International POPs Elimination Project

Fostering Active and Efficient Civil Society Participation in Preparation for Implementation of the Stockholm Convention

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Zero Waste as Best Environmental Practice for Waste Management in CEE Countries

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About the International POPs Elimination Project

On May 1, 2004, the International POPs Elimination Network (IPEN http://www.ipen.org) began a global None Governmental Organisation (NGO) project called the International POPs Elimination Project (IPEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Program (UNEP). The Global Environment Facility (GEF) provided core funding for the project.

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to each country's efforts in preparing for the implementation of the Stockholm Convention;
- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;
- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

IPEP will support the preparation of reports on a country's situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

For more information, please see http://www.ipen.org

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1.0 Introduction

The purpose of this study is to present, using practical examples from the Central and Eastern European countries, procedures resulting in significant reduction of the amount of waste deposited to landfills or ending up in incinerators. This, as a consequence, results in saving of energy and raw materials, and in reduction of releases of toxic substances into the environment. Generally, this strategy is called Zero Waste, and inhabitants of Canberra, Australia decided to adopt it for the first time historically in 1995. In 2003, 69 % of waste was utilised there already[1]. From that time, this idea was adopted in practice in a number of regions of the USA, Canada, Australia, in New Zealand, as well as in Europe. Some municipalities from Central and Eastern European countries have accepted this strategy too. The greatest progress has been achieved in the municipality of Palárikovo in Slovakia, which reduced the amount of wastes deposited to a landfill by 75 % within 6 years (see the case study). The study from Latvia concerns the issue of composting, and the description of a project from the Czech Republic concerns environmental education and composting. The example from Bulgaria describes the waste crisis in Sofia, and the Hungarian study describes the possibilities of recycling in offices and companies.

The study finds links between consequences of our waste management and environmental pollution. The Stockholm Convention, accepted on May 22, 2001, regards waste management as a big source of emissions of persistent organic pollutants. According to the European inventory of dioxin releases of 1995, waste incineration was actually the biggest source of PCDD/Fs (dioxins and furans) in Europe[2]. After adoption of strict limits for incinerators, their emissions were reduced significantly however a part of them was transferred to solid wastes from these plants. Landfill fires, and, especially, illegal domestic waste burning, remain significant sources of PCDD/Fs emissions to air. Zero Waste is a way to prevent this, because one of important tools of this vision is broad education of the public and cooperation with the inhabitants.

Involvement of inhabitants in the waste management system results, in its consequences, in reduction of over-consumption, in minimisation of wastes, in prevention of their formation and in their recycling. It means that if we calculate the reduction of PCDD/Fs emissions thanks to a better method of waste management in the study, we do it just for the purpose of illustration, because the total impacts of this strategy are considerably broader.

2.0 What is Zero Waste and what steps result in its implementation?

Zero Waste is a strategic vision of a community. It supposes that raw materials in the system will be recycled, and will not end in an incinerator or in landfills. At first sight the idea that I will not produce any waste may seem as a utopian dream. However, in fact this is an attainable aim, and an increasing number of states, towns, municipalities and companies all over the world are gradually joining this movement.

In the very beginning it is necessary to realise that the term Zero Waste does not mean reduction of production of all waste to zero - this is not possible in a society oriented on consumption. The term means elimination of the present way of waste disposal by depositing to landfills and incineration. Selection of this aim is important, because it does not present a choice. We must do anything possible in order to achieve it.

The Zero Waste vision requires a change in our way of thinking and of established practices. Instead of solving the problem of what to do with the produced waste, we must concentrate, especially, on the issue of how to manage natural resources more wisely, and how to reduce the total volume and hazardousness of waste.

The Zero Waste conception is the form of waste management when wastes are managed in accordance with requirements of the EU waste legislation, according to the well-known waste pyramid. In the first place, it is necessary to prevent waste creation, secondly, to minimise its amount and toxicity, and, thirdly, it is necessary to repair products. If these steps are not possible, then recycling is utilised. Incineration and landfilling come only at the end of this pyramid.

The Zero Waste concept includes a wide range of steps. Some of them are already required by the present European legislation. The economic and system tools include responsibility of producers for their products. Briefly explained, this means that if a product and its packaging may not be re-used, recycled or composted, then the producer must be responsible for its collection and its safe disposal after the end of its lifetime. In the EU countries, this concept is applied to packaging, oils, electrical waste, accumulators, batteries and single-cell batteries, discharge and fluorescent lamps, automobiles, tyres, and medicines.

Another aim of the European policy is introduction of Integrated Product Policy. The word "integrated" means that the producer accepts responsibility for its product in all stages of its lifetime. A practical example of this policy is use of older parts of copiers in new equipment. Another example is wider use of deposit systems. This system may be applied not only to packaging, but also to tyres or batteries.

Another important step is to introduce real prices in accordance with the "polluter pays" principle. This means that no or lowest fees should be connected with minimisation of the amount of wastes. The costs of the system of collection of separated commodities should be covered partially, and in the case of residual waste full costs should be covered. For example, in France this means that disposal of the residual waste costs 1 - 1.5 EURO per a sack of a volume of 60 litres (8 kg)[3]. This price reflects liquidation of this waste in an incinerator.

Another of the tools applied in the EU countries is financial and tax reform. Its introduction will result in transfer of the tax burden from environmentally-friendly products to pollution producers, and, as a consequence, it will force the industry to reduce its waste production. After all, industry is a model of this conception. For example, Toshiba in an effort to minimise its costs, reduced the number of its production defects to one in a million. Xerox Corp. (Rochester, New York) was able to process 94 % of its hazardous wastes in its plants in the world, and to recycle 87 % of its other wastes, in 1999.

Opportunity for the industry

Another advantage of the Zero Waste concept is that it creates conditions for a number of business activities. The concept supports development of services, such as collection points, repair shops, service workplaces, shops with used goods, second-hand shops and bookshops, and hires services of all kinds. Waste management creates job opportunities also for handicapped persons. Protected workshops for processing of electrical waste in the Czech Republic may serve as an example. Composting may become a supplementary source of income of local farmers. Good examples of this kind are known from Austria.

A new view of waste results in creation of completely new services. The producers do not sell only their products, but also services connected with them. As an example, hiring of televisions or washing machines may be mentioned. The supplier takes care of their maintenance, updating, as well as recycling.

Implementation of the Zero Waste strategy in regions, towns, and municipalities

A precondition of implementation of this concept is an actual effort to reduce the amount of the produced mixed municipal waste. Growing prices of its landfilling and incineration may be also an economic motive of this effort. Implementation of this vision requires combination of a number of activities. The key steps are discovered by a waste audit determining what amount of each kind of waste we produce, and, therefore, where we should fix our attention first. It also finds strengths and weaknesses of the existing situation in the municipality. On the basis of its results, we may already plan our steps.

Figure 1: Analysis of waste, Palárikovo

The result will be an up-to-date waste management which does not damage and pollute its surroundings. Newly created job opportunities will support the local economy, and in the total balance these solutions are cheaper for municipal budgets.

Implementation of the Zero Waste concept requires:

- **To determine the year in which we want to achieve this aim -** usually, this concerns a period of 15 to 20 years, the final aim should be planned in several stages;
- **To involve the public in the intention -** local representatives, entrepreneurs, inhabitants. The public campaign must be a permanent part of the plan. The campaign may include issuance of a leaflet for each household, intensive campaign in the media, opinion polls, lectures, often it is necessary to personally contact households, from door to door, competitions for schools, exhibitions, notice boards on municipal authorities;

- **To promote and support projects for prevention of production of wastes, and for their re-use -** local deposit system, second-hand store selling furniture, building materials, electronics, etc.;
- **To start biological waste composting -** if possible, to support composting in households and communities in the first stage, and, later, a system of collection of biological waste and its composting in the municipality;
- **To create good conditions for separated collection of dry recyclable wastes for the inhabitants -** to ensure sufficient number of containers for recyclable components; in the districts of family houses, a sack system and collection from door to door may be introduced;
- **To introduce collection of high-volume, hazardous wastes, and to set a system of building waste management;**
- **To motivate households -** provide for introduction of just fees according to the amount of produced waste; in the case of lump-sum fees, a lower fee may be offered to people who participate in the system;
- **To increase fees for landfilling and incineration of wastes -** the income from these fees should be used for setting up the Zero Waste system;
- **To support take-back programmes -** to convince the local tradesmen to introduce a take-back system for their products, in accordance with the local conditions;
- **To refuse construction of an incinerator and landfills -** incinerators are demanding from the economic point of view, and the investments do not stay in the region.

3.0 Risks of landfilling

Requirements on landfills become stricter in the EU countries gradually. At the present time, Central and Eastern European countries are spending considerable funds on securing of old landfills. These states had to close down a large number of them. However, the operated landfills also represent a significant source of environmental contamination. The contamination may take place in various ways.

The air may be polluted by releases or burning of landfill gas (emissions of a number of hazardous substances), dust (it may contain heavy metals), higher occurrence of pathogens (microbes, fungi, moulds), flying waste, and also landfill fires are frequent. More than 20 studies prove the impact of landfills on state of health of inhabitants living in their vicinity.

Water may be polluted by release of landfill waters or petroleum substances. Both surface water and underground water may be endangered. Runoffs from landfill may take place during rains, too.

Soil may be polluted similarly. Moreover, the vicinity of landfills is often bothered by rodents, birds, or insects. Also accidents with landslides may not be excluded. Landfills take land unnecessarily.

Figure 2: Broken down hazardous waste landfill in Pozdatky

The further impacts include:

Psychosocial risks, which include factors influencing life quality, such as bothering smell all through the year, flying wastes in front of windows and in gardens, birds flying over the landfill, noise, dust, mud, slime, transport, or unsuitable hours of work in the landfill.

Psychological factors, such as fear of the landfill and stress connected therewith.

Economic factors are also significant. Landfills create a minimum number of job opportunities, and they reduce prices of land and real estate in their vicinity.

Environmental factors, because landfills significantly contribute to global warming due to their methane emissions. Landfilling results in wasting raw material resources.

