

CZECH UNIVERSITY OF LIFE SCIENCES
PRAGUE
FACULTY OF ECONOMICS AND MANAGEMENT



MANAGEMENT OF ORGANIC
HOUSEHOLD WASTE

DIPLOMA THESIS

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Statutory declaration

Hereby I declare that the Diploma Thesis on the subject “Management of Organic Household Waste” is my own work. All the sources used are listed in Bibliography.

Prague, 28th November, 2008

Kristýna Radochová

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Acknowledgement

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Kristýna Radochová



**MANAGEMENT OF ORGANIC
HOUSEHOLD WASTE**

**ZPRACOVÁNÍ A VYUŽITÍ BIOODPADŮ
Z DOMÁCNOSTÍ**

Zpracování a využití bioodpadů z domácností

Souhrn:

Hlavním cílem této diplomové práce je zmapovat současný systém odpadového hospodářství a nastínit možnosti zpracování a využití bioodpadů z domácností.

Práce zkoumá obvyklé způsoby nakládání s odpady ve vybraném městě, postoj obyvatel k biologicky rozložitelným odpadům a nejčastěji užívané postupy třídění a likvidace. Dále je zjišťován případný zájem o oddělený sběr a recyklaci bioodpadů.

V teoretické části literární rešerše jsou uvedeny základní poznatky a informace týkající se vybraného tématu. První část vysvětluje hlavní pojmy, definice, koncepty a nástroje odpadového hospodářství podle různých zdrojů. Druhá část se zabývá legislativními požadavky na území České republiky i Evropské Unie a na závěr je provedena obecná analýza problematiky odpadů organického původu.

Na základě výsledků průzkumu je vytvořen návrh koncepce pro nakládání s biologicky rozložitelnými odpady a zavedení programu na podporu domácího a komunitního kompostování. Dalším návrhem je rovněž úprava systému poplatků za odvoz směsného komunálního odpadu a to tak, aby domácnosti platily za objem vyprodukovaného odpadu a nikoliv fixní poplatek.

Klíčová slova:

Odpadové hospodářství, bioodpad z domácností, biologický odpad, recyklace, kompostování, komunitní kompostování, třídění odpadů, skládkování.

Management of Organic Household Waste

Summary:

The basic objective of this diploma thesis is to provide an overview of current system of organic waste management and to outline the treatment methods of waste generated in households.

The main focus is on waste behaviour of inhabitants of selected town, their attitude to biodegradable waste and the ways of its sorting, respectively disposing. Furthermore, the potential interest in recycling methods of biologic waste has been investigated.

The literature overview presents basic theoretical knowledge connected with the topic, explaining the main terms, definitions, concepts and tools of waste management according to different resources. Further, the legislative frame of the problem is discussed on both Czech and European level and eventually, the general analysis of organic waste is conducted.

The main findings of the survey indicate that the problems of biologic waste management in the selected town need to be dealt with and the proposal suggests the introduction of a program to support home and community composting. Further, the modification of current system of fees for waste collection is recommended so as to charge households for the volume of waste generated rather than paying a fixed yearly amount per head.

Keywords:

Waste management, organic household waste, biodegradable waste, composting, community composting, recycling, waste sorting, land filling.

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1. INTRODUCTION

This diploma thesis deals with the subject of waste management and organic waste in particular. The choice of the topic was inspired by activities and projects of ecologic center in author's hometown. To introduce the subject, following chapters will describe and summarise the main points.

Organic waste originating in households forms substantial part of municipal waste. Unfortunately, it is most frequently disposed of into garbage containers together with mixed municipal waste to be afterwards transported to landfills. There it decomposes in the absence of oxygen and the rotting process is accompanied by production of greenhouse gasses (especially methane) and a liquid that can be highly toxic.

The production of methane and its outflow was the main reason to accept the EU Directive on Landfill of Waste in 1999. This directive requires EU member states to gradually decrease the quantities of biologic share in landfills, which can only be reached by separation, collection, suitable treatment and further utilization of biodegradable waste.

