Project

"Integration of Solid waste management Tools into specific settings of European and Asian Communities"

Activity 2

b) Market research on home composting technologies implemented in Europe

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Thessaloniki, May 2004

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1. Market research on composting technologies implemented in Europe

1.1 Introduction

Recent years have seen a phenomenal increase in the biological waste treatment in Europe. At least 32 % of urban waste production and a large amount of industrial waste, about 40 % of the total waste production in Europe, could be biologically treated via composting and anaerobic digestion. The final products from the treatment are usually used as soil improvers or as fertilisers. They have to meet environmental and market requirements, which will lead to an improvement of the compost quality produced in Europe in the future [1].

The quantity of municipal solid waste in Greece amounts in roughly 4.600.000 tones per year. About 47% from this quantity, that is 2.162.000 tones, are organic wastes [2]. The organic waste management (collection, transfer, treatment and disposal) has many problems, the basic being its final disposal.

Concerning the organic waste treatment in Greece, a facility with high capacity is under delivery in Athens and also includes a mechanical separation and recycling plant including a bioreactor composting facility for the organic fraction. [3]

Municipal solid waste is a possible pollution source; however, it is also possible to use solid wastes as secondary natural resources. In accordance with the demands of the European legislation, solid waste's industry should follow new trends and solutions to solid waste management.

Some EU Member States introduced measures on packaging and packaging waste management with a view to reducing their environmental impacts. Serious Internal Market problems arose when cheap secondary materials from countries with recycling schemes that provided funding for collection and recycling appeared on the markets of other Member States where no such schemes were in place. Collection and recycling activities that relied on cost recovery through the sale of secondary raw material were threatened by collapse.

For this reason, economic operators and Member States approached the Commission to introduce comprehensive legislation on packaging. In 1992, the Commission came forward with a Proposal for a Council Directive on Packaging and Packaging Waste.

Following a prolonged discussion in the European Parliament and the Council of Ministers, Directive 94/62/EC was adopted. This Directive aims to harmonise national measures in order to prevent or reduce the impact of packaging and packaging waste on the environment and to ensure the functioning of the Internal Market. It contains provisions on the prevention of packaging waste, on the re-use of packaging and on the recovery and recycling of packaging waste [4].

The Council Directive 99/31/EC of 26 April 1999 on the landfill of waste entered into force in 1999. The objective of the Directive is to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste, by introducing stringent technical requirements for waste and landfills such as reducing the amount of organic waste that is disposed of to the landfills. The directive brought into force in Greece from December of the year 2002 with the CMD 1572/02 [5]. Article 4 included in this common decision imposes a gradual decrease of biodegradable municipal waste going to a landfill, as following:

- 25% decrease in 5 years from 2002
- 50% decrease in 8 years from 2002
- 65% decrease in 15 years from 2002

The Directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health [6].

1.2 Composting

Composting is the breakdown of organic waste to a fibrous, humus-rich substance which can be used to improve soil structure and fertility.

Specifically, home composting means less waste for collection and transportation. The higher the weight and volume of waste to be transported, the higher the fuel consumption by collection vehicles and the higher the corresponding costs, both to the council’s budget and to the environment. Home composting where compost is returned to the garden creates a neat recycling loop involving no transportation of waste.

1.2.1 Materials to compost

All organic (compostable) material contain a mixture of carbon and nitrogen, this is know as the carbon:nitrogen (C:N) ratio. For best results in the compost pile a balance of carbon and nitrogen,is required, with the optimum being 30:1.

Items containing carbon are generally brown in colour, such as autumn leaves or straw. Items containing nitrogen are generally green in colour, such as kitchen scraps and green grass clippings.

A rule of thumb is to have roughly equal amounts of browns (carbon) and greens (nitrogen). This is known as the 50/50 rule and will balance the carbon:nitrogen ratio at the proper level.

The following is a list of some of the different green and brown materials that can be composted [7]. It is not a complete list. Other materials may be added.

Greens: Nitrogen Rich These materials are usually moist.