The most frequent defects in landfills according to the Czech Environmental Inspection Agency:

Generally, the operators have problems with compliance with the Operational Rules conditions. Further, the most frequent defects include:

- Failure to cover wastes;
- Acceptance of not-permitted waste;
- Insufficient check during acceptance of waste;
- Release of landfill water from the landfill (into a recipient or underground);
- Failure to carry out the required monitoring;
- Incorrect procedure during back flow (recycling) of landfill water;
- Failure to secure the landfill against flying off of wastes;
- Insufficient records in the Operational Book;
- Failure to record balance of landfill water.

4.0 Risks of waste incinerators

Waste incinerators appear again and again as miraculous machines for waste processing. People who have to decide what to do with wastes (politicians or officers) often choose an incinerator as a simple solution for a difficult problem. The waste enters the incinerator on one side, and, after incineration, only one tenth of the original volume remains, just imagine! However, we often do not see where this residue ends, and at what expense incinerators operate. Thanks to the adopted directive on waste incineration, emissions to air and to water were reduced, and also limits for wastes from incinerators are being negotiated, but this does not change the fact that incineration is expensive, and that a significant amount of precious raw materials is lost through it. Incinerators are also sources of pollutants released into the environment in various ways.

The incinerators pollute **the air** by a whole number of hazardous substances. In addition to well-known releases of dioxins, which are prevented, to a considerable extent, by filters in up-to-date incinerators, this concerns a whole range of other halogenated organic substances.
In total about 250 individual compounds were identified in flue gases from waste incinerators with concentrations ranging from 0.05 to 100 □g/m^3 in study published by K. Jay and L. Stieglitz (1995).[4]

Water may be polluted in the case that the incinerator uses it for flue gases treatment, or for washing of fly ashes from flue gases treatment. If a release of such water occurs, then it may endanger the environment. Because of that, limits of the content of harmful substances in waste water from flue gases treatment were introduced in the EU. In the case of dioxins, a limit of 0.3 ng I-TEQ/l was set.

The incinerator incinerates **wastes**, but it also creates them itself. After incineration of solid municipal waste, usually one third of the original weight remains, in the form of slag, ash, and fly ash. The most hazardous components concentrate, logically, in fly ashes and in air pollution control residues. This concerns substances which are usually released to air from incinerators having worse technological equipment. Up to 99.9 % of all dioxins in releases from a municipal waste incinerator may concentrate in fly ashes.[5] A whole number of other POPs was detected in fly ashes from waste incinerators, such as polychlorinated naphthalenes,[6] dioxin-like PCBs, polyaromatic hydrocarbons[7], polychlorinated dibenzothiophenes[8], and others.

Energy we obtain by waste incineration is only a fraction of the original energy used for production of the things we now incinerate. By high-quality waste recycling we can get (or, if you like, save) more energy. In this connection, it is necessary to distinguish waste incinerators from plants burning biomass or other energy sources called often "incinerators" in the press. "To call incineration of mixed waste as its thermal use is a return to the 19th century," says Paul Connett, professor of chemistry at the St. Lawrence University in New York.

The further impacts include:

Psychosocial risks, which include factors influencing life quality, such as bad smells, noisiness of the plants, risk of accident, increase of freight transport in the neighbourhood of incinerators etc.

Psychological factors, such as fear of impacts of the incinerator on health and environment in the vicinity of the plant.

Economic factors are also significant. Incinerators create a minimum number of job opportunities, and they reduce prices of land and real estate in their vicinity.

Obviously, incineration is the most expensive way of waste disposal. Both the incinerators and inhabitants of towns where the incinerators are located pay for the bad economic calculation. Incinerators are constructed on the basis of loans which the towns in the region must secure. Thus, investments into incinerators siphon off money from regions, and only companies constructing the incinerators make a profit from the investments. Depreciation forms about 60 % of the price of waste disposal. Even the fact that grants from EU funds are provided to towns for construction of incinerators is not better. Firstly, it results in distortion of the actual costs for waste disposal, and, secondly, this exhausts means which could be used in a better way. Because of that, assistance for construction of incinerators and landfills from state funds was banned in the Waste Management Plan of the Czech Republic.

Another example of waste management which is not environmentally friendly (the wastes should be handled as close as possible to the place of their production) is again from the Czech Republic, where several incinerators try to improve they situation through import of waste from abroad. Gradually, the conditions for deposition of wastes in landfills are becoming stricter in the states of the European fifteen. This increases pressure on export of wastes from these states into countries in our region.

5.0 Case studies on zero waste practices used in CEE region

5.1 Separated waste collection projects carried out by civic activities - Examples from Bulgaria and Hungary

5.1.1 Waste crisis in Sofia and Roma community recycling activities

Based on the report written by Iskra Stoykova (Romani Baht Foundation, Bulgaria)

Sofia Municipality Waste Management Programme

According to the Municipal Waste Management Programme of Sofia, adopted with decision 586 of Sofia City Council on 13 September 2005 with implementation period September 2005 – December 2009, the only method for waste treatment on the territory of Sofia is storing the wastes at provisional intermediary storage - landfill.

No processing of the household waste is taking place and there are no loading stations or waste separation sites constructed. Composition of household waste as of 2000 is shown in Table 1. Generated household waste in Sofia municipality is presented in Table 2.

Table 1: Morphological composition of household waste as of 2000 (weight %)
Source: Sofia Municipality Waste Management Programme 2005 – 2009

1.	Paper and cardboard	7,9
2.	Polymers	6,8
3.	Glass	12,0
4.	Metals	1,5
5.	Textiles	1,5
6.	Timber	1,0
7.	Leather, rubber	1,0
8.	Food and kitchen waste	35,0
9.	Slag, sand, earth	4,6
10.	Others of predominantly organic origin	28,7

Table 2: Generated household waste in Sofia municipality
Source: Sofia Municipality Waste Management Programme 2005 – 2009

Year	**2001**	**2002**	**2003**
Generated household waste in tons	336 000	352 377	364 444

Note: The quantity of the household waste is according to data of the operator of Suhodol landfill

Until September 2005 the waste of Sofia went to the "Suhodol" landfill which was the first and only depot on the territory of Bulgaria operating according to the EU Directive 99/31. It provided service to four towns and 34 villages with a total population of 1.2 million people. Its capacity was exhausted in June 2005 but depositing continued despite citizens' protests and blockades until September 2005.

According to commitments made by the State, by 2011 Bulgaria has to introduce mass recycling of waste which then needs to be further processed in waste plants. Since 2005 the Sofia municipality has made contracts with the four out of the five private organizations for recovery of waste operating in Bulgaria – Ecobupack, Ecopack Bulgaria, Bulecopack, Re Pack, and Reco Pack. If a private firm that produce packages or packages its goods does not pay a license fee to one of the five private organizations, it should pay a product fee for waste treatment to the State Enterprise for Management of the Activities for Protection of the Environment (EMAPE) at the Ministry of Environment and Waters (MEW). The funds received should be re-invested in new containers for recycling until the whole territory of the country is covered. In fact, these fees are paid by the consumers because they form the price of the products. More details on this are included in a report focused on Sofia zero waste case study more deeply[9].

The role of Roma scavengers and Roma carters for recycling in Sofia

MEW (2003a) estimates that roughly 10,000 people are scavenging rubbish bins and landfills to collect and sell recyclable materials in the territory of Bulgaria. It is not clear where this figure comes from as there are no studies. In Bulgaria, as in many countries where scavenging exists, it is associated with dirt, disease and squalor. This livelihood leads to low life expectancy and high infant mortality. Even if scavengers are not the poorest they are ascribed the lowest status in the society. (Medina, 2000)

The recyclable materials are left by some people next to the rubbish containers but most of them are thrown away mixed, which substantially decreases their quality and collection rate.

In Sofia there are three Roma neighborhoods – *Fakulteta* with a total population of 35,000; *Hristo Botev* with a total population of 13,000 and *Filipovtzi* with a total population of 4,000 people (Figure 3). (Statistics are unofficial, according to information of locally based Roma NGOs, while the official numbers are half as large.)

The total number of Roma scavengers working in Sofia is about 75 of whom 30 are from *Fakulteta*, 20 from *Hristo Botev* and 25 from *Filipovtzi*. The total number of Roma carters working in Sofia is about 205 of whom 100 are from *Fakulteta*, 70 from *Hristo Botev* and 35 from *Filipovtzi*.

The carters usually have two horses each but some of them have 4-5 horses, two of which they rent out to other Roma. Some of the carters have apprentices who are young boys between the age of 10 – 15 year-old who do not receive any wage or money for the materials they have collected during the day but only food and cigarettes. Normally one cart will collect about 100 kg of metal or $2m^3$ of wood and will make on average 1 trip per day each day.

The major types of materials collected by the scavengers and the carters are paper, glass, metals, plastics and wood including the sub-categories as described in the Table 10 in Annex 1.

The main sources of materials are the trash bins; the basements of the people living in blocks of apartments and houses who let the Roma clear them of unnecessary items; the shops; the construction sites, the factories. Recently, the access of carts to the city center has been restricted but the regulations are not followed. Sometimes the carters are arrested by the police because of alleged stealth of the materials transported. Therefore they have started asking for letters from the owners of the shops or the basements acknowledging that they have conceded to give out the materials.

The carters collect mainly iron and non-ferrous metals as well as wooden materials during the winter period (November – March). The scavengers collect paper, glass and non-ferrous metals. Both groups sell the materials collected /apart from the wooden materials/ to local purchasers' collection points or to other Roma living in the neighborhoods, who later sell it to the collection points. The wooden materials are sold during the winter period internally in the Roma neighborhoods and are used for heating.

Figure 3: The three Roma neighborhoods, Sofia, Bulgaria

I – Philipovtzi neighborhood; II – Fakulteta neighborhood; III – Hristo Botev neighborhood

For the purposes of this research interviews with 30 Roma carters and 30 Roma scavengers were made from all three Roma neighborhoods. Besides, 7 collection points for paper, 5 collection points for paper and glass, 4 collection points for glass, 5 collection points for paper, glass, plastics, iron and non-ferrous metals, 10 collection points for iron and non-ferrous metals were visited. The collection points visited are located in 4 administrative districts in Sofia in close proximity or inside the Roma neighborhoods, where the largest quantity of materials is sold.