One of the methods that provides sustainable alternative to land filling is composting. It lowers the weight and volume of waste and produces stable and useful product. In particular, composting enables reduction of organic mass disposed in landfills; it has beneficial impacts on soil and may replace industrial fertilizers. Additionally, composting offers an occasion for business activity, providing income and employment opportunities or even means for therapeutic methods.

The diploma thesis is divided into six main chapters and the structure is as follows:

The aim of the first part is to provide brief introduction to the topic and to explain its importance. Further, it outlines the structure of the whole thesis.

In the second chapter, the objectives of the thesis are formulated, identifying the subject of the survey and the goal of the research. In addition, the methodologic tools chosen are described.

Thirdly, literature overview presents basic theoretical knowledge connected with the topic, explaining the main terms, definitions, concepts and tools of waste management according to different resources. Further, the legislative frame of the problem is discussed on both Czech and European level and eventually, general analysis of organic waste is conducted.

The fourth chapter deals with the empirical part of the thesis, presenting the characteristic of selected town, the system of waste management as well as the case study of community composting project.

Chapter five reports the data collected in the form of graphical analysis, concentrating particularly on common waste behaviour of respondents and organic waste treatment in households.

Finally, sixth part summarises and interprets the outputs of the survey and proposes solutions and recommendations for the development of organic waste management in the selected town.

The thesis is concluded with bibliography and supplements.

2. OBJECTIVES AND METHODOLOGY

2.1. Objectives

The basic objective of this thesis is to provide an overview of current system of organic waste management and to outline treatment methods of waste generated in households.

The subject of the survey is waste behaviour of inhabitants of selected town, their attitude to the organic waste and the ways of its sorting, respectively disposing. Further, the potential interest in recycling methods of biodegradable waste, i.e. composting, will be investigated.

The goal of the research is to describe common waste practices of the inhabitants of selected town. In particular, to find out how big is the share of households that separate and recycle waste, what kinds of waste are sorted the most or what is the approximate quantity of waste generated per week.

Regarding biodegradable waste, the aim is to identify how many respondents separate biodegradable waste, how big is the share of organic waste that is thrown into dustbins, what kind of motivation would persuade the inhabitants to start composting and what is their attitude towards community composting or regular system of organic waste collection.

Last, but not the least, the survey aspires to have slightly educational character, to distribute information about the kinds of waste that may be separated and about the processes of waste utilization. Furthermore, it will emphasise the benefits of composting and explain the negative effects and risks of organic waste landfilling. The options for biodegradable waste treatment will be discussed, to introduce and explain the term community composting.

It should be emphasised, that the purpose of this paper is not to describe composting process from the biological point of view but to concentrate on the sociological, economic and legal aspects of the topic.

2.2. Hypotheses

Based on the literature sources, related survey conducted in the region and the field observations, it is possible to derive following hypotheses to be verified in research. For the hypotheses considered, the criterion for verification will be divergence of $\pm 5\%$.

First expectation is that the share of biodegradable waste disposed to mixed waste is quite high, even in the households that otherwise recycle a lot. In average, it is assumed to reach 30% of the total weekly production of waste.

Secondly, it is expected that the biggest impact on the potential change of waste treatment practices will be by the means of financial motivation. In particular, decreased fees for waste collection would persuade minimally 40% of people to start composting their organic waste.

2.3. Methodology

The theoretical part will be based on background research and analysis of resources related to waste management and organic waste treatment. Consequently, the practical information about composting projects will be acquired from members of ecologic center Paleta in Chrudim.

With respect to the character of investigated issue, the combination of quantitative and qualitative methods will be used; as a main tool for data collection, the method of questionnaire research will be employed. Basically, the survey will be carried out personally during the summer holidays 2008 in the form of a standardized interview in order to avoid any misinterpretation of the questions and a low response rate. Thus, the respondents will not be limited by the offered answers and they would be encouraged to add their own comments, remarks or suggestions.

The sample of respondents will be chosen randomly in one quarter of the selected town, with the aim to identify two different profiles: firstly, the persons living in single-family houses, that are usually joined with small gardens and secondly, the persons living in blocks of flats, who do not have a garden at disposal.

The evaluation of questionnaire outputs will be processed by the online research software Easy Research (www.easyresearch.biz) and interpreted by the means of graphical analysis. The calculations of arithmetic mean and median will be used to acquire average values and to enable generalization of results.