- green leaves
- weeds before they go to seed
- vegetable/fruit peels and scraps
- spoiled food
- green grass clippings
- coffee grounds, including the filter
- tea bags
- egg shells (crushed)
- breads
- cooked pasta and rice
- flowers

Browns: Carbon Rich
These materials are usually dry.

- evergreen needles
- dry leaves
- dried brown grass clippings
- bark chips
- straw
- prunings and cuttings
- dryer/vacuum lint
- hair
- bird cage cleanings
- cardboard/paper
- sawdust

A few materials should be avoided, since they cause problems such as odours and pest attraction.

- meat, bones and fish scraps
- dairy products
- fatty/oily foods, including cheese, butter, oil and salad dressing
- weeds with mature seeds
- pet wastes
- walnut shells
- rhubarb leaves
- plants or grass clippings that have been treated with chemicals
- diseased or insect-infected plants
- charcoal or coal ashes

1.2.2 Factors in composting

To improve the composting process, some of the following parameters should be controlled and used by the best way.

Air

Air is necessary for the organic matter to decompose in an aerobic environment. This will result in fast, odour free decomposition. If there is a lack of oxygen in the compost pile, it will begin to smell like rotten eggs. Aerating will eliminate odours and speed up the decomposition process.

There is no set rule for how often to turn or aerate the compost. There are many factors that determine the frequency of turning such as: the size of the pile, the types and amounts of material being added to the pile. Turing the pile every week or two will result in faster composting, provided that all the other factors in composting are maintained.

Moisture

Moisture is needed to maintain composting activity in the pile. The microorganisms that decompose the organic matter need moisture to move around and break down the material. If the pile becomes too dry, composting activity will slow down and eventually stop. If the pile gets too wet, it may begin to smell bad.

Heat

If a compost pile has enough water and oxygen, a good balance of material, and enough volume, temperatures in the pile may reach above 55° C. Heat is the result of the work of the micro-organisms that are decomposing the organic material. Temperatures of 55° C are desirable, because they kill weed seeds and speed up the composting process [7].

Table 1 presents the conditions under which the composting process should take place.

Table 1. Composting parameters and typical limits [8]

Conditions	Typical values
C:N ratio	25:1 – 30:1
Water content	40 – 70%
Aeration (O_2)	> 5%
pH	6.5 – 8.0
Temperature	54 – 60 (^oC)

1.2.3 Composting bins

A well-designed bin should allow easy access to the pile inside and have spaces or holes in the sides for air to circulate. A lid will help retain moisture but is not necessary [7].

The recommended bin size is about 1 cubed metre. There are a few things to consider for a home composter such as the aeration or airflow and the accessibility to the composting material (important when turning and aerating the compost).

1.2.4 Worm composting

Worm composting is a method for composting food waste into a rich, dark, earth-smelling soil conditioner. The great advantage of worm composting is that this can be done indoors and outdoors, thus allowing year round composting. Worm compost is made in a container filled with moistened bedding and redworms. Mixing food waste with the worms for a period of time, and micro-organisms will eventually convert the entire contents into rich compost [9].

Worms

The two types of earthworm best suited to worm composting are the redworms: *Eisenia foetida* (commonly known as red wiggler, brandling, or manure worm) and *Lumbricus rubellus.* They are often found in aged manure and compost heaps.

Bedding

It is necessary to provide a damp bedding for the worms to live in, and to bury food waste in. Suitable bedding materials are shredded newspaper and cardboard, shredded fall leaves, chopped up straw and other dead plants, seaweed, sawdust, compost and aged manure. The bedding in the bin should be varied as much as possible, to provide more nutrients for the worms, and to create a richer compost. A small amount of sand or soil is necessary for the worm's digestion of food.

It is very important to moisten the dry bedding materials before putting them in the bin. The bin should be about three-quarters full of moistened bedding. Lift the bedding gently to create air spaces which help to control odours, and give freer movement to the worms.

Containers

The container should be made from wood or plastic. Wood container is preferable because it is more absorbent and a better insulator for the worms.