The flow of the materials: the collection shops and the reprocessors

There is no reliable data on the number of collection shops in Sofia municipality as well as in the country as a whole. The number according to various sources fluctuates between 500 and 1,800 for the territory of Bulgaria. In principle, the collection shops should obtain their license from the Regional Inspectorate of Environment and Waters but no such database is kept presently.

There are eight producers of *paper* with recycling facilities. The two biggest reprocessors Trakia Papir Plc and Belovo Plc recycle 90% of the waste material. There is a substantial difference in the price of used paper and cellulose, which makes recycling paper very profitable. The secondary raw materials are 50% of all raw materials used in the paper production. The companies do not have technologies for recycling paper covered with polymers, foil, grease, *etc.* (such as Tetrapak). Of the 276,913t paper waste generated in 2001, 125,163t was packaging waste and around 65,000t was recycled.

In Bulgaria the recycling metallurgical industry is gaining momentum after main factories were privatized and are currently being modernized and increase their production capacity. The major reprocessors of scrap from ferrous metals are Stomana Industry Plc – Pernik, Kremikovtzi Plc – Sofia, LeKoKo Plc – Radomir and the iron casting factory in Ihtiman. The scrap metal from non-ferrous metals are purchased and reprocessed by Yumikor Copper Plc. – Pirdop, Sofia Copper Plc., Alchomet Plc. – Shoumen, Cabelsnab – Sofia.

According to the review of the Bulgarian Association for Recycling (BAR), which is a non governmental organization with members that comprise 80 percent of the market of scrap ferrous metals and 90 percent of the market of non- ferrous metals, the revenue of the recycling industry of scrap metal formed 2.7 percent of the GBP of the country in 2003. The major companies on the market operate all of the following: little collection shops; regional basis for collection; central basis for sorting and treatment; reprocessing plants or export.
The scrap from steel is 100 percent exported because there is no reprocessing capacity in the country. The proportion between reprocessed in the country and exported scrap from ferrous metal is 68 percent to 32 percent. In the case of non-ferrous metals this proportion is 34 percent to 66 percent. The transportation costs in the case of exports sometimes reach 10 percent of the price of the scrap and the prices are formed based on the quotes from the London Stock Exchange. Around 11,000t metals were recycled in 2001. The metal packaging waste was 21,473t out of 65,123t total metal waste.

There are six companies producing *glass*. Four of them have technologies for glass recycling, three have an interest in recycling, and only one - Stind Plc - is actually recycling glass - mainly waste from the fillers. In 2001, 12,000t of glass waste was recycled, the glass packaging waste was 88,000t and the total glass waste 141,000t (MEW, 2003a). The first installation for glass recycling with metals separation, milling and cleaning equipment was constructed in Kichevo, Varna municipality in 2001. (BEEA, 2003) Even if glass can be recycled many times, the low purchase prices and the high requirements for purity and separation of the different colours of glass make its recycling unprofitable.

All current reprocessing capacities can meet the recycling targets except for *plastics*, of which only 11% can be recycled (MEW, 2003a). The high-technologies needed for the separation of different plastics, the contaminated nature of the plastics received from containers, the limited number of recycling facilities, and the low prices of the imported polyethylene plastics for recycling and primary raw materials all lead to high recycling costs for municipal waste plastics. There is still no facility for automatic separation of the different plastics types in operation. All this results in recycling of mainly waste from industrial processes: PP (polypropylene) and PS (polystyrene) plastics: 2,000-3,000t/y. The plastic collected by the shops is around 400-500t/y (Argus and MD Urboproject, 2001). The total plastics municipal waste is estimated to be 263,000t/y, of which 106,000t/y are packaging waste (MEW, 2003a). Until recently there was no recycling of PET plastics in Bulgaria, so the collected PET plastics were exported. An installation for recycling of PET has been constructed in Shumen by Metarex Ltd in 2002 (MEW, 2003c).

There is no collection or recycling of other packaging materials such as textiles, composites, and wood (Argus and MD Urboproject, 2001).

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5.1.2 The separate waste collection program in public and office buildings (IPP) in Budapest, Hungary

Based on the report written by Balasz Tömöri (HuMuSz, Hungary)

The separate waste collection program in public and office buildings (IPP) carried out by HuMuSz Recycling Ltd. has started in 1998. The Ministry of Environment (MoE) asked an NGO HuMuSz to write a study on introduction of separate waste management in the buildings of MoE. The NGO analyzed the content of their waste bins and wrote the study.

Few months later, the MoE asked HuMuSz to help to realize the project. According to Hungarian laws only companies can get permits to transport and handle waste, NGOs can not get the necessary permits. So, HuMuSz became the coordinator of the recycling project of MoE. After accepting the request, they decided to implement the project step-by-step and to start with separated paper waste as a good first step of the recycling project. The members of the NGO chosen the type of waste bins, good places for their location in every floor of the office buildings, and the containers for larger volumes of separated waste as well.

We educated and checked the cleaning staff regularly. We got enough space to store some waste and had regular contact with recycling companies. We called them to come when there was a lot of separated waste available, making the transport more cost-effective.

Every 3rd month all the officers get information on how much waste they collected separately; how much energy, natural resources they saved.

Seeing that it was a serious project of a credible NGO, and that waste is transported and further separated by credible recyclers, all the officers and cleaning staff cooperated a lot. It was time to come up with separate waste collection of other waste streams.

The successful pilot project was named in a government decree written to state institutes and offices on the importance of showing good example to public. This was the good example that HuMuSz is running a separate waste collection program in buildings of MoE.

Most probably thanks to this government decree – since HuMuSz did not advertise - state owned institutes and the business sector started to be interested in this service and HuMuSz had to think about how to move further.

We had to found a company to get permission for handling and transporting waste, so HuMuSz Recycling Ltd. was founded. We got a van and colleagues prepare a small hydraulic jack to lift heavy containers onto the van.

Currently, HuMuSz Recycling is organizing separate waste collection programme in the buildings of 11 state or business offices including the MoE, National Park headquarters, Office building of the Hungarian Parliament, Hungarian Meteorological Service, Allianz Hungary insurance company and others (see Annex 1 - Table 11). All these public buildings, state institutes and companies are located in Budapest, except for the Regional Environmental Centre of CEE which is in Szentendre, 25 kms from the capital. That makes the logistics easier and more economical to organize.

There is a strong demand from new offices as well.

Brief description of practice

The IPP of HuMuSz Recycling Ltd has several phases:

I. Preparation:

1. Study the office and its streams and amount of waste
2. Finding the places of collection points on every floor of the building, finding the waste bins, and a finding a suitable place preferably on the ground floor level where large amounts of separated waste streams can be stored
3. Educating the cleaning staff and the employees of the office by giving lectures, advertising it through wallpapers, spreading a leaflet and answering practical questions

II. Running the program:

1. monitoring the cleaning staff
2. regular feedback to each and every participant of the program on the approximate amount of waste she/he collected and the primary resources saved by this activity
3. replacing bins and information material if needed
4. when the storage at every office is full of separated waste HuMuSz Recycling Ltd is organizing logistics; collecting the same waste streams from more office buildings and transport it to recyclers

Specific outcomes from the IPP recycling project

Before these offices started to collect their waste streams (listed above) separately, the waste ended up in disposal facilities. Approximately 60% of it went to Rákospalota waste incinerator, the rest to the waste landfill of Pusztazámor.

The offices do not stop producing waste which is not recycled, but the total amount of waste disposed is reduced significantly.

Table 3: Overview about outcomes of the project for year 2005.

Waste stream	Waste collected, 2005	What is happening with it?
Paper	76 265 kg	Preparation in Budapest then recycling in Csepel (H)
PET	2 949 kg	Preparation in Budapest then recycling in China
Glass bottle	14 740 kg	Preparation in Budapest then recycling in Czech Republic
Battery, akku	187 kg	Preparation in Budapest then landfilling in Aszód (H)
Office hazardous	281 kg	Preparation in Budapest then incineration in Dorog (H)
Electronic	5 040 kg	Preparation in Budapest than recycling in various metal recycling companies (H)
Fluorescent lamps	92 kg	Preparation in Budapest then landfilling in Aszód (H)
Furniture	1000 kg	reuse

Table 4: IPP project costs sum up in Euros.

Item	Sum per annum
Salary of the two coordinators	14 000
Cost of the operation of the transporter van	1 200
Cost of different waste bins	2000 – 8000
Amortization of waste bins	400
Operation of the office and costs of communication	600
TOTAL	**18 200 - 24 200 Euros a year**

The report carried out by HuMuSz within IPEP gives more examples about options for separated waste collection and waste reduction tools in Hungary (Tömöri, B. 2006).[10]

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5.2 Zero Waste strategy in Palárikovo (Slovakia) - a municipality driven project

Based on the report written by Bronislav Moňok (Friends of the Earth, Slovakia)

The municipality of Palárikovo is located 80 km east of Bratislava, near the district town of Nové Zámky. The municipality has 4,380 inhabitants who live in 1,618 housing units. From this number, 1,165 live in family houses, and about 600 inhabitants live in 34 blocks of flats.

The municipality had to start solving the issue of wastes in 1999, when its municipal landfill was closed down thanks to stricter legislation. At that time, the municipality could choose either the possibility of transporting the wastes to another landfill, connected with higher payments both for the transport and for the fees for landfilling, or to start composting and recycling of wastes. In addition to that, the new legislation set a number of other obligations of municipalities, which had to be solved, too.

