard	5.2
Composite material (tetra)	1.4
Glass	4.1
Iron	1.7
Non-ferrous metals	0.8
Plastic	2
PDPE	6.9
PET Bottles	3.2
Other plastic	1.8
Textille	4.7
Leather	1.4
Diapers	6.1
Wood	0.7
Construction waste	1.9
Waste of electrical and electronic equipment	0.4
Hazardous waste	0.4
Small particles (<10mm или <20mm)	4.4

Source: National Waste Management Plan of the Republic of North Macedonia 2018-2024

Good waste collection practices are key to proper waste management and of course a high recycling rate. Today, coverage is variable and incomplete, especially in rural areas. In urban areas, municipal waste collection coverage is around 90%, while in rural areas it varies between 15% and 70%. It is necessary for public utilities to provide 90% by 2020 and 100% by 2024 mixed municipal waste collection rates.

Metal waste

Wastes are mainly collected as recyclables. The collection of other fractions depends primarily on market conditions and is largely implemented by the informal sector. The Waste Framework Directive (2008/98/EC) requires the establishment of separate collection of paper, metal, plastic and glass which is technically, economically and environmentally viable.

Although there is no "door-to-door" waste collection, municipalities are working on waste disposal schemes at a specific location where citizens can dump waste into separate containers and waste containers. Where these procedures are introduced, special waste sorting technology will be established to obtain material suitable for further processing on the domestic and international market. The material must be eligible for export under the green list control under the EU Waste Shipment Regulation.

Biodegradable waste

No separate collection of garden or other biodegradable waste is organized. All organic waste is disposed of at a landfill. In some rural municipalities there are domestic composting initiatives.

Separate treatment of organic waste gives the opportunity to return certain nutrients and organic matter to agricultural land.

Biodegradable waste that makes up more than 1/3 of municipal waste under the Waste Framework Directive will need to be separately collected and processed/composted.

The most efficient first step, in terms of volume and easy implementation, is the composting of garden waste into the so-called "windrow system". This procedure is a feasibility study in agricultural rural areas.

Food waste composting with In-Vessel composting and digestion involves complex plants that can treat different types of waste. The aim is to remove biodegradable fraction from landfills and produce high quality compost or digestate for agricultural or horticultural application. The products can also be used in the restoration of closed landfills in the surface layers.

RDF and SRF

Production of Refuse Derived Fuel (RDF) and Solid Recovered Fuel (SRF) for renewable energy will be explored, including the use of existing combustion capacity. There are two cement kilns that can use this fuel. This approach will require the development of treatment facilities to prepare the waste.

Waste from packaging

There are about three hundred companies that have a license for packaging waste management in North Macedonia.

- Paper and board: 40 companies have storage and treatment permits. Two companies produce new products, the other sell or export.
- Metals: 87 companies have storage and treatment permits. One is a metal waste smelter, and the other sells or exports.
- Plastics: 121 companies have storage and treatment permits. Four make new products, others sell or export.
- Glass: Three companies have collection and storage permits and are exported.
- Wood: 97 companies have storage and treatment permits.

Waste Management Aims

For the Republic of North Macedonia by 31 December the following aims should be achieved:

- Recovery of 60% of packaging waste
- Recycking at least 55% of waste
- Specific packaging waste recycling:
- 40% plastic waste;
- 20% wood waste;
- 50% metal waste;
- 30% aluminium waste;
- 40% glass waste;
- 70% paper and cardboard waste.

Reduction of generated municipal waste

The reduction in the amount of municipal waste and its potential hazard at the source can be achieved by:

- stimulating multiple use of the primary packaging;
- composting of the biodegradable fraction of household waste when it is acceptable in settlements and use of compost in gardens;
- composting of green waste from public and private green areas, such as parks, gardens, orchards, nurseries;
- separate collection of hazardous constituents of municipal waste and handover of the system for their recovery.

The more successful reduction of hazardous constituents in municipal waste depends, to a large extent, on the smaller quantity of hazardous constituents in products and packaging that are placed on the market.

Recycling of municipal and other non-hazardous waste

The mayors of nine municipalities, including the City of Skopje, including Makedonski Brod, Bitola, Ohrid, Vinica, Resen, Kriva Palanka, Veles and Prilep, reported 3.129,47 tonnes of processed municipal and other non-hazardous waste in 2018. Expressed as a percentage it is 0,7% of the total reported, collected and transported municipal and other non-hazardous waste in 2018. Of the reported quantities of processed waste 2.383,97 tonnes is recycled paper, cardboard, plastic, glass and metals, and 745,5 tonnes of waste is composted.

		Quantity (tones)	%
Processed municipal and other non-hazardous waste	Removed municipal and other non-hazardous waste	472.556,1	99,3
	Composted waste	745,5	0,7
	Recyced paper, cardboard, glass, plastic and metal	2.383,97	

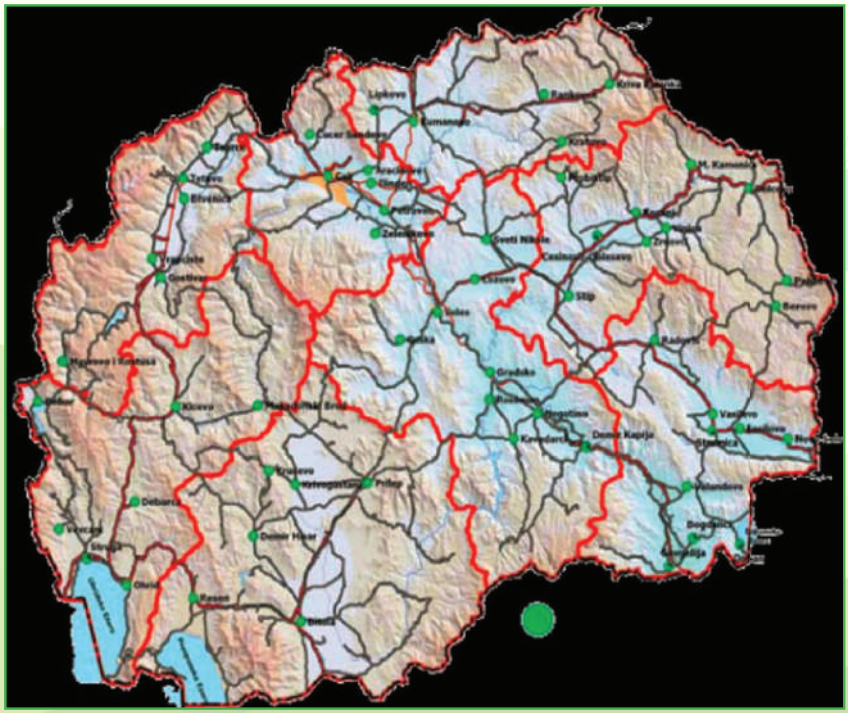
Table 1. Display of disposed and rocessed municipal and other non-hazardous waste

Disposal

In 2016, the total landfill of all landfills is 610.227 tons with a total area of 2.443.000 m^2.

From the map shown below it can be seen that almost every municipality has its own non-standard landfill, ie. there are a total of 43 municipal "active" landfills or by regions:

	Number	Total surface (thousand m²)	Active surface (thousand m²)
Total	43	2433	1166
Vardar region	7	634	241
East region	9	252	141
Southwest region	6	222	201
Southeast region	7	416	306
Pelagonia region	7	76	44
Polog region	1	12	9
Northeast region	5	271	164
Skopje region	1	550	60



Waste management in the municipality of Probistip

Waste collection, transportation and disposal is done by the Public Utility Company "Nikola Karev" by depositing the waste at the municipal non-standard landfill near the city. The landfill does not comply with the requirements of national and EU

legislation. According to available data, there are 22 landfills on the territory of the Municipality of Probistip, especially in rural areas not covered by the waste collection system.

Public Utility Company (PUC)

Currently, the municipality has overall responsibility for waste management, and PCE is the main provider of waste management services, which performs daily waste collection and disposal at a landfill. The Public Utility Company (PUC) responsible for waste collection and disposal in the municipality of Probistip is PUC "Nikola Karev".

The following table gives an overview of the scope of waste collection in the municipality of Probistip.

Table Coverage with waste collection

Billing area (%)	Probistip
Served population (%)	90
Total population	15480
Urban population (%)	67
Rural population (%)	33
Urban population - number of inhabitants	10372
Rural population - number of inhabitiants	5108
Total served population	13932
Urban served population (%)	67
Rural served population (%)	33

Waste generation and composition

Annually, about 3.300 tonnes of waste is generated in the municipality of Probistip.