Finally, SWOT analysis will be used to summarise the situation in Chrudim from the point of view of organic waste management and potential for home and community composting support.

3. LITERATURE OVERVIEW

3.1. Background Information

3.1.1. Basic Terms and Definitions

Waste

In common words, waste is something that is left over or that it is no longer needed. Additionally, wastes are such items that people are required to discard, for example by law because of their hazardous character. Therefore, it is necessary distinguish the waste precisely since the items classified as waste are subject to many requirements. There exist many definitions of waste, but the most important ones have been set out by the OECD and the EU.

The definition contained in the OECD/Eurostat Joint Questionnaire on Waste is the most explicative and exhaustive one: *Waste refers to materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard. Wastes may be generated during the extraction of raw materials, during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity.*

The EU Commission provides legal definition of waste in Waste Framework Directive: *Waste shall mean any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard.* The Commission has drawn up a list of wastes belonging to one of the sixteen categories listed in Annex I.

Organic / Biodegradable / Biologic / Waste

According to the Council Directive on Landfill of Waste, biodegradable waste means *any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard.*

The Glossary of Environment Statistics specifies biological waste as *waste containing mostly natural organic materials: remains of plants, animal excrement, biological sludge from waste-water treatment plants etc.*

Finally, European Environmental Agency defines organic waste as *waste containing carbon compounds; derived from animal and plant materials.*

In this paper, the terms organic, biodegradable and biologic waste will be used as synonyms to describe the waste that could be composted or processed into useful products using other biological treatment.

Household waste

Household waste simply means the waste material usually generated in the residential environment.

Waste management

Waste management refers to supervised handling of waste material from generation at the source through the recovery processes to disposal.

The characteristic activities of waste management include:

- collection, transport, treatment and disposal of waste
- control, monitoring and regulation of the production
- prevention of waste production through in-process modifications, reuse and recycling

To summarise all the definitions mentioned, for the purpose of this thesis, management of organic household waste shall be understood as directed process of dealing with

organic waste from the point of its generation till the final treatment, concentrating on the possible recycling solutions in the urban area.

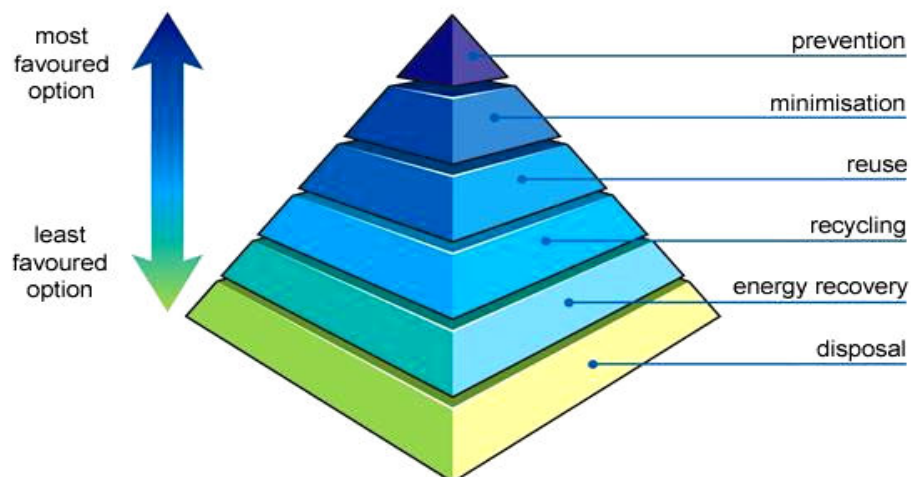
3.1.2. Waste Management Concepts

An overall approach to waste management combines a range of treatment methods. As the most significant ones in relation to biodegradable waste should be mentioned Waste Hierarchy, Integrated Waste Management, Polluter-Pays Principle or Zero Waste Management.

Waste Hierarchy

The Waste Hierarchy scheme was firstly introduced into European legislation by the European Union's Waste Framework Directive of 1975. It is based on the chain of waste management priorities and described by the "3Rs": Reduce, Reuse, Recover. The highest priority is given to prevention and reduction of waste, followed by reuse and recycling and the very last option is disposal to landfill, which should only be exercised in a controlled manner.