The first step the municipality did was an analysis of the existing situation. It determined composition of municipal waste in the municipality. Approximately 30%, by volume, was represented by biological waste, 25% by PET-bottles, 15% by paper, 5% by glass, and further 5% by other plastics. The municipality also found that, in spite of 17 years of education of the public, the local people practically do not use the local collection point for secondary raw material. Thanks to this analysis, the municipality came to the conclusion that preservation of the existing system of deposition of waste to a landfill would be several times more expensive for it than before. Further, it realised that if it wanted people to separate more waste, it would have to create a system of collection showing the maximum possible comfort. But, simultaneously, such a system had to be feasible from an economic point of view.

Implementation of the project started in 2000 through intensive education of the public concerning reduction of biologically decomposable municipal waste - promotion of domestic composting. Regularly, two-times a year, the inhabitants obtain, in their households, leaflets on domestic composting with the possibility to use the municipal composting places. Education of the public is ensured also by means of local media - press, radio. The citizens association "Palárikovská ekologická spoločnos" (Environmental Association of Palárikovo) produces, for free, composting tanks for the interested persons, and it supplies them to households together with information leaflets. In order to support composting, the municipality bought also a chipper, and in the time of thinning out of trees it ensured chipping of branches for the inhabitants.

Since 2002, an integrated system of separated waste collection has been implemented in the municipality. The system started by collection of four basic components - glass, paper, plastic packaging - PET-bottles and multilayer combined materials. At present, about 18 kinds of collected components form part of the system. However, only raw materials marketable on the basis of contracts concluded in advance are separately collected. Till 2004, the municipality introduced gradually separation of paper and cardboard, tetrapak, glass, various types of plastics, metal packaging, textiles, electronic scrap, tyres, batteries, cables, high-volume waste, hazardous waste, and small building waste.

Economic stimulation of the inhabitants is important. In 2000 to 2003, people paid a lump-sum fee (7.4 EURO for people who do not separate waste, and 4.7 EURO for people who do separate). Now, when 99 % of inhabitants have participated in the system, the PAYT (pays as you throw) principle has been applied. The waste producers pay only for mixed municipal waste which is disposed of through landfilling. They do not pay for the separated commodities. The fee for removal of one dustbin of a volume of 110 litres is 1.08 EURO.

The municipality uses a sack system for collection of the separated materials. At present, the wastes are collected once in two months. Simultaneously with the sacks, electrical waste and high-volume waste is collected. The municipality gets the sacks at a low price (in the beginning, it got the sacks for free, now it pays 0.025 EURO per one sack), and it started the whole system with minimum investments. The separated raw materials from the sacks are clean and may be more easily processed. The system is beneficial also for the inhabitants who do not have to carry the wastes anywhere. In the time of collection, they put the sacks in front of their house.

A collection yard, where people can bring separated components of municipal waste, according to their needs, is under operation in the municipality. After reconstruction of the collection yard is finished, a room of still functional things which people will be allowed to take for free - small devices, white goods, furniture, etc. - will be present in its premises.

The separated components are further processed in the municipality. The PET-bottles are separated according to colours, the other plastics according to the material. The separation is carried out in a simple way - on big tables, around which sacks on the materials are hanging. The raw materials are further pressed in bales. The money for the press (10,300 EURO) was received from the Recycling Fund established by the state.

Figure 5: Sorted waste collection, Palárikovo

Thanks to the fact that 28 additional municipalities from the neighbourhood (50,000 inhabitants) joined Palárikovo, the municipality obtained a contribution for construction of a Regional Collection Yard from the Recycling Fund.

The municipality is an example to its inhabitants. The Municipal Authority separates seven components of its waste, and, in addition to that, it is composting its biological waste. Further, it constructed two small composting plants in the municipality. In Slovakia, biological waste in the amount of up to 10 tons may be composted in unsecured places. In addition to that, the municipality introduced a green line for the inhabitants. Its services reside in that if somebody wants to get rid of something what somebody else could still use, the municipality mediates this offer to the other people. Through this, it meets the principle that the best way is to prevent waste production.

The whole recycling system is beneficial from an economic point of view, and profitable for the municipality, which derives the highest income from recycling of PET-bottles. What is important is that the municipality manages the whole system itself. It also continually improves its system. For example, in order to reduce its costs, it began waste separation also in the cemetery.

The municipality was the first municipality in Slovakia which openly adopted the Zero Waste system. It wants to further reduce its waste production. It carried out a new analysis of composition of the mixed waste and it found that biological waste forms 68 % of its amount. Thus, it wants to start activities promoting composting again. One of these activities is mediation of sale of composters to the inhabitants. Thanks to purchase for the whole region, their price can be lowered considerably.

Figure 6: Waste selection at cemetary in Palárikovo

The local companies became involved in the whole waste management system, too. The original fears that the system would be a competitor to the company Sběrné suroviny (Secondary Raw Materials) proved to be erroneous. This company is engaged in the purchase of metals only. The separation takes place also in the post, elementary school, as well as nursery schools. Children take part in a competition in tetrapak collection.

These results were successfully achieved thanks to enthusiasm of responsible people lead by Iveta Markusová, and voluntary help of young people. Friends of the Earth - SPZ, an environmental organisation from Košice, helped the municipality.

Table 3: Reduction of the amount of municipal waste disposed by landfilling:

Year	1999	2000	2001	2002	2003	2004	2005
Amount	1,300 t	1,250 t	985 t	750 t	550 t	470 t	330 t

Table 4: Efficiency of the waste management system in the municipality

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Mixed / residual waste [t]	1,250	985	750	550	470	330
Amount of mixed waste [kg/inhabitant/year]	285.4	224.8	171.2	125.6	107.3	75.3
Reduction of the amount of mixed waste in comparison with the year 2000 [by %]	-	21.2	40	56	62.4	73.6
Separated raw materials [t]	-	-	118.6	174.8	263.4	316.65
Biological waste used in municipal composting plants [t]	-	-	-	-	300	420
Biological waste used through domestic composting [t]	-	-	-	-	335	431
Degree of material utilisation of municipal waste (including the domestic composting) [%]	-	-	-	-	54.5	77.9
Degree of material utilisation of municipal waste (without the domestic composting) [%]	-	-	-	-	65.6	69

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5.3 Composting of biodegradable waste - Examples from Latvia and Czech Republic

5.3.1 Composting of biodegradable municipal solid waste in Stopini and Kekava municipalities, Latvia

Based on the report written by Ruta Bendere (Waste Management Association, Latvia)

Basic information about municipal solid waste in Latvia
According to the performed investigations[11], in 1995 in Latvia 248 kg of municipal solid waste (MSW) was generated per inhabitant. During the last decade the amount of generated MSW increased similarly as in other European countries[12]. Figure 6 represents the MSW production per inhabitant from 1995 to 2003. The composition of the municipal waste is presented in the Figure 7.

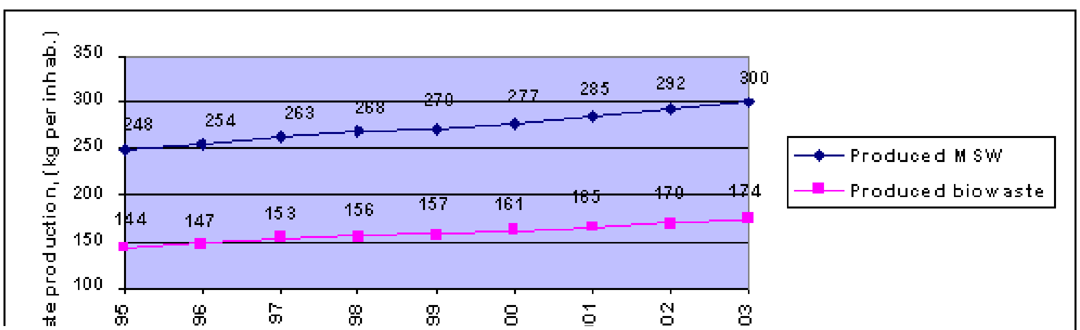
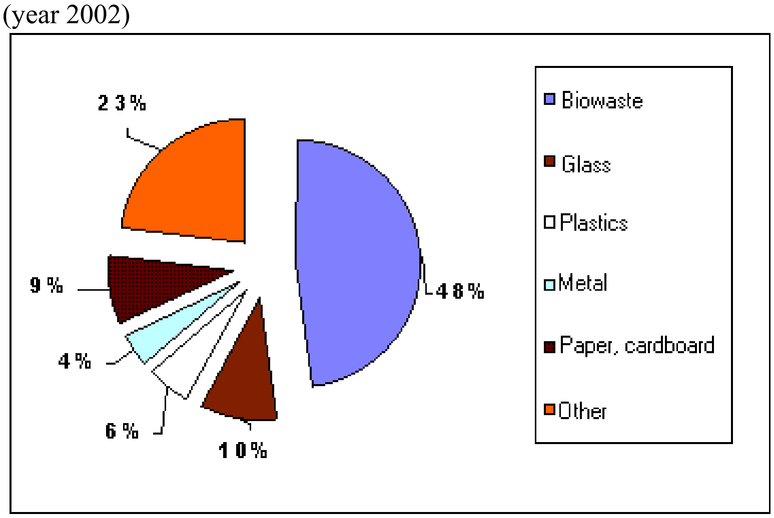


Figure 7: The composition of the municipal solid waste in Latvia (year 2002)



The official data from Waste management plan of Latvia reveals that only a small part of municipal waste is recycled (see Table 5) and the largest part of waste in Latvia is disposed of. Large improvements in that direction are performed in the field of biodegradable waste management. Pilot projects for separate collection of biodegradable waste were realized to get a practical knowledge of handling with organic waste and recycling to produce a high quality fertilizer.

Table 5: The utilization of MSW in Latvia.