The average waste generation per capita is 0,296 t/capita/year.

The following table shows the percentage share of individual waste fractions in the total waste generated in the municipality.

Table: Average waste composition

Waste category	%
Garden waste	27,81
Other biodegradable waste	28,56
Paper	4,46
Cardboard	3,5
Glass	2,27
Metals (black)	0,17
Aluminium (non-ferrous)	0,11
Tetra	0,9
Packaging waste (plastic)	1,14
Plastic bags	7,88
PET bottles	2,14
Other plastic	1,3
Textile	4,55
Leather	0,56
Diapers	3,37
Wood	0
Building materials and demolition materials	1,51
Waste from electrical and electronic equipment	0,01
Dangerous substances	0,08
Fraction (<20 mm)	9,69

- Share of biowaste in total waste: 56,37%
- Waste generation index is: 0,296 t/year or 0,81 kg/day
- Waste handling tariff (PUC): 2,4 MKD/m^2/year (for households), 5 MKD for others

Collection of the waste

Municipal waste is collected with two types of collectors, 120 L household plastic containers and 1,1 m^3 containers for collective living facilities.

The waste is collected by several specialized waste collection vehicles of a public utility company with a capacity of 8, 10 and 16 m^3, as well as a tractor. The PUC is expected to receive one vehicle of 10 m^3 and one of 4 m^3 in the near future.

Local non-standard landfill

The final disposal site of the municipal waste is located in Neokazi settlement, Ozren. This non-standard landfill covers an area of 35.000 m^2 with estimates of total landfill of approximately 353.846 m^3 on which PUC "Nikola Karev" disposes of the waste.

Landfills

According to available data, there are 22 uncontrolled (illegal) landfills, especially in rural areas. The following table shows the main characteristics of uncontrolled landfills (area, volume, etc.).

Table: Wild dumps

Settlement	Surface (m^2)	Volume (m^3)	Priority over required measures			Priority over time of measures envisaged		
			Direct rehabilitation investigation	Additional investigation	Additional investigation and monitoring	Short term	Medium	Long term
Probistip	2500	6250	✓					✓
Buciste	100	30	✓					✓
Gajranci	10	5	✓					✓
G. Stubol	10	20	✓					✓
Dobrevo	50	50	✓					✓
Dobrevo	40	60	✓					✓
D. Stubol	25	25	✓					✓
Kundino	14	28	✓					✓
Lezovo	20	40	✓					✓
Pisica	50	25	✓					✓
Plesenci	50	25	✓					✓
Strmos (Красно село)	20	20	✓					✓
Strmos (River)	50	50	✓					✓
Стрмош (White stone)	50	250	✓					✓
Zletovo (bridge)	10	15		✓				✓
Zletovo (турско рипување)	40	80		✓				✓
Zletovo (upper neighborhood)	50	250		✓				✓
Zletovo (bridge Tursko rudari)	100	50		✓				✓
Bunes	24	36	✓					✓
Dreveno	8	64	✓					✓
Ratavica	150	150	✓					✓
Tripatanci	50	50	✓					✓

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SYSTEM „PAY AS YOU THROW"

(Excerpt from: "Brochure on Project Goals, Activities and Outcomes")

Introduction

The waste management policy in the Republic of North Macedonia is set out in the Waste Management Strategy 2008-2020, the National Waste Management Plan 2009 - 2015 and the relevant waste management programs at central and local level plans and programs. Waste management in the Republic of North Macedonia is regulated by the Law on Waste Management (Official Gazette of RM) No. 68/04, 71/04, 71/04, 107/07, 102/08, 134/08, 09/11, 123/12, 147/13, 163/13, 51/15, 146/15, 156/15, 192/15, 29/16 and 63/16). The management of special waste streams is regulated by special laws (packaging and packaging waste, electrical and electronic equipment and waste electrical and electronic equipment, batteries and accumulators, and waste batteries and accumulators).

Solid waste management remains a significant problem for all Balkan and Mediterranean countries, under constant pressure from relevant EU legislation, but equally important under public pressure. In general, waste management services in the country do not comply with national and international regulations. They are incomplete, contain only inefficient collection and poorly controlled or uncontrolled landfill, with no additional elements of advanced waste management as defined in EU waste directives. The poor quality of waste collection services

is due to outdated and partially inadequate collection vehicles, poor location and waste collection facilities, poor human and financial resource management, poor performance (and cost) monitoring, etc.

In the Republic of North Macedonia, it may be problematic that dualism of methodologies exist i.e. methodology for charging for waste collection per square meter of housing is still in use instead of charging per kilogram of waste produced as is the practice in European countries.

The Waste Directive (98/2008), i.e. the updated national waste disposal legislation sets a number of very ambitious targets, both in terms of mixed municipal waste collection and in the specific collection, selection and recycling of waste. Special emphasis is placed on organic waste ie. separation of bio-waste to be recycled at the source of generation and implementation of a system that would allow users to pay only for the amount of waste they dump on landfill.

Waste management policies include a range of additional measures such as regulatory, economic, educational and information instruments. The purpose of the economic instrument is to persuade waste producers to direct landfill or incineration towards recycling of materials in order to optimize the use of resources while contributing to the reduction of waste management service costs.

Economic instruments are implemented through national or regional waste policies, such as taxes on waste disposal, by-laws, deposit refund schemes, extended liability of major waste producers, trading permits, recycling subsidies, tax exemptions value added (VAT), etc. Most of these measures fall within the scope of local governments.

However, in the context of municipal-level solid waste management, the PAYT approach is an economic instrument that is applicable at the municipal level by charging residents according to the amount of waste they produce.

The technical implementation of the PAYT approach is based on the following three pillars: waste producer identification, waste quantity measurement and disposal cost (e.g. per kilogram and/or discharge). Experience so far shows that the waste tax should not only depend on the amount of waste generated, but should consist of a basic and variable fee. On the one hand, this reflects the structure of waste disposal costs, which consists of fixed and variable costs, and on the other hand, the inclusion of a fixed (basic) tax helps to avoid illegal dumping practices that may increase if fees are payed only on the collected quantities of waste.

Figure 1 shows the conventional structure of the waste allowance, with the single components referring to weight-based fees only.

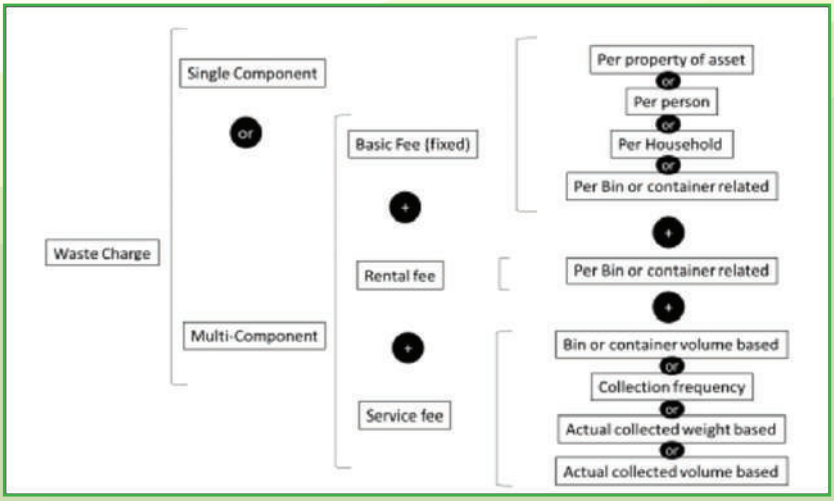


Figure 1 - Possible components of waste compensation

The PAYT approach means that a significant portion of the overall fee is distributed according to the amount of waste collected to motivate waste selection and recycling.

1. Waste selection

Supporting and expanding the organic waste selection schemes in the environments where it originates (source of origin) is the only way to meet the objectives of the Waste Framework Directive, regardless of which treatment technology will be used after sorting. Since, at this point, in all the Balkan countries the waste selection schemes do not include organic waste, there is an obvious need for appropriate action in that direction. The biggest problem that all municipalities will face is the readiness of the general public to participate in the primary selection of organic waste. This means that citizens will have to separate organic waste from other municipal waste and treat it in their immediate vicinity (e.g. to compost it in different types of composters). However, most municipalities in the Balkans do not have such waste treatment facilities.