The container depth should be between twenty and thirty centimetres. Options to one large (and heavy) box are a number of smaller containers for easier lifting and moving and more choice of location. The book illustrates a variety of containers.

Depending on the size of the container, drill 8 to 12 holes (0.6 – 1.3 centimetres) in the bottom for aeration and drainage. A plastic bin may need more drainage - if contents get too wet, more holes should be drilled. The bin should be raised on bricks or wooden blocks, and a tray should be placed underneath to capture excess liquid which can be used as liquid plant fertilizer.

The bin needs a cover to conserve moisture and provide darkness for the worms. If the bin is indoors, a sheet of dark plastic or burlap sacking placed loosely on top of the bedding is sufficient as a cover. For outdoor bins, a solid lid is preferable, to keep out unwanted scavengers and rain. Worms need air to live, so the bin should be sufficiently ventilated [9].

Wormcomposting is a very efficient method. Worms can compost wastes faster than any other type of composting method. There are also very efficient in digesting kitchen food wastes. Each day a worm eats half its weight in food. The care and feeding of worms take far less effort than maintaining an outdoor compost pile.

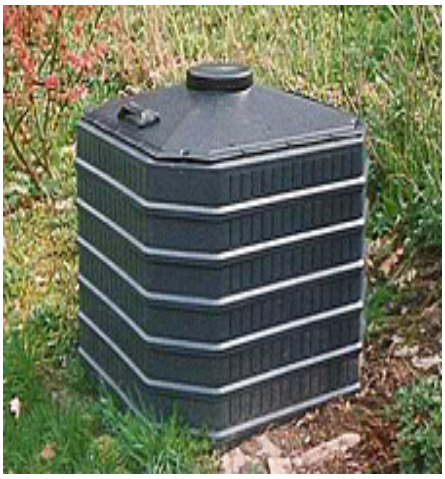
This system is composed of a box to contain the worms; the worms themselves; a controlled environment; and regular maintenance procedures.

1.3 Composting Bins

There is a large number of home-composting technologies implemented successfully in developed countries. Some of these the available technologies are presented bellow:

1.3.1 Bio-activator stacking system

The Bio-Activator is an advanced design that allows for easy expansion. Because it consists of stackable interlocking frames, it is adjustable in size and can be moved quite easily. When the compost is ready to use, just begin removing the top frames one by one and start a second, new pile next to the first. A sturdy, hinged lid with adjustable aeration dome attaches to uppermost frame. The Bio-Activator is double-walled, with a partial inner third wall; the resulting insulating effect is very important in moderating temperature extremes, and therefore speeds up the composting process by maintaining a constant environment [10].

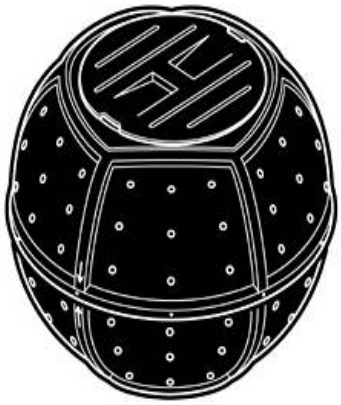


Specifications	
Size Dimensions	92cm x 92cm x 13.5 cm per frame
Capacity	5 frames = 0.34 m^3 7 frames = 0.49 m^3
Weight	20.4 (5 frames + lid) 27.2 kg (7 frames + lid)
Composition	100% recycled charcoal grey plastic - UV stabilized
Usage	hot composting of yard waste and food clippings
Key Features	sectional stacking units, expandable, good for colder climates
Cost	96.5$ (5 frames + lid) per unit 109.5$ (7 frames + lid) per unit

Figure 1. Bio-activator stacking system [10]

1.3.2 Bio-orb roll up system

The large volume of the spherical Bio-Orb is better insulated at holding heat from microbial activity than other bins of comparable capacity. Simply fill with organic materials and roll every 5-10 days - no mixing, no mess - this insures optimum heat build up and provides needed oxygen for microbial activity. Rolling movement allows contents to decompose aerobically, producing a sweet pleasant aroma [10].