The method of treatment or disposal	Waste type	Waste quantity (percentage of all)
Disposed in the dump sites or landfills	Unsorted municipal waste	77 %
Used as secondary materials	Packaging material or biodegradable organics	10 %
Incinerated	Organics	6 %
Used as building materials	Inert materials	5 %
Stored	Hazardous municipal waste or reused waste	1 %

Treatment of biodegradable municipal solid waste using composting technologies - Managing the biodegradable waste

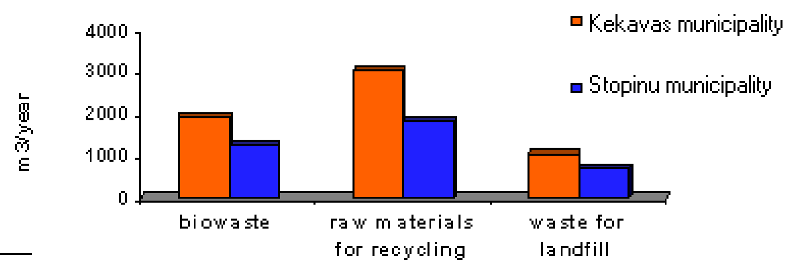
The main goal of the project described in this case study[1] was to create and implement an optimal scheme for local municipalities for the separate collection of the municipal biodegradable waste and elaborate and apply the appropriate composting technologies on pre-industrial scale to provide the high quality compost from the biodegradable municipal waste.

The project realization plan includes the six tasks - to create and implement the biowaste sorting system for Kekava and Stopini Municipalities (Task 1); to elaborate composting schemes for the produced biowaste types and quantities according to the selected treatment technologies and to control the bio processes and produced compost (Task 2); to apply the selected composting technologies for sorted biowaste treatment: composting using open windrow technologies (Task 3) and composting using the bioreactor prototype (Task 4); to disseminate the project results (Task 5) and to ensure the project management (Task 6).

All those activities will eliminate the negative biowaste impacts on the environment as the active biodegradable organic fraction will be taken out of the stream coming to landfills and returned to the life cycle as high quality fertilizer.

The project was started with collection of information about the waste management situation and produced types and quantities of different biowaste in the selected project areas. It became obvious that the

Figure 8: Main components of household wastes composition in two municipalities in Latvia.



[1] Project title: Treatment of biodegradable municipal solid waste using composting technologies. Project location: Latvia, Stopini and Kekava municipalities. Project start date: 01.10.2003 Project end date: 31/12/2005 duration 27 months. Beneficiary Waste Management Association of Latvia (LIFE03 ENV/LV/000448)

most optimal from economical and environmental aspects was to arrange the collection points for sorted biowaste and secondary used raw materials near the big apartment dwellings and at the same time to provide active work with the waste producers.

As a system for secondary raw material collection (glass, plastic and paper) was already in use in some places of Stopini and Kekava Municipalities, it was planed to involve separate collection for three main types of waste - biowaste, raw materials for recycling (glass, plastic, paper and other) and mixed waste currently mostly for landfilling in Latvia (see Figure 8). On the bases of main activities: the systematic work with municipal authorities and staff; regular meetings with different groups of society (school pupils, waste collectors, inhabitants from many apartment dwellings, etc.) provision of dissemination activities and materials (films, guide books, booklets, leaflets, posters and special bio waste collection bags with information on waste collection), was prepared and implemented the first source separate system in Latvia for collection of biodegradable waste in both municipalities.

On the basis of the results of investigations and methodology elaborated in the Institute of Microbiology and Biotechnology of the University of Latvia and the tests of the collected municipal biowaste content the compost composition was elaborated and experimental composting of biodegradable MSW from households was realized.

It was realized by using two composting methods in open air – windrows and piles, and a closed bio reactor vessel. The design and creation of the pilot equipment -bio reactor, which was the main option of task 4, was done by Harman Ltd.. The practical exploitation of the bio reactor was provided by Meliorators Ltd. in Marupe. The design of pilot equipment was elaborated according to the proposed quantities of collected biowaste per week and this produced a bioreactor with the capacity of 25 m^3 waste per week. It was concluded that the main conditions for continued work of the reactor is - the size of waste components, relation of nitrogen and carbon for activation of microorganisms and temperature regime. For cold winter conditions the bioreactor needs a surrounding temperature for activation of aerobic process of not less than plus 10° C. A description of biowaste composting technologies is given in more details in Annex 2 to this report.

Information on the Project activities and results were published in the newspaper „Poligons", reflected by the prepared web site www.lasa.lv, published interviews in public communication tools, organizing the TV broadcasts, by participation in the exhibitions and conferences. For the information of local society a guide book, posters and leaflets were prepared and published. A lot of seminars were provided for large public participation, but at the end of the project the film "Composting" was produced and the book "Biowaste management" was published. All the project results, including visits to implementation sites, were presented at the conference with more than hundred specialists and representatives from different municipalities.

The project output:

- arrange 9 sorted waste collection points in Kekava municipality with 28 special biowaste containers and 18 source separated waste collection points with 40 special biowaste containers in Stopini.
- each month approximately 60 m^3 of biowaste from households (~ 30% of all produced biowaste) was collected separately

- elaborated and implemented the optimal bio waste composition for composting in open air windrows and piles
- arranged a new composting site in Marupe and technologically improved composting site in Stopini
- supplied and used for composting all planned technical units (compost mixer, crusher, loader)
- designed and constructed the pilot equipment – bioreactor with a capacity of 25 m^3 of biowaste compost weekly
- provided tests of composting processes in open (open air windrows and piles) and closed (bioreactor) conditions
- provided tests of compost quality and elaborated methodology for obtaining high quality compost
- on the bases of achieved results prepared and presented reports at the World Congress of Biomass in Rome in 2004 and European Congress of Biomass in Paris in 2005
- Prepared and published the book "Bio Waste Management Methods" and produced a TV film "Biocomposting";
- Project activities were reflected on the web site www.lasa.lv, and represented by articles in local and regional newspapers and journals;

The main project results are used as theoretical and practical foundation for elaboration of contract work with the Latvian Environmental ministry "Proposal for biowaste management according the demands of EC Directive 199/31/EC and regulations of Cabinet of Ministry of Latvia No.15."

Conclusion

According the results of project activities, we can conclude that the main bases for the successful implementation of elaborated biowaste separate collection schemas is an active participation of all society groups in the proposed waste management system. More preferable is the waste collection system which includes not only separate biowaste collection but is established as an integrated system and includes all recyclable components of municipal waste. At the same time the project will give real benefits in the development of waste management if after the demonstration phase the results of the provided work can be implemented in practice without additional costs or principal changes. It means that the project must elaborate the waste management schema which is prevalent not only from the point of reduction of waste disposal impact but is economically stable and sustainable.

Additionally the project promotes the real cooperation between NGOs, municipalities, state institutions and companies and gives the real opinion in managing and implementation of EC projects

The project performance gave a set of main parameters characterizing the recovery of biowaste and the quality of the compost and promoted the selection of an optimal aerobic process (see Table 10 in Annex 1 and description in Annex 2 to this report). It was concluded that the composting in a closed reactor is more preferable.

5.3.2 Domestic composting in micro-region Kosířsko (Czech Republic)

Based on the report written by Jiřina Popelková (Hnutí Duha - Friends of the Earth, Czech Republic)

This project is an example of public education and information campaign supporting domestic composting in a defined territory – the micro-region of Kosířsko (8 municipalities, in total 9,816 inhabitants) - within the period of 5 months. The purpose of the project was to also prepare a plan of further activities. It means that this was a "starting" project, which should be followed by further projects.

The purpose of the project was to increase awareness of the inhabitants and representatives of the municipalities concerning domestic composting, on two levels:
a) To show the importance of domestic composting in waste management conception of each municipality;
b) To explain correct procedures when starting a compost, during composting, and during use of the compost in the garden.

Another purpose was to prepare a strategy of increased of biological waste utilisation in the micro-region, and to submit it for approval.

Secondary purposes were important too. These purposes were to obtain more information on the amount and composition of household waste in smaller municipalities, and to map attitudes of local people to this issue. The project was carried out under the support of non-governmental organizations (NGOs). Funds for the project were ensured by an association of municipalities (micro-region Kosířsko). The municipalities are smaller municipalities with typical village buildings (family houses with gardens). An exception was the municipality Lutín with 3,212 inhabitants, half of whom live in a block of flats in a big housing estate.

In total, 2,254 tons of mixed municipal waste was produced in Kosířsko in 2004. In comparison with the year 2001, this represents an increase of 75 %. In the municipalities Hněvotín, Drahanovice and Ústín, the increase was about threefold. This increase was probably caused by introduction of a lump-sum fee since January 1, 2002.

The municipalities do not have a waste management plan. In the municipalities, waste paper, plastics, and glass are separated (usually into containers in a few places in the municipality; an exception is formed by two municipalities where people separate plastics into sacks which are collected from the individual houses). No system of management of biological waste from the inhabitants exists. Only in the municipality Lutín is there a one-day collection of garden waste which is carried out twice a year. Green waste from public vegetation is managed differently in the individual municipalities. In the majority of cases, grass is used for mulching or transported to a dunghill, leaves are transported to a dunghill, and branches are burned. The municipalities have never before solved the issue of waste management jointly.

Not only here, but in the whole Czech Republic, there may be noticed a departure of households from domestic composting and a yearly increase of amount of municipal waste in dustbins, and, increasing costs of municipalities and increasing fees for the inhabitants connected with that. The micro-region Kosířsko is not exceptional in this respect. To the contrary, it is typical according to our assumptions. It will be possible to use results of the project in other municipalities and micro-regions.

Activities

1) Questionnaire opinion poll
A questionnaire was delivered to all households. The level of return of completed questionnaires was about 10 %. From the received responses, 99 % of households are composting (in various ways). However, the return of questionnaires was low and the results are not statistically significant.

2) Preparation of a strategy of a gradual solution of the issue of biological waste in the region (for 3 years)
- It comprises: domestic and communal composting, supplementary separated collection, and a system of motivation tools for the citizens, communication with the public, economic assessment of the whole proposal, a system of continuous monitoring and evaluation of efficiency.

3) Discussions about the strategy with representatives and inhabitants of the municipalities and its presentation

4) Design of a model composting site in Těšetice which will be used for composting of green waste from the school garden and from municipal land. An educational board was placed at the composting site

5) Organisation of meetings for the inhabitants; Explanation of domestic composting and of negative features of garden waste burning, discussion, projection of a presentation with photographs of composters, chippers, etc.