When talking about the beginnings of such activities, it may be best to start with the larger generators of this type of waste. Catering facilities, hotels and restaurants have the following characteristics:

a) generate large amounts of organic waste in their kitchens and places of service;
b) professionals deal with waste, not the general public;
c) some hotels and restaurants implement waste selection schemes at the site of generation due to HACCP and ISO regulations;
d) pay high amounts to municipalities for waste management,

which is not correlated with the amount of waste they generate; and

e) consider recycling an important promotional tool that makes their company socially responsible and environmentally friendly.

The generation waste selection schemes that focus on precisely these facilities can help achieve the required goals with much less resources and effort, but should never minimize the need to involve individual households in this process that actually is also the ultimate goal of the waste directive (98/2008).

2. Pay As You Throw - PAYT

PAYT the system or "Pay As you Throw" may be an additional incentive to reduce the waste management costs created in hotels and households. In this context, the selection scheme may be complemented by the addition of autonomous composting units (ACUs) for the processing of collected organic waste on site, ie. in the environments where it is created. The selection and recycling of waste at the point of generation for catering facilities and households, supported by the PAYT and ACU organic fraction treatment system, is exactly what the BIOWASTE project aims to do with the municipalities involved, in Greece, Cyprus and the Republic of North Macedonia. The innovative nature of the project is also linked to PAYT and ACU as they are considered the most modern in terms of management and treatment. The experience, knowledge, information and data collected from the realization of the BIOWASTE project will be important for all tourism municipalities on the Balkan Peninsula and the Mediterranean region. Finally, the implementation of BIOWASTE can be significant for many municipalities comprised

of small and isolated communities, for which waste collection costs are sometimes twice as high as those in urban areas.

In this concept, the municipal waste selection scheme is specifically designed for the catering sector and small/decentralized communities and is geared towards biodegradable waste (food waste, food waste and green waste). The main objective is to achieve a quality separation of biodegradable waste from other municipal waste as well as its appropriate treatment at a specific location. The "Pay As You Throw" system (hereinafter PAYT) uses specially designed weighing equipment built into the waste collection trucks and bins with chips.

This allows for a direct correlation of each waste producer with the quantities it generates you get accurate data on the amount of mixed waste that each hotel, restaurant or household produces. The scheme for collecting and processing the data used is shown in Figure 2.

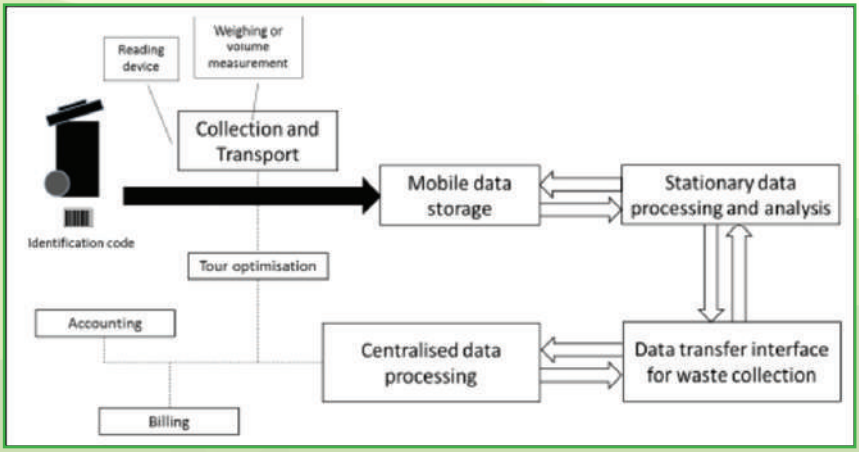


Figure 2 - Process identification scheme for electronic identification and data transfer for bin identification

All bins and containers should be encoded, and the pickup trucks are equipped with a reading device and a measuring device. The data is transferred to the central facility via real-time telemetry, where end-user processing, accounting and billing appear. It also uses the data collected to measure the economic efficiency of the system and to optimize system logistics.

Figure 3 shows a waste collection truck equipped with a waste identification system and a weight measurement system, which requires regular maintenance and calibration due to vibrations during truck operation.

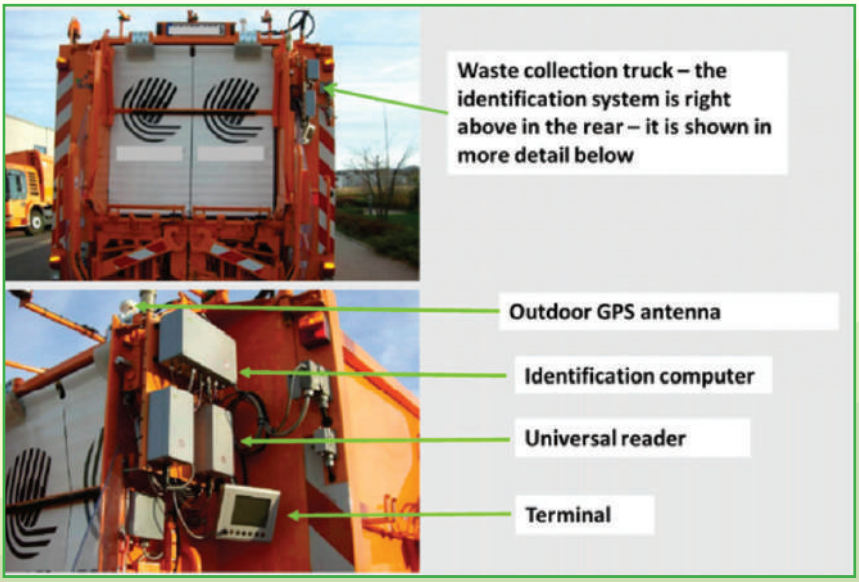


Figure 3 - Waste collection truck equipped with identification system

As for organic waste, they are collected separately and introduced into the Autonomous Composting Unit (ACU) and composted on-site, thereby reducing collection and

transportation costs, treatment costs in the central unit (if any) and enable the production of high quality usable product (compost).

PAYT and ACU are considered the most advanced in the waste management process, including innovative technologies. The need for all of the above stems from the legal requirements of European environmental legislation and specifically the Waste Framework Directive (98/2008). Specifically with regard to organic waste, the objective set by the 2020 Directive is to collect and process 10% of the organic waste produced in each municipality.

For the proper implementation of the PAYT system in the municipalities, the operational capability of the waste management authorities must be upgraded. PAYT has well-developed logistics systems that incorporate GIS and GPS technologies.

In the PAYT metering system, each bin when weighed is measured and recognized. Each bin is associated with a particular family, restaurant or hotel and has an identification code. To identify and measure bins, data from vehicle telematics (Remote Useful Data Transfer), bin identification equipment and weight sensors are required.

Implementation of the PAYT system will enable users to separate organic waste from other waste (organic waste is treated in the ACU in their immediate vicinity), and the remaining waste that will end up in the dumped bin can be accurately measured. and allows the user to pay only for what is dumped in the truck and transported to landfill. Given that in the municipality of Probistip organic waste accounts for about 40% of total municipal waste, it can be easily concluded that if

users properly use PAYT and ACU they can significantly reduce the waste bill.

3. Specification of the equipment used in the PAYT system

Required equipment procured in the Municipality of Probistip for implementation of the PAYT system covers a wide range of temporary storage systems (bins and containers), adaptation of a waste collection vehicle fitted with a bin weighing device, telematics equipment and waste identification equipment, as well as bins with identification chips.

Recommended equipment for hotels and restaurants

Equipment for temporary storage of organic waste in hotels are bins or containers. Bins are usually located inside the hotel, usually in the kitchen. In addition, it is a good idea to obtain food waste collection bags, which need to be made of biodegradable material and adapted to be sufficient to store waste for at least two days.

The bins used in the kitchen are 80 L plastic or stainless steel and should be easy to clean.

In addition, hotels and restaurants have also been provided containers of 1.100 L for non-compostable waste and should be chipped for identification by the PAYT system. These containers will be placed outside and their weight will be measured and recorded.

Recommended equipment for households

Temporary Household Storage (TCE) equipment comprises compostable bags and bins, usually located indoors. For indoor use, a small 10 L bucket is recommended. These baskets also

have a handle for easy removal of their contents. In addition, household chips are also used with plastic chips with a capacity of 80 L for non-compostable waste. Bins are set outside and their weight will be measured and recorded.

Equipment for measurement system

In the PAYT measurement system, each bin when weighed is measured and recognized. Each bin is associated with a particular family, restaurant or hotel and has an identification code. To identify and measure bins, vehicle telematics, weight and bin identification equipment and weight sensors are required.