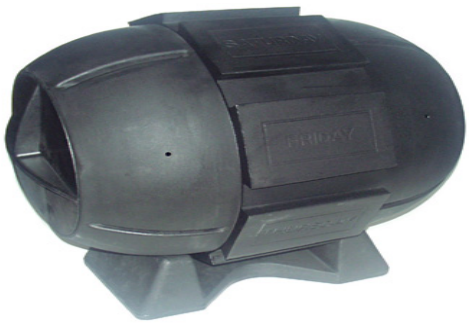


	Specifications
Size Dimensions	Large – 91.44 cm diameter
Capacity	Large – 0.38 m^3
Weight	9.5 kg
Composition	recycled plastic - black color absorbs solar heat
Usage	shredded leaves and grass clippings, kitchen waste
Key Features	Movable, aerates and mixes as it rolls, fun
Cost	99.5 $ per unit

Figure 2. Bio-orb roll up system [10]

1.3.3 Composter mixer

The composter mixer is double walled and the air-core construction help to keep the temperature in the optimal range. If it is necessary, holes provide air for ventilation and drainage. The days of the week are stamped on the side in order to help the user to remember the last time the bin was turned. The technology also appears the following characteristics: a) generous recessed foot treads utilize leg power for easy rotation and b) custom-designed curved base allows mixing in place, without rolling [10].

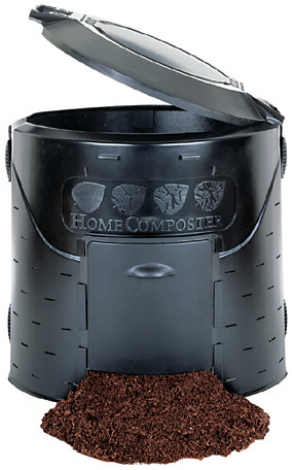


Specifications	
Size Dimensions	Rolling Chamber – 81.28cm L x 60.96 cm Diameter Base – 53.34 cm L x 33.02 cm W x 16.51 cm H (Total H = 81.28 cm)
Capacity	0.2 m^3 mixing chamber
Weight	13.61 kg
Composition	UV-resistant, heavy-duty polyethylene resists the elements
Usage	yard and garden waste, food scraps
Key Features	mixes in place - great for compact gardens, uses leg power
Cost	125$ per unit

Figure 3. Composter mixer [10]

1.3.4 Home composter

This generously sized bin is well suited for kitchen wastes and soft yard clippings. The unit features a locking lid top with a rain-catchment system comprised of two sunken semi-circles with drip holes. Two convenient sliding doors, one on each side at the unit's base, make harvesting of the finished humus a breeze. Door openings are approximately 33.02 cm wide by 33.02 cm tall, with a hands-free locking system when in the upright position [10].

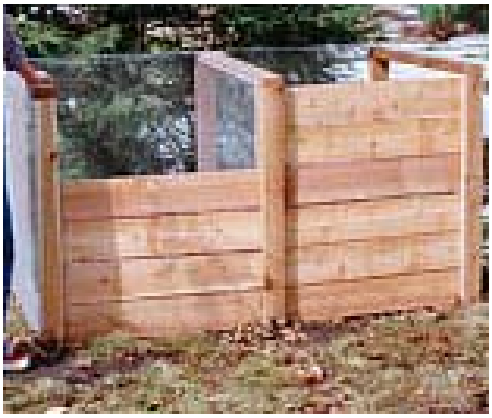


Specifications	
Size Dimensions	81.28 cm H x 81.28 cm x 76.2 cm - top opening 67.31 cm x 71.12 cm
Capacity	0.37 m^3
Weight	9.07 kg
Composition	black recycled plastic - 60% post-consumer, 40% post-industrial
Usage	ideally suited for family of 5-6
Key Features	locking lid, lightweight
Cost	69.75$ per unit

Figure 4. Home composter [10]

1.3.5 Earth engine - double bin

This kind of bin is made from environmentally responsible, weather-resistant frames. It has galvanized screens and hardware inhibits rust formation. 10 adjustable cedar slats allow easy access to separate storage bins. It is also has enormous capacity of about 1.7 square meters of space [10].