6) Distribution of the booklet „How to compost correctly“ to all households

7) Analysis of the composition of household waste - with a focus on biological waste content
Results of the analysis: in the districts of family houses, biological waste (both kitchen and garden) forms 37 % of household waste in dustbins, in the districts of blocks of flats this is 40 %.

8) Programmes of environmental education in schools (ca 60 classes). The programmes met with a high interest of teachers.

Unfortunately, the project showed that both representatives of the municipalities and their inhabitants underestimate the issue. Mayors of the municipalities are also rather busy. During implementation of the project, waste production in the region was not reduced, however, this was not the aim of this stage of the project. The budget of the project was low, about 3,100 EURO.

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6.0 Zero Waste practices and unintentional POPs releases

Municipal waste management is a potential source of POPs emissions. The Stockholm Convention, Annex C, specifies sources of PCDD/Fs, PCBs, and HCB in connection with waste management:

Part II
(a) Waste incinerators, including co-incinerators of municipal, hazardous or medical waste or of sewage sludge

Part III
(a) Open burning of waste, including of landfill sites

The Zero Waste programme has much wider consequences. If its principles are applied, emissions are reduced thanks to reduction of over-consumption, minimisation of wastes, as well as thanks to energy saving during recycling. Thanks to broad communication with the public, and comfort of the system, domestic waste burning is reduced.

In this study presented zero waste practices prevent flow of wastes to waste landfills and municipal solid waste incinerators. It prevents also unintentional POPs releases from their significant sources, which are waste incinerators and/or fires at landfills. Table 6 shows for example dioxin (PCDD/Fs) releases per 1 ton of disposed municipal solid waste according to UNEP Dioxin Toolkit 2005 edition. [13] Other figures can be calculated when we use some other default emission factors. Some of them per 1 ton of municipal solid waste for Central and Eastern European countries are presented in Table 7.

Table 6: PCDD/Fs releases by burning 1 ton of municipal solid waste under different conditions / source categories according to UNEP Dioxin Toolkit, 2005 edition.

Source Categories	Potential Release Route (µg TEQ/t)			
	Air	Water	Residues	Total
Low technol. combustion, no APC system	3,500	-	75	3,575
Controlled comb., minimal APC	350	-	515	865
Controlled comb., good APC	30	-	207	237
High tech. combustion, sophisticated APCS	0.5	-	16.5	17
Landfill fires	1,000	-		1,000
Uncontrolled domestic waste burning	300	-	600	900

Table 7: PCDD/Fs releases by burning 1 ton of municipal solid waste under different conditions / source categories according to data from CEE region and EU.

Source Categories	Potential Release Route (µg TEQ/t)			
	Air	Water	Residues	Total
Modern MWI, Czech Republic[14]	0.93			
MWI Termizo Liberec, dioxin filter, Czech Republic[15]		-		50
MWI Termizo Liberec, dioxin filter, Czech Republic[16]	0.9	-	29 - 90.2	29.9 - 91.1

Source Categories	Potential Release Route (µg TEQ/t)			
MWI in Bratislava, data for 2003, (meets the EU limit for air emissions 0.1 ngTEQ/m^3), Slovakia[17]	0.4			
MWI in Košice, data for 2003, (does not meet an EU standard 0.1 ngTEQ/m^3), Slovakia[18]	60			
Older MWI, Europe[19]	25-1,000			
Up-to-date equipped MWI, Europe[20]	0.5			
Modern MWI in England and Wales, data for 2002[21, 22]			10.1 - 183.7	
Landfill fires				No data

Note: MWI = Municipal Waste Incinerator

According to a number of studies, emission factors in the Toolkit relating to landfill fires, as well as to illegal domestic waste burning, are too high. As follows from the two graphs at Figures 9 and 10, there exists a significant link between PCDD/Fs emissions and PVC content in the waste.[23]

Figure 9: Burning Domestic Waste in Steel Barrels and Open Piles – Emission Factors for Releases to Air (GW = garden waste; HHW = household waste; RDF = refused derived fuel; OP = open pile; B = barrel)

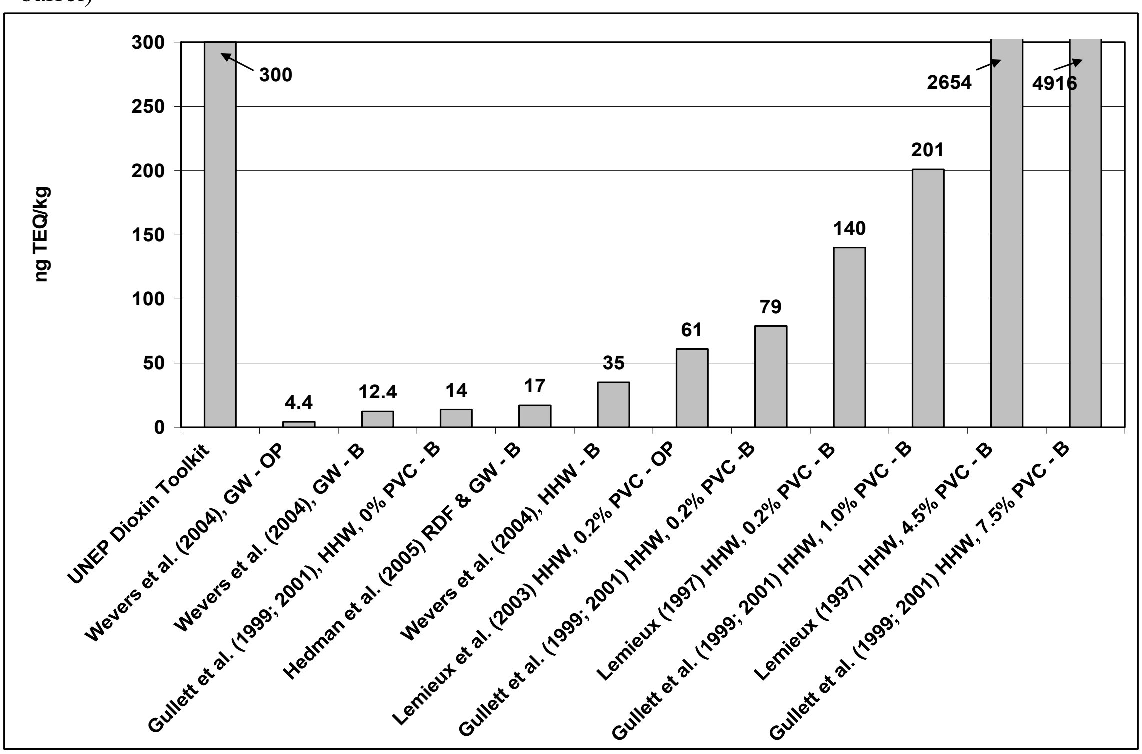
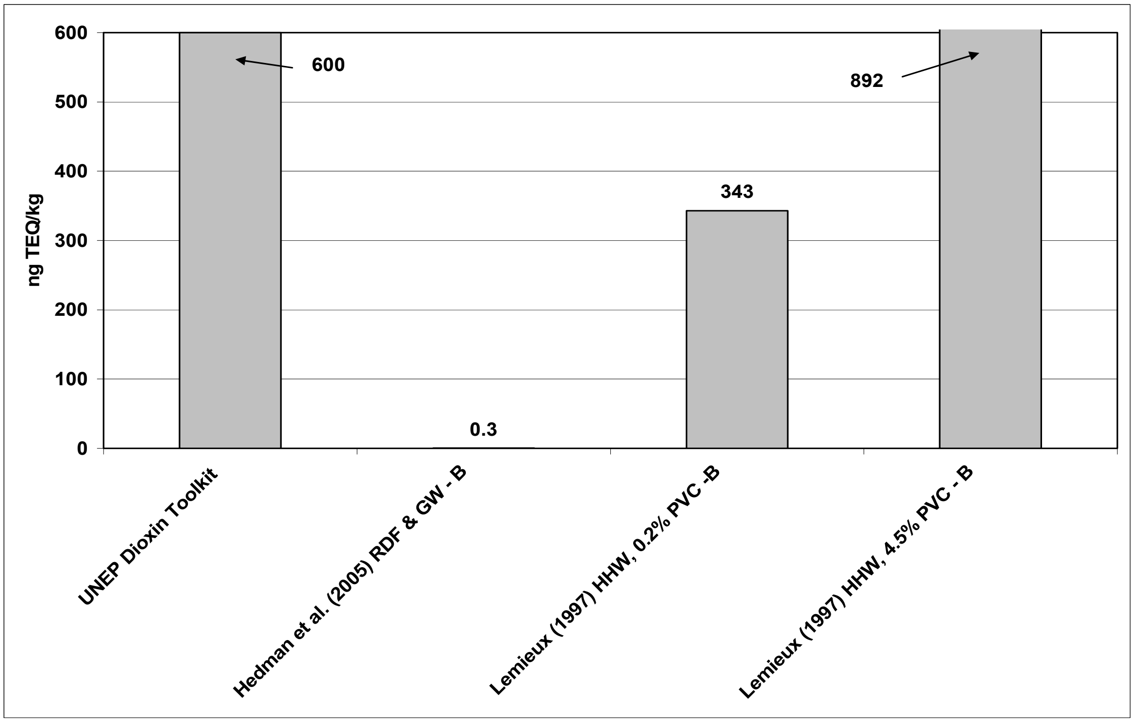


Figure 10: Burning Domestic Waste in Steel Barrels and Open Piles – Emission Factors for Releases to Residues (GW = garden waste; HHW = household waste; RDF = refuse derived fuel; OP = open pile; B = barrel)



For calculation of emission default factors for landfill fires are less data available with wide range of results. In a landfill fire simulation, Hirai et al. (2005)[24] burned refuse derived fuel (RDF) in a steel bowl filled with soil for example. The RDF was comprised of paper and textiles, 51.8 percent; plastics and leather, 32 percent; wood and grass, 5.3 percent; garbage, 9.5 percent; non-combustibles, 0.4 percent; and others, 1 percent. They reported emission factors for releases to air of 23-46 ng TEQ/kg and for releases to residues, 120-170 ng TEQ/kg, with 70-90 percent of the dioxins partitioned to the residues. Hirai et al. report shows that landfill fires can emit less dioxins than the UNEP Dioxin Toolkit estimates. Therefore it is always better to make calculations within some range.