3.1. Weight measurement, telematics and waste identification equipment

Telematics equipment for vehicles

The vehicle tracking device must be approved by CE certification. The device has LED status, SIM card slot and GPS/GSM antenna jack. The device must use GPS system to continuously calculate vehicle position and 3G/GPRS for mobile communications. Its small size should allow it to be installed on any type of vehicle, while the unit should be kept hidden in invisible parts of the vehicle.

Its key features include:

- Small size - flexibility in installation;
- Telecommunications with mobile operators via GPRS, SMS, CSD;
- Built-in GPS receiver mounted at an unobtrusive location;
- Fully programmable to cover each application;
- Ability to send messages in real time;
- Wireless programming switching (over the air via GPRS).

The vehicle tracking device operates with a power supply of between 5, 10 and 30 volts. Thus, there will be no need for external voltage transformers for vehicle application (passenger or professional). The device should have status indicators. The GPS will calculate the position of the vehicle every second. The information is transmitted to the central processor and used according to the application requirements. The need for a small size GPS-GSM (tracking device and antennas) allows it to be fitted to any vehicle. More digital inputs need to be programmed.

This unit can monitor different sensors or devices such as:

- Emergency button,
- Contact with magnetic doors,
- Collision sensor,
- Engine start sensor.

In addition, the device should have a built-in battery that is constantly monitored on the GPS receiver status switch, as well as the main power supply.

Equipment for weight identification of the bins

The bin-weight identification system uses state-of-the-art technologies to identify the electronic identity of each waste bin as well as to measure the weight during the collection of the waste with the waste collection truck.

The vehicle is equipped with an RFID reader, measuring sensors and data control unit, which is directly connected to the vehicle's telematics device (GPS/GPRS) to send recorded data to the central management application.

RFID chips are mounted on waste bins whose weight is measured and must be specially designed to work outdoors. During waste collection, the bin is automatically weighed and its

electronic identity is recorded by the RFID reader. Subsequently, position, weight and identity data (time-marked event) are sent to the control center where they are stored in the database for further processing and display on a digital map.

RFID chips should be passive (without battery) to ensure their maximum possible life and maintenance. In addition, they should be suitable for operation in particularly difficult conditions, such as those common in public waste collection services. In particular, they are required to be resistant to impacts/vibrations, UV, water and chemicals that can be used to wash bins.

All waste bin measurement and identification equipment (chip, antenna, tags and weight measuring sensors) are required to be specially designed for outdoor use, with degree of protection against input IP65/68 (depending on position and exposure of outdoor conditions) and should be able to operate at temperatures from -20 °C to +75 °C. Especially for RFID readers, technical specifications for exposure to extreme conditions (if available) should be mentioned, as waste bins are constantly exposed to harsh and uncontrolled conditions.

The range of RFID chips from the reader antenna needs to be at least 2 m to ensure successful identification of waste bins without problems.

Weighing is performed automatically when the waste is lifted without requiring further action by staff. The measuring equipment should consist of modules/sensors described in the following sub-chapters.

Module for communication and signal processing

The module for communication and signal processing is the core of the system. It collects sensor data and uses a specially designed algorithm to calculate the weight of the waste, while controlling the RFID reader. Finally, it transmits all data (waste weight and identity) from the vehicle's telematics unit in real time. In addition, the unit should be able to self-diagnose peripheral fault and inform the control center of these defects, enabling the measuring system to be timely and to increase its reliability.

Measuring sensors

Measurement sensors are used to calculate the weight of waste during bin collection. All of these parameters should be taken into account to compensate for changes in sensor readings as a result of external environmental conditions, e.g. tilting the vehicle, minimizing weight measurement error.

All sensors are robust, industrial, specially designed and manufactured for outdoor use. They must operate safely under extremely harsh environmental conditions (extreme temperatures, vibrations, shocks, water penetration) and have high electrical surge protection, reversed polarity and electromagnetic protection. Also, they should not include any mobile parts, thus minimizing system maintenance requirements.

The method of measurement must be reliable and the installation of all individual devices must be carried out with the least possible disruption to the existing upgrade of the waste collection truck, so as not to interfere with the operation

of the vehicle. In any event, eventual damage to the metering system, electrical or mechanical, should not cause the vehicle to fail to carry out the waste collection program. Sensors should be carefully installed in locations protected from any potential external impacts.

An important advantage of the measuring system is its ability to easily calibrate and adjust, a process indispensable for all measuring machines. The system is required to be frequently calibrated by technical personnel without the use of specialized electronic or other equipment.

3.2. Plastic waste bins

Appropriate waste collection bins procured for implementation of PAYT system in Probistip Municipality.

Bins for households without wheels

The bins used in households or kitchens for the classification and collection of organic waste are made of high quality raw materials, according to the most stringent industry rules and according to ISO 14001 - ISO 9000. Their capacity is 10 L. The bucket has a smaller removable handle with a handle that provides hygienic conditions and is easy to use.

Figure 4 - Small organic waste selection bins

Bins with two wheels

Bins of 80 L capacity, consisting of a main body and cover, must be fitted with two wheels with a fixed angle of Φ200mm. It must be designed in accordance with European specifications EN-840-1.

The material is high density polyethylene of excellent quality of at least 3 mm (body) and 4 mm (bottom), enriched with special additives that effectively protect against sudden temperature changes (cold or heat), chemical effects of solar radiation. The wheel axle must be made of high strength galvanized steel. The wheels have an outer hose that allows for easy, comfortable and quiet movement. The cover will be firmly attached to the main unit with special connectors fitted with handles, ergonomically positioned to facilitate discharge opening.

Figure 5 - Chipped plastic containers with a capacity of 80 L

The main body is made of monoblock and is specially designed to be free of deformation. Its design (shape, rounded surfaces) and perfectly smooth inner surface guarantee the cleanliness and hygienic use of the bucket even when plastic bags are not used. The carrier handle must be ergonomic to allow easy transport. The lid must be specially reinforced to have a long service life and allow easy adhesion to the lift standard. Both wheels must provide easy and comfortable movement even on slopes or stairs. The shaft must only be secured and opened using special tools. At the bottom of the bucket there is a special hole for draining the liquids after cleaning the bucket. This hole should be covered with a special cap that will be absolutely sealed. They should be equipped with a chip. The jeep must be protected and almost invisible.

The waste bin has ISO 9000 quality assurance certificates, quality control certificates and ELOT equivalent to EU countries. According to EN 840, as well as the CE safety certificate, all metal elements should be galvanized.

Large plastic wheel bins (Containers)

Mechanical collection bins follow STANDARD EN 840-2, 5, 6 and are purchased to accept hotel and restaurant waste. Bins capacity is at least 1.100 L, as evidenced by the product test analytical report on the EN-840 quality certificate.

On the side surfaces of the bucket and approximately in their center are two cylindrical tubes which are used to suspend the bucket from the bucket discharge mechanism. The bucket also has the necessary handles for easy movement and ergonomic use.

They must have absolute resistance to very low and very high temperatures, climate change (and even extreme) and chemical reactions. The weight of the bucket will be approximately 50-55 kg and the body thickness approximately 5 mm.

The main body of the bucket is of pyramidal shape, with increasing cross section, ensuring that it is completely drained from the material by sliding it into the lifting device. They should be equipped with a chip. The chip must be protected and almost invisible.

Figure 6 - Chipped plastic bins (containers) with a capacity of 1.100 L

Due to the weight of the materials it contains during transport and its discharge, the main body of the four-sided bin should be specially reinforced to avoid deformation of the walls during use.

The bucket has four heavy duty tires of optimum design with a diameter of at least Φ200 and a rotating 360° vertical axis so the bucket is flexible if it is to be moved in tight places. Each bucket will be immobilized with separate foot brakes on both wheels that are activated by simply pressing with the foot.

At the bottom of the bucket there must be a special hole for draining liquids after cleaning the bucket. This hole must be covered with a special lid and specially covered so that it is absolutely sealed.

Conclusion

Implementation of PAYT is a very good practice for municipal waste management, as the waste collection system by weight provides the opportunity to achieve high rates of separated and recycled organic waste in the waste source area itself. Improving the efficiency of the selection and recycling process of organic waste is a priority for EU Member States, and helps to adhere to comprehensive recycling norms for 65% of municipal waste and 75% of packaging waste by 2030, according to the new objectives in the proposed waste directive.

Implementation of the PAYT schemes, together with the development of appropriate infrastructure, awareness-raising of citizens and other recycling technologies policies, will help to achieve such objectives as required by the waste management directives. So far research shows that other types of waste collection have so far failed to achieve the same levels of organic waste recycling, in the environment where they are created, as the PAYT system has been.