Figure 1: Waste Hierarchy Scheme



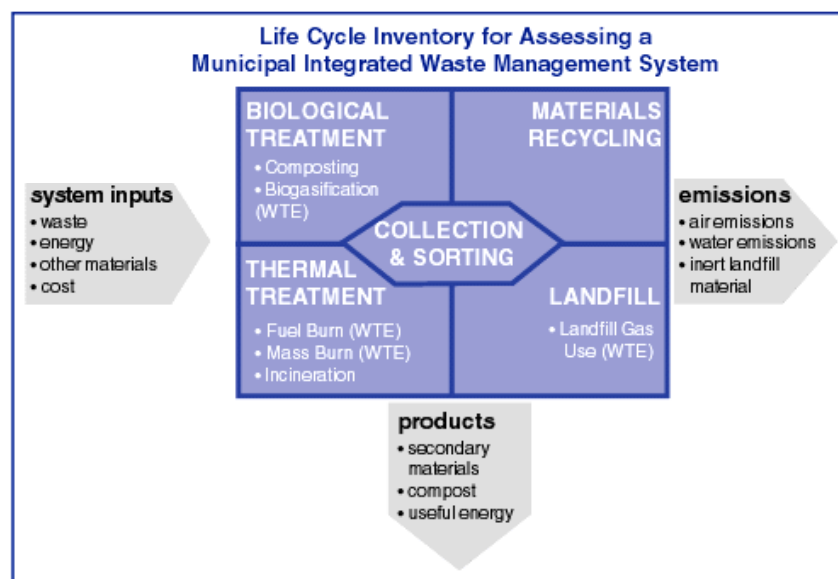
Source: http://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal_files/image005.jpg

Integrated Waste Management

The Integrated Waste Management model deals with the life cycle of municipal solid waste from the moment it becomes waste until it ceases to be waste by becoming a useful product, residual landfill material or an emission to air or water. According to Callan (Callan-Thomas, 1996), integrated waste management system promotes using a combination of techniques and programs aimed at source reduction, recycling, combustion, and land disposal, in that order.

The inputs are waste, energy, other raw materials and costs. The outputs from the system are in the form of products (reclaimed materials, compost) and emissions (emissions to air and water and residual landfill material).

Figure 2: Integrated Waste Management



Source: <http://www.csr.org/archives/iwm.htm>

Polluter-Pays Principle

The Polluter-Pays Principle was first declared in 1972 by OECD and at EU level in 1987 by European Community Treaty. The principle claims that the party responsible

for producing pollution should also be responsible for paying for the damage caused to the environment.

It is also known as Extended Polluter Responsibility, which was defined by the OECD Fact Sheets as *a concept where manufacturers and importers of products should bear a significant degree of responsibility for the environmental impacts of their products throughout the product life-cycle. (...) Producers accept their responsibility when designing their products to minimise life-cycle environmental impacts, and when accepting legal, physical or socio-economic responsibility for environmental impacts that cannot be eliminated by design.*

Zero Waste Management

Kropáček explains Zero Waste Management as a strategic vision that expects that materials will not flow through the economy from top to bottom to be disposed in landfills or burnt, but on the contrary, that recycling will ensure material circulation in the highest rate possible (Kropáček, 2003).

Besides, the conception focuses on the whole life cycle of product and to some extent it comprises the polluter-pays principle. It supports not only recycling but also replacement of rare resources by the renewable alternatives. Additionally, it also motivates the industrial producers to take in the account the value of waste and to search for the new ways of utilization.

3.1.3. Waste Management Methods

As described in the Friends of the Earth briefing (Pellaumail, 2001) the methods of waste management can be divided into three main groups according to the waste hierarchy scheme.

Waste prevention and minimisation

Waste prevention aims to eliminate the waste before it is created. The methods of waste minimisation include for example reuse of second-hand products, repairing broken

items instead of buying new ones, designing products to be refillable or reusable and encouraging consumers to avoid using disposable products.