Table 9 shows potentially saved dioxin releases by presented zero waste practices from several CEE countries. The pilot calculation is based on the amounts of recycled waste per one year as described above and in the details of projects in different CEE countries. These amounts are as follows in Table 8.

Table 8: Amounts of recycled or composted solid waste in projects described in this report.

Case study	Recycled / Composted wastes
Palárikovo/Slovakia	162.0 t/year
Stopini a Kekava/Latvia	180.0 t/year
Sofia/Bulgaria	42.0 t/year
Budapest/Hungary	85.2 t/year

The amounts of waste that are counted into the calculation of prevention of POPs releases do not include wastes that can not be burned (glass), that ended at landfills (hazardous waste) and/or were burned (wood, part of hazardous waste).

Table 4: UNEP Dioxin Toolkit-based calculation of prevented dioxin releases because of waste taken away from waste flows to waste incineration and/or landfilling.

Dioxin source category / subcategory	**Case study Palárikovo**	**Case study Kekava and Stopini**	**Case study Sofia**	**Case study Budapest**
	g TEQ			
Low technol. combustion, no APC system	0.579	0.643	0.150	0.304
Controlled comb., minimal APC	0.140	0.156	0.036	0.073
Controlled comb., good APC	0.038	0.042	0.010	0.020
High tech. combustion, sophisticated APCS	0.003	0.003	0.001	0.002
Landfill fires	0.162	0.180	0.042	0.085
Uncontrolled domestic waste burning	0.146	0.162	0.038	0.077

Total savings of dioxin releases can vary from 1 mg up to 643 mg per year by only smaller demonstration projects using pieces of the Zero Waste strategy in CEE countries. By using other than UNEP Toolkit emission factors we can get different figures. These differences can be estimated from comparison of emission factors demonstrated in Table 7 with those set up in UNEP Dioxin Toolkit. There are differences in estimations of releases through waste incineration residues for example, but this is not major matter of this study.

The calculation for the case when waste separated by recyclers in projects described by this study would be burned in a modern municipal waste incinerator such as Termizo Liberec reveals that 14 to 42 mg TEQ dioxin releases could be prevented by recycling of 469.2 tonnes of waste. This is the total waste amount per one year taken by described projects away from the waste flow and recycled / composted. This calculation is based on data obtained about dioxin releases flows for this municipal waste incinerator. In reality the savings are much greater when we include energy and raw materials input into products that were saved. Energy generation and different products production generates also some amounts of unintentionally produced POPs. These savings are not easy to calculate.

Machálek, P. et al. (2005) quotes also some air emission factors for updated municipal waste incinerator based on data from CEE region for PCBs and hexachlorobenzene. For PCBs it is 0.016 up to 2,000 µg/t of burned waste and for HCB it is 150 µg/t of burned waste.[25] Also Korean scientists measured HCB in MWI flue gases and found levels between 5.6 and 54.9 ng/m^3.[26] It is clear that zero waste practices can lead also to prevention of these toxic chemical releases into the environment and not just PCDD/Fs.

If we calculate the reduction of PCDD/Fs emissions in the selected cases, we do it just for the purpose of illustration, because the total impacts of this strategy are considerably broader.

7.0 Conclusions and Recommendations

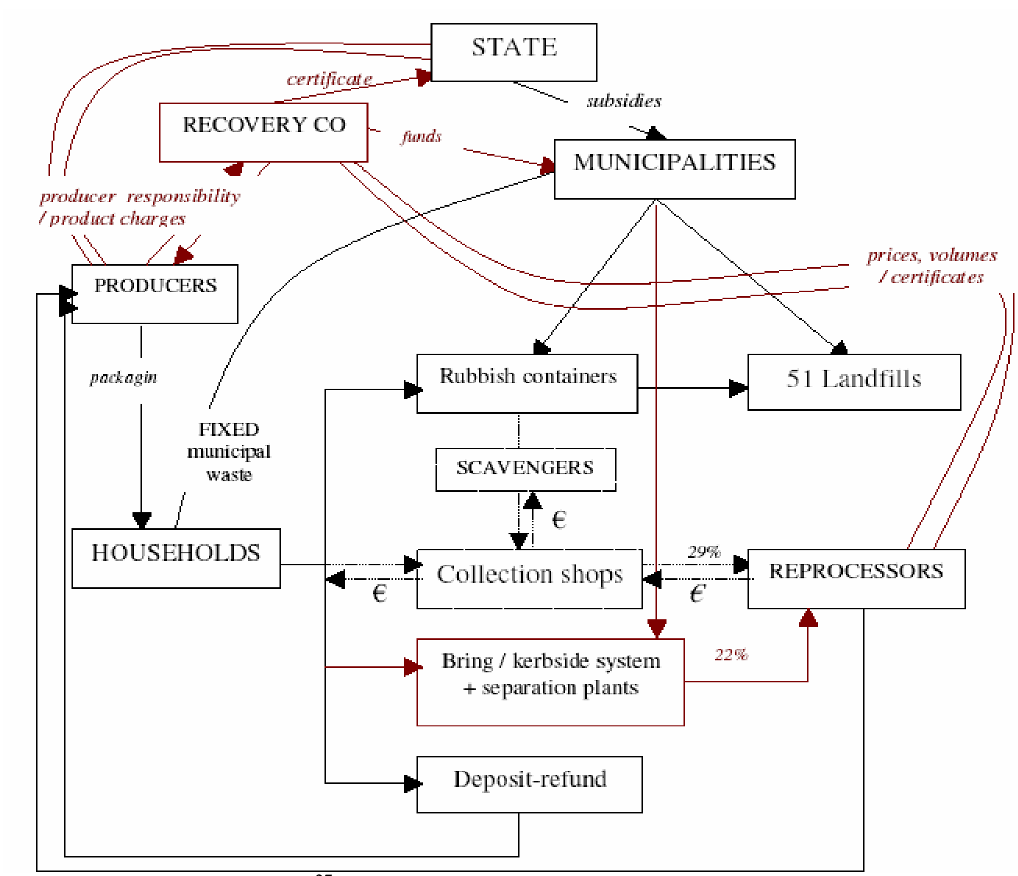
Total prevention of dioxin releases can vary from 1 mg up to 643 mg per year by only implementing small demonstration projects using pieces of the Zero Waste strategy in CEE countries. This is a lot when we look at the figures of total dioxin releases estimates and compare them with the scale of the projects. It stresses even more the need for broader introduction of Zero Waste strategies as a Best Environmental Practice and as one of the important tools to minimize and finally eliminate unintentional POPs releases.

The Zero Waste strategy can one of the rare waste management strategies that leads to real decrease of produced municipal waste (real waste minimization) as shown in an example from Palárikovo, Slovakia. Key elements of a successful introduction of the Zero Waste strategy are its simplicity and engagement of the public. In a long term vision it is also important to increase pressure on savings and prevention of waste production. This is also a key element in a long term strategy in POPs elimination from waste disposal how it is documented in this study.

It is also necessary to look at an option of a PVC ban. In the CEE region the prices of gas and gasoline are rising and people are using brown coal and lignite to heat their houses again. This unfortunately brings the problem of waste burning in household stoves. Therefore it is important to get rid of PCV as a major contributor to dioxin formation in domestic waste when it is burned.

Recycling of waste can create jobs for a broad group of people in society as shown in the example from Sofia. It is a simple job and does not need some highly sophisticated skills. Building of new landfills and waste incinerators is a step backwards.

Figure 11: Government Strategy for meeting the recycling and recovery targets in Bulgaria (Red lines denote proposed changes to the current system; dashed lines are entities, which will gradually disappear).



Source: Velkova, M. R. (2003).[27]

Other recommendations include:

- The polluter-pays principle should not only be present in the law: it should be enforced by awarding the municipalities not only with responsibilities but also with an adequate budget for meeting them.
- The full costs of the waste management services should be accompanied by the monetization of the environmental externalities. This can be achieved by setting higher standards or imposing taxes on landfilling and processing of primary raw materials.
- Targets can be reached at the lowest cost by the obligated producers of packaging and landfill operators if trade in recycling, recovery and biodegradable waste reduction certificates is allowed. Reprocessors, composting plants, landfills with methane extraction will be able to issue these certificates and be compensated for the environmental benefit they deliver. This will set the prices correctly and stimulate plastics, glass and organic recycling and increase metals and paper recycling.
- Simple solutions can be very powerful such as a plastic bag environmental charge, which would be able to eliminate a large proportion of this unnecessary input to landfills.

The Government and NGOs can also help the scavengers set up co-operatives and regional marketing associations through loans and grants. Scavengers' co-operatives can circumvent the low prices of the collection shops and improve the status of the scavengers. This practice has proven very beneficial for the standard of living of the scavengers in Indonesia, Columbia and Brazil where scavengers earn up to twice the minimum wage (Medina, 2000). The co-operatives accumulate funds and can invest in transportation and separation equipment. They can gather funds for education, health and life and accident insurance.

Over the last few years, co-operatives have been created in many Latin American and Asian countries: Venezuela, Peru, Ecuador, Guatemala, Costa Rica, the Philippines, and India. Scavengers' co-operatives can promote grassroots development in an economically viable, socially desirable and environmentally sound manner.

Annex 1 - Tables

Table 10: The major types of materials collected by the scavengers and the carters including quantity per month and prices
***** Exchange rate: 1 USD = 1.6 leva; 1 EUR = 1.95 leva, Change: 1 leva = 100 stotinki (st.)