Marija HADZI NIKOLOVA, PhD

AUTONOMOUS COMPOSTING UNITS FOR MANAGEMENT OF BIODEGRADABLE WASTE

Sustainable ways of waste management (reduction, reuse and recycling) contribute to reduced waste generation, reduced consumption of natural resources (material and energy) and provide recycling of matter and energy in nature. On the contrary, with the unsustainable ways of waste management (landfill and incineration), the materials contained therein, as well as the energy used to generate it, are irreversibly lost and additional environmental pollutants are created.

Sustainable ways of waste management point out that items that are no longer needed, even those that have lost their use value, are not just unnecessary garbage that we need to get rid of forever. They all contain valuable resources that can be reused. Thus, not only do we not pollute the environment with waste, but we also prevent the rapid use of limited quantities of natural resources and close the circular flow of matter and energy in nature, which has long been disrupted by humans.

Waste Landfill Directive

The Waste Landfill Directive 1999/31/EC aims to provide high standards for waste disposal in EU Member States and to stimulate waste prevention by composting biodegradable waste as well as recycling. The Directive includes provisions to

reduce the disposal of biodegradable waste in order to avoid adverse environmental impacts including:

- Reducing the creation of landfill gas that contributes to the intensification of the greenhouse effect, ie contributes to climate change;
- Reducing the creation of landfill gas that contributes to the intensification of the greenhouse effect, ie contributes to climate change;.

Article 5 (1) of the Directive covers the objectives of diverting biodegradable waste from landfills, requiring the promotion of waste selection, the recycling of materials and the recovery of energy.

For Member States that have not introduced such guidelines, achieving the objectives of the Directive poses a challenge to local authorities and the industry for sustainable waste management and the development of alternative biodegradable waste management schemes that will provide environmental benefits in an economical way. The best way to manage biodegradable waste is to select it at the site of its generation and composting, with both centralized and decentralized biodegradable waste composting schemes equally effective.

For Member States that have not introduced such guidelines, achieving the objectives of the Directive poses a challenge to local authorities and the industry for sustainable waste management and the development of alternative biodegradable waste management schemes that will provide environmental benefits in an economical way. The best way to manage biodegradable waste is to select it at the site of its generation and composting, with both centralized and decentralized biodegradable waste composting schemes equally effective.

Solid waste management is a significant problem for the Republic of North Macedonia, especially at a time when the country is making significant steps towards EU accession. Despite the harmonized national legislation, little has been achieved in the field of harmonization with numerous EU Directives or Regulations, and in particular with the Waste Framework Directive (98/2008), which sets a number of very ambitious targets, in particular organic waste (food waste and garden waste). The objective set by Directive 98/2008 for 2020 is that 10% of the organic waste produced in each municipality be selected and appropriately treated. But until now, the process of selecting waste at the site of its creation has not yet started in the Republic of North Macedonia.

The current waste management system in the Republic of North Macedonia primarily focuses on waste collection and disposal at landfills. There are 55 municipal landfills, officially provided by the utilities and only one sanitary landfill in accordance with the minimum requirements of relevant EU legislation. In addition, there are about 1.000 smaller illegal landfills across the country, created by locals in rural areas who receive no waste collection service. The National Waste Management Strategy envisions the establishment of 5-7 regional landfills according to EU standards. On October 20, 2009, the Government adopted a Decision Establishing an Integrated Waste Management System in the East and North-East Region through Public Financing.

In order to raise the awareness of the local population about the need for waste selection and its appropriate treatment at the end of 2017 and the beginning of 2018 in the municipality of Probistip started the realization of the project Using the

system "PAY AS YOU THROW" and Autonomous Composting Units (ACU) on Biodegradable Waste Management, a project co-financed by the European Union and National Funds of the participating countries.

The main objectives of the Project are:

- transfer and application of innovative technologies (Autonomous Composting Units);
- Introducing the possibility of creating organic fertilizer - compost from organic waste of the local population, catering enterprises and local government in order to reduce greenhouse gas emissions and protect the environment;
- raising awareness among locals that they can make money from what they now consider to be waste;
- reducing the amount of waste that is dumped on landfill;
- reducing the cost of transporting waste to landfill;
- reducing the price that households and catering companies pay for the disposal of municipal waste;

Bio-waste, according to the Waste Framework Directive (98/2008), is biodegradable waste that includes food waste from households, restaurants, catering facilities and food processing plants, as well as garden waste.

Biodegradable waste is actually one of the "most polluting" fractions in total waste streams, and composting redirects waste from traditional ways of management, such as incineration and landfilling. As one of the largest household and catering waste fractions, selecting and diverting organic waste from a landfill to the ACU can significantly contribute to meeting local recycling targets.

Types of waste targeted to composting schemes

All composting schemes are aimed at biodegradable waste fractions from households and catering (hotels and restaurants) as major generators of this type of waste which include: waste and food residues and garden waste such as grass, branches and leaves (picture 1).

Biodegradable waste is waste that can be easily degraded by the action of microorganisms in the presence of oxygen. Without proper management, this waste causes multiple negative environmental impacts. Therefore, composting, as a method of decomposing biodegradable waste, is the best low cost alternative to overcome this problem.

Figure 1 - Compostable waste

Having in mind that the largest generators of organic waste are catering facilities and households, 2 Autonomous

Composting Units, each with a capacity of 60 t/year have been procured for the realization of the project in Probistip (Figure 2). One composting machine for hotels and restaurants is set in the immediate vicinity of the city's Green market, and the second one for households is set in the Kalniste Urban Community. The project includes two larger hotels ("San Niko" and "Cresovo Topce" and other smaller restaurants), as well as 80 households from UC Kalniste.

To select the waste, 80 households were given 10 L bin for collection of biodegradable waste and 80 L chipped bin for the remaining waste. The population received training on proper waste selection and use of the Autonomous Composting Unit. Autonomous composting units greatly facilitate the traditional way of composting at home.

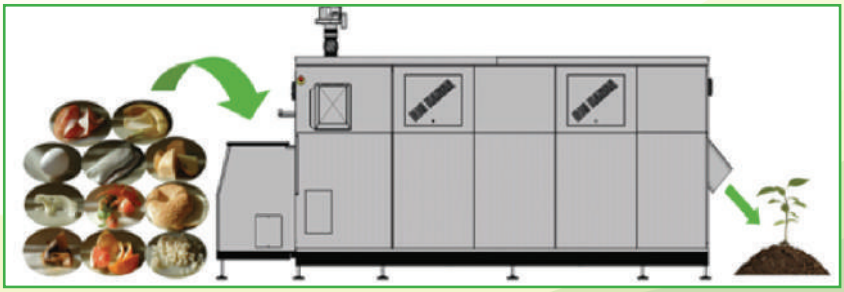


Figure 2 - Autonomous Composting Unit

The successful diversion of landfill biodegradable waste relies on the selection of this type of waste at the site of its generation. If biodegradable waste is not selected from mixed waste at the site of its generation, its further separation is a labor-intensive task and results in additional costs. Source waste selection offers the opportunity for high quality "clean"

composting waste and the opportunity to obtain a high quality compost product. "Clean" waste collected through site selection is more likely to meet the standards for obtaining quality compost that will be suitable for sale or use, benefiting the environment as well.

Composting unites the three sustainable ways of waste management, i.e. it contributes to the reduction of waste (reduction), reuse and recycling of waste. In fact, composting was one of the oldest ways to recycle waste and get high quality organic fertilizer - compost. Composting is a natural process of decomposing organic matter into a final product called COMPOST (Figure 3).

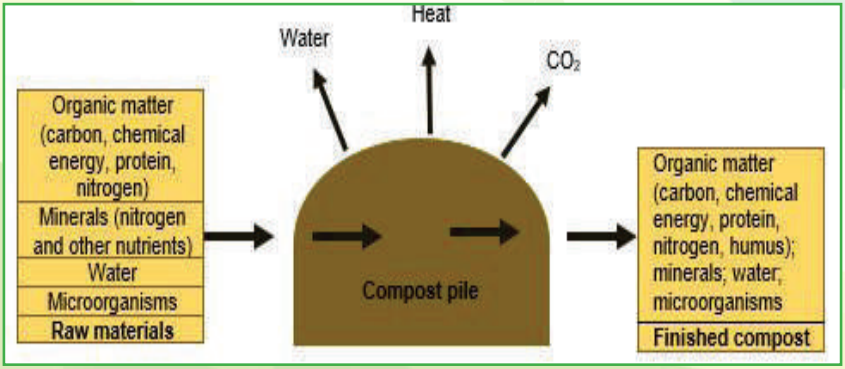


Figure 3 - Schematic representation of the composting process

The composting process enables:

- efficient recycling of organic matter (figure 4) ,
- reduction of the quantities of waste carried to landfills,
- the creation of natural fertilizer used in the production of healthier foods,
- significant economic impact - reduction of transport costs and waste to landfill,
- which, as mentioned, are the basic goals of the Project.