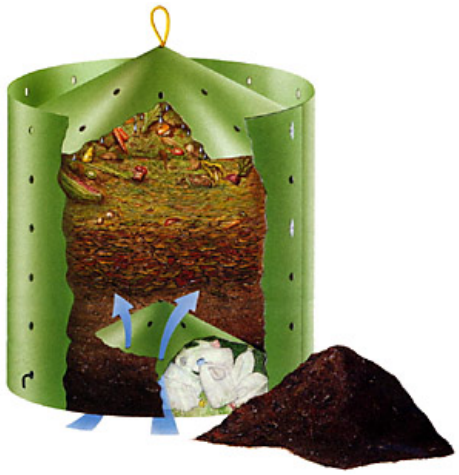


Specifications	
Size Dimensions	91.44 cm H x 172.72 cm L x 91.44 cm W
Capacity	1.5 m^3
Weight	Double – 27.22-29.94 kg - varies with the density of the cedar wood
Composition	cedar and galvanized metal parts
Usage	yard and kitchen wastes
Key Features	double bin design, large capacity, attractive
Cost	215$ double 148.5$ single

Figure 5. Earth engine, double bin [10]

1.3.6 Brave New Composter

Brave new composter bin is a unique dual cone design which virtually eliminates need for constant turning. The patented cone shaped top retains heat and moisture and the bottom cone draws air into the centre to increase aerobic activity. The air holes are less than 1.27 cm diameter holes. It is durable and weather resistant and the bottom cone secures firmly to the ground and the adjacent bin wall with galvanized steel pins [10].



Specifications	
Size Dimensions	81.28 cm H (Large) or 71.12 H (Small) with variable diameter
Capacity	REGULAR = adjustable - up to 0.67 m^3 (MINI =0.31 m^3)
Weight	9.07 kg (Large) 5.9 kg (Small)
Composition	made from 100% UV-resistant recycled plastic soda bottles
Usage	all-purpose
Key Features	low cost, light weight, adjustable size
Cost	75$ per unit

Figure 6. Brave new composter [10]

Table 2. Summary on the above home composting technologies.

Type of composting bins	Capacity (m^3)	Usage	Key features	Cost
Bio-activator staking system	0.34 (small) 0.49 (large)	Hot composting of yard waste and food clippings	Sectional stacking units, expandable, good for colder climates	96.5$ (5 frames + lid) per unit 109.5$ (7 frames + lid) per unit
Bio-orb roll up system	0.38 (large)	Shredded leaves and grass clippings, kitchen waste	Movable, aerates and mixes as it rolls, fun	99.5 $ per unit
Composter mixer	0.2 mixing chamber	Yard and garden waste, food scraps	Mixes in place - great for compact gardens, uses leg power	125$ per unit
Home composter	0.37	Ideally suited for family of 5-6	Locking lid, lightweight	69.75$ per unit
Earth engine – double bin	1.5	Yard and kitchen wastes	Double bin design, large capacity, attractive	215$ double 148.5$ single
Brave new composter	0.31 (mini) 0.67 (regular)	All-purpose	Low cost, light weight, adjustable size	75$ per unit

1.3.7 Composting toilet systems

The composting toilets technology can be used in many different situations. These technologies are found in many different situations such as in islands; in deserts, in rainforests, in high mountains, on beaches; in homes, rest stops, education centres, campgrounds, lighthouses, parks, religious retreats.

Many types of compost toilets are available in the market. They are designed to suit a variety of customs, cultures and climates, and vary enormously in price. The selection of the most appropriate type and design of compost toilet will depend on many factors which include social and cultural norms, existing hygiene and sanitation practises, sources of drinking water, availability of organic residues, climate, soil types, patterns of habitation and local construction materials etc.