Type of materials	Price per unit/kg/m3	Quantity per month	Total value per month*
Corrugated cardboard	0.08 – 0.10 st.	24 tons	2400 leva
newspapers	0.06 – 0.08st.	12 tons	960 leva
Mixed paper	0.07 st.	6 tons	420 leva
Jar caps	0.50 st. – 0.60 st.	8.8 tons	4,840 leva.
Lead	0.60 st.	4.1 tons	2,460 leva
Zink	0.60 st.	8.2 tons	4,920 leva
Pig iron	0.28 – 0.30 st.	175 tons	49,000 leva
Aluminum plate	2.20 leva	4.1 tons	9,020 leva
Aluminum soft	1.90 leva	2 tons	3,800 leva
Aluminum hard	1.70 leva	6,15 tons	10,455 leva
Brass yellow	2.80 leva	2 tons	5,600 leva
Brass white	3.20 leva	6,15 tons	19,680 leva
Copper sheets	6.70 – 7.00 leva	6,15 tons	42,200 leva
Lead acid battery	0.20 st.	41 tons	12,300 leva
Iron hard	0.30 st.	110 tons	33,000 leva
Iron soft	0.18 – 0.20st.	100 tons	19,000 leva
Mineral water bottles	0.30 st.	4.5 tons	1350 leva
Plastic canister	0.20 st.	4.5 tons	900 leva
Nylon bags	0.10 st.	11.25 tons	1125 leva
Plastic bottle crates	0.25 st.	11 tons	2750 leva
Beer bottles	0.05 st.	28,000 units	1400 leva
Wine big bottles	0.06 st.	42,000 units	2520 leva
Wine small bottles	0.04 st.	8,400 units	336 leva
Brandy big bottles	0.05 st.	11,200 units	560 leva
Brandy small bottles	0.03 st.	19,600 units	588 leva
Vodka big bottles	0.06 st.	14,000 units	840 leva
Vodka small bottles	0.04 st.	11,200 units	448 leva
Coca cola small bottles	0.08 st.	14,000 units	1120 leva
Coca cola big bottles	0.10 st.	14,000 units	1400 leva
Broken glass	0.02 st.	33.6 tons	672 leva
Jars with normal caps	0.04 st.	22,400 units	896 leva
Jars with screw caps	0.05 st.	19,600 units	980 leva
Wooden material: woodwork, cupboards, crates, etc.	10 leva/m3	8200 m3	82,000 leva

Table 11. Brief overview about IPP project

	Name of office where the IPP of HuMuSz Recycling Ltd. is introduced	People involved in (number of persons)	Start of project	Waste streams collected separated					
				Paper	PET bottle	Glass bottle	Batteries	Office hazardous	CD
1	Allianz Hungary (insurance company)	362	1999-08-05	yes	yes	-	yes	yes	yes
2	Regional Environmental Centre of CEE	113	2000-12-12	yes	yes	yes	yes	yes	-
3	Ministry of Environment and Water	710	2001-08-01	yes	yes	yes	yes	yes	-
4	Headquarters of Duna-Ipoly National Parc	45	2001-11-23	yes	yes	yes	yes	yes	-
5	Northern Hungarian Environmental Inspectorate	118	2002-04-01	yes	yes	-	yes	yes	-
6	Publicis Kft. (marketing and PR company)	77	2002-05-07	yes	yes	-	-	-	-
7	Közép-Duna-völgyi Environmental Inspectorate	169	2003-06-01	yes	yes	yes	yes	yes	-
8	Hungarian Meteorological Service	195	2004-01-01	yes	-	-	yes	yes	-
9	Office building of the Hungarian Parliament	763	2004-05-01	yes	yes	yes	yes	yes	-
10	ZSIGMOND HÁZ real estate company	51	2005-06-01	yes	yes	-	yes	yes	-
11	Office building of the Prime Minister's Office (for providing services)	588	2005-12-01	yes	yes	yes	-	yes	-
Total number of participants:		3191							

Table 12: Main parameters of compost produced in bioreactor (1 – 3) and open windrows (4 – 6)

No of sample	Dry matter (%)	pH	C (% in dry matter)	N (% in dray material)	C : N	P (% in dry matter)	K (% in dry matter)
1.	41,40	7,49	43.1	2.48	17.4	1.03	0.87
2.	38,86	7,78	40.5	2.33	17.4	1.12	0.64
3.	37,08	6,37	37.8	1.68	22.5	0.54	1.12
4.	55.08	6.75	32.19	0.42	76.4	0.41	0.51
5.	47.14	7.37	32.30	0.49	65.9	0.34	0.49
6.	52.48	6.25	27.84	0.37	75.2	0.30	0.47

Annex 2: Description of biowaste composting technologies in Ulbroka and Marupe

a) Bio waste composting by open windrow methods

The raw materials forming a pile of the windrows were placed in the layers taking in account the balance between materials with high carbon and low carbon content. Each layer was ~ 0.2 - 0.3 m thick. Additional to the compost material were added microorganisms such as Tr. viride, Tr.lignorum, or association of nitrificators (inoculums) facilitating the composting process.

Fig. 12: Compost piles in Ulbroka

Preparing procedure of compost material:

- Bottom layer ~ coarse material;
- First layer low carbon material;
- Second layer ~ layer of high carbon material;
- Third layer ~ layer of garden soil or ready compost material or inoculums.

Than all layers were mixed and placed as the part of pile or windrow, if necessary the pile was watered. Each new portion which was added was prepared in similar way until the high reached 2-3 m for piles (fig. 12) or ~ 1.5 m for windrows (fig. 13).

The mixing of the compost pile in Ulbroka was realized with the help of manure spreader. The mixing of windrows in Marupe was realized by Backhus stridden turner.

At the beginning of composting the main attention was paid to temperature and moisture level in a pile. An optimal level of moisture in the pile promoted the growth of thermophylic bacteria and simultaneously degradation of organic wastes. Source separated biowaste from households, which was brought to the separate field, was mixed with sawdust, leaves, straw and sapropel (mud). For this mixture the pH value was measured with indicator paper or pH-meter. If there was acetic reaction in the mixture, addition of lime or dolomite meal in small quantities was supplied. The mixed material was placed on the concrete by a 20-30 cm layer and watered with water suspension containing inoculums. In such manner prepared material was used to form the pile with 2-3 m height. The remaining layers were treated only with water.

Fig. 13: Compost windrows in Marupe

Microbial activity resulted in exothermal reaction, and temperature in pile was gradually increased to 50 - 60 °C. In 7-10 days from the beginning of composting process the temperature was decreased. At this step an intensive mixing of a pile was performed to provide the necessary aeration.

The material for composting in Marupe was prepared in a similar way as it was done in Ulbroka. Firstly material was prepared in the field, afterwards – composed in windrows. The first layer was treated with water suspension containing inoculums. Moisture content in material was about 60-65 %, the pH value – in a range of 5-6.

The composting process was started in early spring; therefore it was impossible to enrich the material to be composted even with sloped grass - material containing nitrogen. To balance C and N content in input material, waste brewer's yeast and sludge from waste water treatment plant were added. The process was monitored: temperature was increased already in 4 days achieving 55 °C, then the windrow was turned by a turner. After some days, the temperature gradually decreased to 18 °C. After 4 months composting process the hygienic indexes, i.e. *Salmonella* spp. and *St.aureus*, were $3{,}10^2$ and $2{,}69.10^3$, correspondingly. The C:N ratio in compost windrow varied from 20 to 26.

b) Composting with pilot equipment – bioreactor

Experimental biodegradable waste composting plant (further in text: reactor) was design and produced as pilot equipment for the realization of closed bioreactor composting process. It provides food and biowaste fermentation together with bibulous materials – peat, saw dust, shredded straw and others.

The main technical parameters of bioreactor are presented in the Table 13.

Table 13: Technical specification of bio reactor

Technical parameters	Description
1. Type of plant	stationary
2. Capacity of reactor, m^{3-}/twenty-four hours (if the temperature of incoming material not lower as 14 ^{0}C)	until 5
3. Installed power, kW	26
4. Specific consumption of electric power, kWh/t	10-15
5. Working volume. m^3	25
6. Working regime	all the year

Experimental biodegradable waste composting reactor has welded construction. It consists of 25 m^3 tank, on a foundation of four rotating and one stationary shaft, which are equipped with aeration openings, to blow the air in compost mass, unload transporter, upper leveling transporter, movable bars, rake type rod and aeration fan. On the top of reactor there are removable lids for load – in openings, as well pulling up covers on the sides of reactor to have access to the movable bars. The drive of reactor consists of electric engines, three stage speed reducers and motor reducers.

General technological process of biomass composting in bioreactor includes:
1. Conditioning of biowaste material
2. Preparation of mixture for composting
3. Loading of biowaste mixture in to the reactor
4. Treatment of mass by composting in the reactor
5. Unload compost
6. Stabilization of compost.

1. Conditioning of biowaste material was done to remove inert and other materials, non suitable for composting. For small amounts it was done manually, but at bigger – by screening.
2. Preparation of mixture for composting was realized according prescription of biologists, using compost mixer “BACKHUS 14.28”.
3. Loading of biowaste mixture in to the reactor by belt conveyor.
4. Composting in the reactor
5. Unload of compost. Unloaded compost from the reactor is transported to the outside of composting – reactor’s zone by belt conveyor. The composted mass was transported to the compost stabilization field by front loader.
6. Stabilization of the composted mass.

At the beginning 25 m^3 of correctly prepared raw material was loaded into the reactor. An upper leveling transporter was switched into the work, when the raw material reached the upper leveling transporter. To fill in the raw material evenly, it has to be smoothed down by rake type rods.

For rotating shafts and an unloading transporter are used for unloading compost from the reactor. The regular (each 2-3 hours) measurements of temperature and oxygen content were done to maintain the optimal composting process. The average temperature of mass above 60 ° C must be reached to prepare the reactor for normal operation conditions. This compost was used at the same district (Marupe) dump for covering of landfill.

The project beneficiary: Waste Management Association of Latvia (WMAL), project partners: municipality of Stopini, municipality of Kekava, Institute of Microbiology and Biotechnology University of Latvia (IMB, municipal company Ltd. Getlini 2, Meliorators Company, Jand Company, and Harman Ltd.

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