Figure 4 - Circling the state of matter

The application of compost is repeatedly useful. Its most important role is to enrich the soil with organic matter, which is a food for living organisms, enhances its quality and stability.

Compost:

- nourishes plants
- allows better soil aeration
- retains water, has increased capacity for moisture retention
- reduces erosion

For this reason, compost should be used wherever possible in: orchards, gardens, nurseries, parks, green areas...

Why to compost?

Saving

- Compost is a quality organic fertilizer that is free of charge.

Protecting the environment

- By composting the amount of waste that ends up in landfills can be reduced by 1/3!
- Decrease in landfill gas production contributing to intensification of greenhouse effect ie climate change!

- Groundwater pollution is reduced by preventing wastewater draining fluids!
- Compost improves soil structure and prevents it from drying out!
- Compost reduces soil erosion!

Parameters affecting the composting process

The most important parameters affecting and contributing to the efficiency of the composting process and obtaining quality compost are: temperature, moisture content, carbon and nitrogen component ratio (C:N) and pH in the waste material. Optimal sizes of these parameters for the efficiency of the composting process are: carbon and nitrogen component (C:N) ratio of 20:1 and 30:1, moisture content between 40% and 70%, available oxygen concentration greater than 5%, pH 5,5 - 8,5.

The carbon component of organic waste in the composting process determines whether mineralization will occur or nitrogen immobilization will occur. Mineralization is the process of converting organic nitrogen into mineral forms (ie ammonium and nitrate); Immobilization is the incorporation of nitrogen into the biomass. If the C:N ratio is greater than 20:1, the microorganisms will immobilize the nitrogen in the biomass. If the C:N ratio is less than 20:1, nitrogen can turn into ammonia, a gas that is released into the atmosphere causing an unpleasant odor. In general, food waste is rich in nitrogen, while garden waste (leaves and branches) is carbon-rich. The complexity of carbon compounds also affects the rate of decomposition of organic waste. The waste from fruits and vegetables is easily

degraded because it contains mostly sugars and starches. In contrast, leaves, branches, tree bark decompose more slowly because they contain cellulose, hemicellulose and lignin.

The low moisture content prevents the composting process because microorganisms need water. The moisture content also regulates the temperature. A moisture content higher than 70% means that the compost has a higher water content than air (oxygen), leading to anaerobic conditions.

The air temperature that enters the composting machine has a great influence on the activity of the microorganisms in the composting material, and hence on the degree of its decomposition. In temperate climates, the composting process occurs most rapidly from spring to autumn, while in winter the activity of microorganisms can be delayed. Because of this, the Autonomous Composting Units also have a heater that warms the air temperature that enters the cylinder in which the waste material in the ACU is stored during the winter. The function of the heater is to heat the air entering the ACU at a temperature above 10-15 °C.

Considering that the waste from restaurants and households is composed mainly of food residues, ie it contains more nitrogen, to maintain the ratio of carbon and nitrogen within the recommended range, pellets are added in addition to the waste in the composters to increase the carbon content.The pellets also have the function of absorbent material, that is, they regulate the moisture content of the material in the compost

The autonomous composters have two humidity and temperature sensors (Figure 5). One humidity sensor shows the volume content of water (VWC) in the material in the cylinder of the compressor (marked in brown), and the other sensor shows the relative humidity of the cylinder (shown in blue). Temperature sensors indicate the temperature of the air entering the cylinder (16 °C) and the temperature of the air leaving the cylinder (19 °C). In addition there are sensors that indicate the temperature of the waste material in the three stages of decomposition of the material in the cylinder (Figure 6).

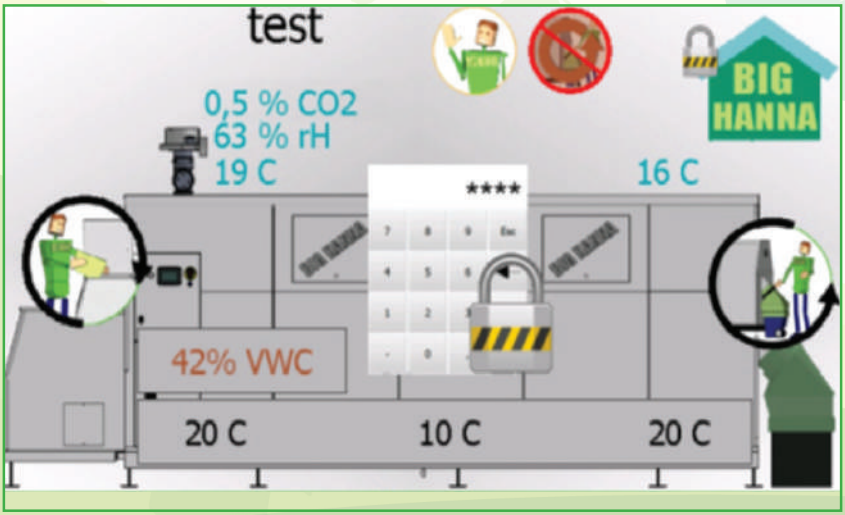


Figure 5 - Humidity and temperature sensors

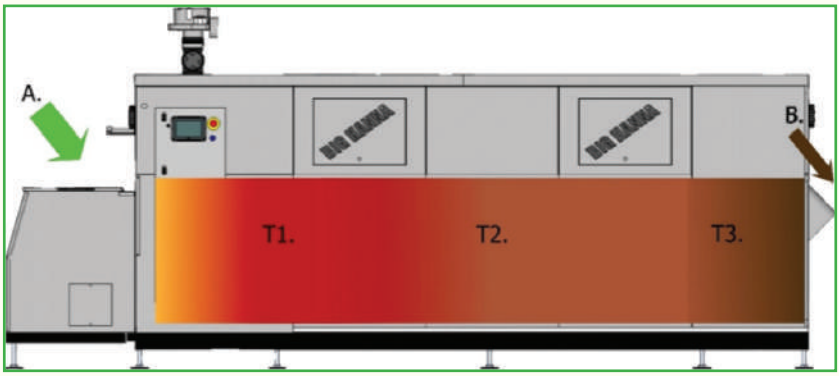


Figure 6 - Phases decomposition of the material in the cylinder

A. Input of fresh food waste and pellets into the ACU

T1 - thermophilic phase, Temperature: 50-65 ˚C, humidity 40-70%.

T2 - Mesophilic phase, Temperature: 25-40 ˚C, lower humidity.

T3 - Phase of maturation, Temperature: 20 ˚C, lowest humidity

B. The compost is automatically emptied from the cylinder.

For the aerobic composting process the minimum oxygen content should be 5%. As the activity of the microorganisms in the composting material increases, so does the oxygen consumption. If oxygen supply is not replenished, composting can turn into anaerobic decomposition, which often results in an unpleasant odor. The aeration of waste material in the ACU cylinder is made possible by air inlet and regulation of the aeration mode by adjusting the cylinder speed and pause between them, ie the wait time. When the cylinder rotates, all the material in the cylinder is supplied with oxygen. For further aeration of the material, the ACU has a built-in fan that runs

continuously at low speeds and ensures proper air flow. The biological process largely depends on the air supply to the cylinder. When the material is aerated, water vapor, CO_2 and heat are released (Figure 3). One turn can lower the temperature to 10-15 °C in ACU. If the airflow is too high, the compost material will dry out, if too low, the material will be too moist and/or have a bad smell coming out of the compost. When the cylinder rotates, all the material in the cylinder is supplied with oxygen. For further aeration of the material, the ACU has a built-in fan that runs continuously at low speeds and ensures proper air flow. The biological process largely depends on the air supply to the cylinder. When the material is aerated, water vapor, CO_2 and heat are released (Figure 3). One turn can lower the temperature to 10-15 °C in ACU. If the airflow is too high, the compost material will dry out, if too low, the material will be too moist and/or have a bad smell coming out of the compost.

Regarding the required pH value of the waste material, bacterial degraders require a pH value in the range of 6,0 to 7,5, and fungal degraders prefer a pH of 5,5 to 8,0. If the pH of the material exceeds 7,5, the likelihood of ammonia gas separation is increased.