A toilet composting system should have odourless control and guarantees that it will not smells bad, easy installation and operation and should be designed for the convenience of the owner [11]

2. Organic waste treatment in Greece

2.1 Composting plants in Greece

Many compost plants are proposed to be constructed in the future, in Greece. Up to now a facility with high capacity is under delivery in Athens. It includes a mechanical separation and recycling plant and a bioreactor composting facility for the organic fraction. It will also treat mixed Municipal Solid Waste (MSW) (mechanically separated) and it will include a DANO type drum, and tunnel composting. Its daily capacity will be 1200 tons MSW [3].

A composting plant was in operation, in the city of Kalamata in Peloponnese, but the operation has been stopped because of the management problems.

Another one composting plant is completed and delivered during November 2004 on the island of Crete and specifically in the Chania Prefecture. This facility includes a recycling and composting plant and will be under operation on January of the year 2005. During the first 6 months (the first semester of 2005) the facility will be in pilot operation and a large information campaign will take place in parallel, so that the citizens will be well trained for the program’s implementation [12].

There are no facilities processing source separated organic waste as yet, although it would be fairly easy to do as green waste is collected separately anyway. Some municipalities have thought of doing this, but they have not been able to secure funding as yet.

In the next 5-10 years several composting facilities for mixed MSW and sludge will be funded (to a large extent by EU subsidies through the 3rd Community Support Framework) and possibly some for green waste. Source separation of MSW is not foreseen to occur on a wide scale, though some pilot-scale projects might start in the same period. At present, there is no feeling that standards are to change or to be completed with limit values for high-grade compost to be used as products, unless EU legislation requires this. First of all, this will be the EU landfill directive and secondly the EU Biowaste Directive, depending on the date when it will come into force heavy metal content is expected to be well below the Hellenic limits [13].

2.2 Home composting in Greece

Pilot programs on home composting activities have been applied in many countries all over Europe. Organic waste treatment and especially home composting is not so common activity in Greece despite the stress from the EU and the Greek legislation. Some efforts on home composting have been organised locally from the municipality of Elefsina in Athens and the municipality of Thermaikos in Thessaloniki.

Voluntarism and home composting in the municipality of Elefsina

The municipality of Eleusina can be characterised as a semi-urban area which has no high built-surface ratio. In the frame of the volunteerism for the feasible management of the organic waste, some educational activities took place. Specifically, students, young people and citizens were trained on environmental issues, such as integrated solid waste management and organic waste treatment. 60 composting bins were given to students' volunteers and their families through the project. Two types of composting bins were given to the participants, bins of capacity 340l and 680l for the apartment buildings and the single houses, respectively. The volunteers were educated on the composting process, participating actively on solid waste reduction at this area. The citizens that participate to the project use the compost to their gardens and their flowerpots. This pilot project started on July 2003, finished on July 2004 and was

funded from the Municipality of Elefsina, the Greek Ministry for the Environment Physical Planning and Public Works and the Ecological Recycling Society. The program is expected to be continued after the completion of the project because of the volunteer's high participation and the first successful implementation [14].

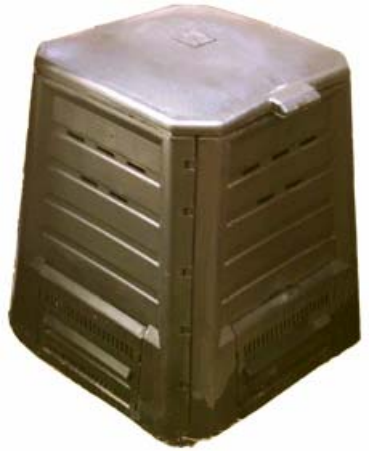


Figure 7. Composting bin in the municipality of Elefsina

Home composting in the municipality of Thermaikos

The municipality of Thermaikos shows roughly the same characteristics with the previous municipality. It mostly includes single houses with garden, a fact that encourages the implementation of home composting programs, since there is enough space for the necessary equipment and green waste's collection. The citizens were informed from the responsible for the project's implementation which was the local authority and the university.

Firstly, 50 composting bins were given to the volunteers and then 80 more bins were also used. Each composting bin had a capacity of 200lt and the expenditures for the bin's supply covered from the municipality. The project started in the year 2001 and some of the volunteers are still producing compost for their gardens [15].

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