The size of the organic waste is an important factor affecting the activity of the microorganisms and the aeration of the composting material. The tinned waste has a larger area per unit volume, allowing better and easier access for the microorganisms to their substrate, which speeds up the composting process, thus all food or garden waste that is selected and placed in the ACU must be cut into small pieces of 2-3 cm in size.

Waste management is everyone's responsibility. Anyone who creates waste is responsible for the way it is handled. With the selection scheme of biodegradable waste generation and composting, we not only help the environment, but we also help ourselves economically as we save our money on a daily basis, which would otherwise be dumped into containers and landfills.

Darko LAZAROV, PhD

ECONOMIC EVALUATION OF THE PROJECT MANAGEMENT AND TREATMENT OF ORGANIC WASTE IN THE MUNICIPALITY OF PROBITTIP

The main objective of the economic evaluation of the biowaste project is the detailed study and analysis of the financial and economic benefits of the implementation of the municipal waste management project through the application of modern organic waste treatment technology to a select group of households and catering establishments on the territory of the municipality Probistip. The ultimate goal is to identify whether the application of this type of organic waste treatment will be effective for all households and businesses in the municipality of Probistip through the simulation of this pilot project of the selected group of households and businesses.

So far, waste treatment in Macedonia has not received much attention and priority from local governments and the general public. Namely, waste management and management is still seen through the prism of the social sphere in the sense that public utilities responsible for waste management are not guided by purely economic aspects in defining the cost of utilities and the costs of delivering them. This often results in the inefficient operation of utilities, which is seen as generating losses and low quality of utilities. In addition, little attention is paid to the environmental dimension in terms of pollution and other adverse effects of inappropriate waste treatment.

Intensifying the country's integration process with the EU will unequivocally impose full compliance with European environmental directives and regulations, which in large part also relate to proper waste management. One of those aspects is the treatment of organic waste. In this respect, this project not only has financial and economic benefits in terms of rationalizing the costs of municipal waste management, but much more needs to be seen from a broader socio-social perspective.

Research methodology

The methodology to be used for achieving the economic evaluation of the organic waste treatment project is based on the application of cost-benefit analysis, net present value (NPV) and rate of return (IRR), as well as sensitivity analysis (sensitivity analysis).

Cost-benefit analysis should show whether the project is financially viable or not. To answer this question, the analysis will be based on the calculation of the discounted net present value of the investment in the project and the estimation of the rate of return on investment relating to the establishment of an organic waste management system.

The following is an equation for calculating the discounted net present value:

$$NPV = \frac{CF_0}{(1\_r)^0} + \frac{CF_1}{(1+r)^1} \dots\dots\dots\dots\dots \frac{CF_n}{(1+r)^n}$$

where, NPV - net present value, CF - expected value of future investment, which in this particular case is reduction of municipal waste management costs, r - interest rate and n - number of years of machine depreciation. On the other

hand, the rate of return shows the rate shows the degree of profitability of the investment itself, which means the higher the rate of contribution the more economically viable the project is, and in such circumstances the shorter the time period for the investment to be invested.

Objective empirical evaluation of the above indicators (net present value of the project and rate of return on investment) that are part of the cost-benefit analysis requires two sets of data. The first set of data concerns the costs associated with the initial investment in machinery, equipment and its installation, as well as current operating and equipment maintenance costs.

The second set of data is extremely important in assessing the potential benefit of the organic waste management investment itself. This data is related to the current waste management costs of the selected households and businesses related to the gross wages of the staff employed in the Waste Management Unit within the PUC, oil costs and depreciation of waste vehicles, costs for disposal of municipal waste at landfill and other operating costs related to waste management.

The two datasets that will be used in conducting the empirical analysis are obtained through the project expert's knowledge, the technical staff involved in the project, survey research and through a detailed analysis of the municipal utility waste management in municipality of Probistip.

Initial investment in the organic waste management system

Assessment of the investment in the organic waste management system as part of the bio-waste project on the territory of the Municipality of Probistip consists of the cost of two autonomous composting units for organic waste treatment and the value of construction works related to construction, adequate infrastructure and works related to implementing a security system.

The table below shows the amounts of investment in machinery and construction.

#	Individual prices for equipment per work package 4:	No.	Unit price MKD	Total price
1.	Autonomous composting units	2	5.696.115,00	11.392.230,00
2.	Construction, infrastructure and security system operation	2	181.405,00	362.810,00

In addition, the initial investment within the project includes: 1) the value of the purchased and installed monitoring systems (GRPS system) and vehicle measurement system, 2) 2 plastic containers of 1.100 liters size for the business premises, 80 bins of 100 L volume and 100 ordinary bins for selected households, 3) 4000 biodegradable bags for 10 liters bins.

The table below shows the value of individual investments in associated equipment associated with the selection and treatment of organic waste.

#	Individual prices for equipment per work package 3:	No.	Unit price MKD	Total price
1.	GPRS system and vehicle measurement system	1	943.275,00	943.275,00
	Plastic bins with 4 wheels 1100l	2	16.605,00	33.210,00
3.	Plastic bins with 2 wheels 80-100l	80	3.198,00	255.840,00
4.	Plastic bins without wheels 10l	100	738,00	73.800,00
5.	Biodegradable bags for 10 liter bins	4000	29,00	116.000,00

For a full and detailed analysis of the costs associated with the investment in organic waste management, the monthly operating costs for the management of organic waste related to electricity costs, pellets as inputs in the production process and other maintenance costs will be estimated.

Assess the potential benefits of the project by streamlining the costs of municipal waste management

We can analyze the potential benefit of the project through the prism of reducing the operational costs of municipal waste management that the PCE makes. Such cost reductions are extremely important in opening up opportunities to reduce the cost of communal waste collection and management services for those households and businesses involved in the project should the current service cost methodology be changed. for collection and management of communal waste based on m2 area and introduction of new methodology according to the amount of waste dumped.

The table below shows the total costs of the PUC for waste management throughout the municipality.

P.6	Description of the cost	Value
2.4	Number of persons engaged in waste management on the territory of Probistip	10
2.5	Expenses for salaries of persons engaged in garbage collection	3 550 000 mkd/yea
2.6	Oil costs per km for trucks collecting communal waste	954 044 mkd/yea
2.7	Depreciation expense (vehicle servicing, consumables, repairs, etc.)	597 250 mkd/yea
2.8	Costs of landfill waste disposal	391 900 mkd/yea
2.9	Other costs related to waste management	101 831 mkd/yea

If we divide the total costs of the PCE for waste collection presented above by the total number of households on the territory of the Municipality of Probistip, we will get the data on average household waste management costs. These costs are largely in line with the household costs involved in the project, which is a real approximation. In addition, data on the total amount of municipal waste of selected households and businesses and the percentage of the relative share of organic waste in total municipal waste will be taken into consideration. Lastly, the potential benefit estimates will take into account the value of agricultural waste that comes out as the main output from organic waste treatment.

No less important, economic analysis and evaluation is not only based on the narrower financial benefit and cost-effectiveness of the project, but much more on the wider social interest and greater social benefits of reducing pollution and protecting the environment as one of the most important priorities.

Afrodita ZENDELSKA, PhD

IMPACT OF THE PROJECT "BIOWASTE" ON THE ENVIRONMENT

The European Waste Directive (98/2008) requires the selection and treatment of 10% of the organic waste produced in each municipality.

For this reason, the project "Biowaste" is being implemented in part of the Municipality of Probistip, which foresees the selection and recycling of organic waste with the process of composting in autonomous composters.

Prior to the implementation of the project, field surveys were carried out which showed that the amount of waste produced in the municipality of Probistip is around 3.300 t/year, and the average waste generation per capita is 0,296 t/capita/year or 0,81 kg/day. Of the total waste, 56,37% is bio-waste, 49,33% of which is garden waste and 50,67% is other biodegradable waste, food waste.

So far, there was no waste selection in the municipality of Probistip, so all municipal waste was dumped on landfill.

By selecting organic waste from other solid waste and recycling it reduces the harmful impact on the environment, such as: unpleasant odor spread, damage to vegetation, air pollution, groundwater and soils, landfill fire due to the easy flammability of methane and global warming.

The main environmental benefits of composting organic waste in these composters compared to landfill disposal are:

1. Reduce greenhouse gas emissions.

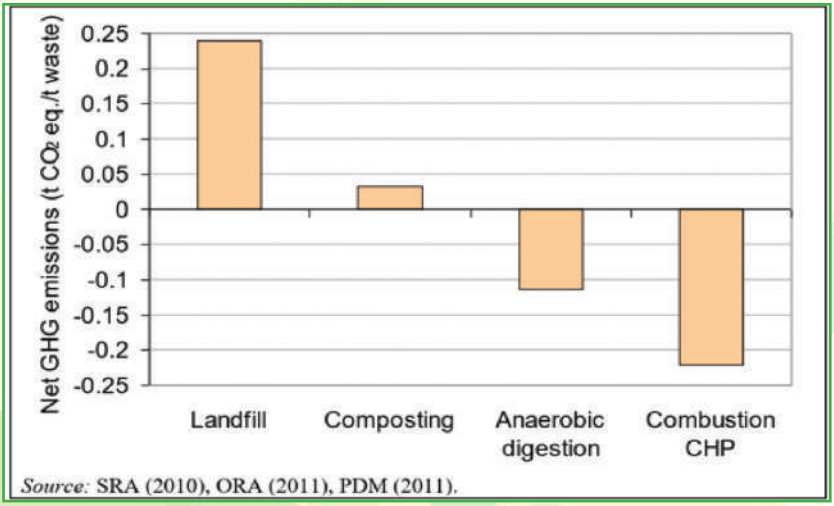
Greenhouse gases contribute to an increase in the greenhouse effect. This effect occurs as a result of the increase in the amount of radiation that is absorbed into the atmosphere rather than emitted from the surface of the Earth and becomes warmer, resulting in global climate change. Some of the greenhouse gases that contribute most to the greenhouse effect are methane (CH_4) and carbon dioxide (CO_2).

These same gases are present in landfill gas, which is a natural by-product of the decomposition of organic material in landfills. This gas is made up of about 50% methane, 50% carbon dioxide and a small amount of non-methane organic compounds. Methane is a very powerful greenhouse gas that is 28 to 36 times more efficient than CO_2 in trapping heat in the atmosphere. Specifically, 1 t of methane has the same effect on global climate change as 28 - 36 t of CO_2.

In landfill of organic waste, the process of decomposition takes place in two stages. Organic waste is first subjected to an aerobic phase where due to the presence of oxygen, carbon dioxide is released and then the anaerobic phase dominates. During the anaerobic phase, methane is emitted from the organic material.

Selecting organic waste and recycling it into autonomous composters will reduce greenhouse gas emissions. The composting process allows for higher aeration when composting organic waste, creating less harmful carbon dioxide gas, rather than methane. The amount of carbon dioxide emitted into the air during composting is far less than the amount of methane emitted when organic waste is discharged to landfill.

Specifically, one tonne of landfill organic waste generates up to 1,3 t CO_2 eq. of methane emissions during anaerobic landfill decomposition, but if the composting process is used, the amount of gas generated is reduced to approximately 0,21 t CO_2 eq. tonnes of organic waste. This comparison can be seen in the following graph.



Source: SRA (2010), ORA (2011), PDM (2011).

Autonomous composters are upgraded with a biofilter, which reduces the emission of gases resulting from the composting process. This biofilter also reduces the small amount of CO_2 generated during composting, as well as the odor that normally occurs when organic material decomposes.

2. Reduce the amount of leachate occurring on landfills

By selecting organic waste and recycling it into autonomous composters, in addition to reducing greenhouse gas emissions, the amount of leachate that appears at the landfill will be reduced.

The decomposition of organic waste in landfills creates leachates. The formation of this leachate is due to the natural decomposition of the organic material along with other liquids and chemicals that are discharged to the landfill, but also occurs as a result of the removal of soluble compounds, so that rainwater entering the landfill dissolves these compounds, penetrating thus polluting the groundwater alongside the soil.

Due to high toxicity, leachate is a major threat to the environment, leading to eutrophication of water systems and toxic effects on fauna caused by various pollutants.

The exact chemical composition of the landfill leachate depends on the composition of the waste, the climatic conditions, the age and the degradation of the solid waste.

3. Reduction of landfill surface.

As mentioned above, approximately 56,37% or more precisely 1.860 t/year of the total landfill waste is organic waste. Selecting and composting this type of waste will reduce the amount of waste discharged to the landfill, thereby reducing the need for frequent expansion and increase of the landfill area.

The environmental benefits of this are great, it will reduce land degradation and damage to vegetation.

4. Reduce the transportation of waste collection and disposal.

Reducing the amount of waste deposited at the landfill will also reduce the frequency of household waste transport to the landfill.

Collection of solid municipal waste may occur less frequently, which, in addition to reducing fuel consumption, also reduces the emissions of the gases emitted by the vehicles themselves. Fuels used in transportation generate methane, carbon dioxide and nitrous oxide emissions.

5. Utilization of nutrients, in particular phosphorus and avoidance of fertilizer production.

Compost is an organic humus. During the composting process, carbon and nutrients (nitrogen, phosphorus and potassium) are recycled and reclaimed and used in soils.

Compost allows to change the soil structure and content of organic matter, thereby helping to prevent soil erosion and providing additional nutrients, organic carbon and enhancing the activity of soil microorganisms.

Due to its versatile application, the quality and characteristics of the compost must be adapted for its proper use.

Because compost improves soil structure and microbiological activity, it serves as a fertilizer or as a means to improve soil quality in an environmentally friendly manner without the addition of chemicals. The largest use of compost is in agriculture, food production and horticulture. Increased use of compost will reduce the need for fertilizer production.

6. Soil improvement and carbon sequestration.

Soil carbon sequestration is the removal of carbon dioxide from the atmosphere and storage in liquid or solid form in the soil.

The benefits of carbon sequestration in soil are difficult to quantify but are still estimated at around 0,18 t CO_2 per tonne of compost. The compost produced from 50% food waste and 50% vegetable waste (by weight) contains about 1,5% nitrogen, 0,5% phosphate and 1% potassium. This percentage depends on the type of composting. Worm composting retains a higher percentage of nitrogen in the compost due to the lower temperature that occurs during the composting process.

Ljubica NASKOVA, MSc

CONCLUSION

The "Pay As You Throw" project went through several phases during its implementation. The first reflects the need to get acquainted with the project itself, its goals, activities, budget, procurement of equipment. The second, most important, reflects all the strength, time and energy invested by all project participants in achieving the project goals. In this sense, the full human potential that was available for public procurement (11 for the municipality of Probistip and 3 for the needs of University "Goce Delcev"), several modifications to the project specification, as well as the organization of the procurement and installation of the entire project were utilized equipment. Third, last, and not least, is the preparation of all the information material intended for the end users of the project results. The population, the municipality and its administration, the public utility company and the catering facilities in Probistip.

Recall the events that marked the implementation of the project.

During the period of implementation, the following took place:

- 5 coordination meetings (Katerini-Greece, Heraklion-Greece, Probistip, Republic of North Macedonia, Yermasoyia-Cyprus and final meeting in Katerini-Greece);
- 2 Info Days (Yermasoyia-Cyprus, Probistip, Republic of North Macedonia);
- Supply of 2 waste containers with volume of 1100L;
- Purchase of 80 waste bins with volume of 80L;

- Purchase of 80 waste bins with a volume of 10L;
- Purchase of 4.000 plastic bags for household waste collection;
- Purchase of 2 Autonomous Composting Units;
- 2 platforms were built with complete infrastructure for installation of composting devices;
- 11 video stories were published on regional and local TV stations; 11 text articles published on the web pages of the University and municipality of Probistip and the FB page of the project;
- 7 trainings were held for the target groups: 2 for the catering facilities and 5 for the population of UC Kalniste;

The total value of the project is €1.338.255,00, of which for municipality of Probistip €277.758,00 and €83.040,00 for the University "Goce Delcev" in Stip.

Training on the use of composting devices covered 96 people, employed in catering facilities and 80 household representatives from the Urban Community "Kalniste".

Thanks to the implemented activities, the municipality of Probistip is the first municipality in the country where the waste separation procedure has started on the spot where it is generated. Also, this project is the first step towards elaborating the most acceptable methodology for charging waste collected by public utilitiy companies. This has opened up the possibility of starting to generalize the principles of the work of other public utilitiy companies, which in the near future will have to adjust their calculation methods when invoicing a service.

Finally, perhaps the most important element. This project significantly contributes to raising awareness among the local population of the need to reduce the amount of waste that has ended up in landfill to date and can (appropriately processed) be restored to the natural recycling cycle. Also, this project enables

the realization of the quantities of waste that will end up at the landfill and accordingly the proper planning of the movement of the garbage collection vehicles. This will significantly reduce greenhouse gas emissions and reduce the risk of contaminated groundwater and surrounding landfills.