Re-use and recycling

Recycling means the process of extracting resources from waste with the aim to recover or to reuse the material. The principal methods of recycling are physical reprocessing, biological reprocessing and energy recovery.

Physical reprocessing

The general understanding of the term 'recycling' usually represents the collection of different types of waste and the consequent separation. The most common materials being sorted are plastic bottles, glass bottles, paperboard cartons, newspapers, magazines and cardboard.

Biological reprocessing

The purpose of biological treatment is to control and accelerate the natural process of decomposition of organic matter. It can be used for various kinds of biodegradable waste, particularly plant material, food scraps and paper products. The main methods used are composting and digestion processes that enable the transformation of organic material into mulch or compost. In addition, waste gas (such as methane) can be captured and used for generating electricity.

Energy recovery

Waste products contain significant amount of energy that can be retrieved in two ways, either directly, by using the waste as a fuel or indirectly, by converting the waste into another type of fuel (steam and electricity in a turbine).

The most used methods of energy recovery represent pyrolysis and gasification: the waste is heated to high temperatures with limited oxygen availability.

Disposal methods

Landfill

The most common practice in dealing with waste is still land filling. Landfills may cause a number of environmental problems, such as wind-blown litter, unpleasant smell, or attraction of pests. Another frequent by-product of landfills are gases (most often the greenhouse gasses methane and carbon dioxide) that are produced because of anaerobic decomposition of organic waste.

Although this method is regarded to have increasingly negative impacts on the environment, there exist modern types of landfill that can be quite inexpensive and hygienic solution for waste processing.

Incineration

Incineration, sometimes referred to as thermal treatment, is based on the combustion of material. The waste is burnt in the so-called Waste-to-Energy facilities (furnace or boiler) and further converted into heat, gas, steam and ash.

Incineration is a practical method of waste disposing but at the same time, it is very controversial method because of ecological reasons, mainly the emission of pollution gases.

3.1.4. Waste Management Tools

Waste management tools can be divided according to various criteria. This chapter will concentrate on classification of waste management tools in accordance with Czech legislation, particularly the Implementation Program for Biodegradable Waste and the Act on Waste no. 185/2001 Coll.:

- **economic tools** - fees, taxes, tax allowances, sanctions, subsidies etc.
- **administrative tools** - legal, institutional and other normative tools
- **other tools** - voluntary agreements, informative tools etc.

However, there exist also other types of categories according to:

Time point of tools implementation

- **preventive measures** - applied before the creation of a problem
- **corrective measures** - aimed at solving the already existing problem

Stimulation of subjects concerned

- **positive incentives** - motivating to a certain required behaviour by supporting the environment-friendly actions
- **negative incentives** - motivating to a certain required behaviour by means of penalties for activities realized in violation of environment protection

Economic Tools

Economic tools of waste management are based on the market oriented approach. Particular measures influence the price of production inputs or even the products and thus have impact on the volume of sales or production of specific goods.

The advantage of economic tools lies in their easy adjustment and wide effect on both business and public segment. The implementation of economic tools is generally connected with lower costs, especially in comparison with administrative tools.

Unfortunately, these measures do not motivate to change the behaviour; the main function is fiscal effect, i.e. the possible gains from payments.

The most used economic tools in the Czech Republic are remuneration of collection, separation and disposal of municipal waste, charges for waste deposition, sanctions and taxes.

Administrative Tools

Administrative tools are based on the unequal position of two subjects: state and waste generator. State enforces the protection of environment by the means of directives, restrictions, limits, norms, standards and sanctions imposed for breach of conditions. It should be mentioned that the effective control is rather problematic.

The principal administrative tools of waste management are defined by the Act on Waste and by the delegated legislation, specifying the rights and duties of waste generators, authorised persons, and state or local government administration bodies.

State administration of waste management is exercised by Ministry of environment, Ministry of Health, Ministry of Agriculture, inspections, custom authorities, regions, district authorities and municipalities.

Other Tools

These tools support the administrative and economic tools and are characteristic by the aspect of voluntary application, such as information campaigns supporting recycling or voluntary contracts establishing cooperation between industry and public administration. To bring forward a few examples, among other tools we classify: environment friendly products labels, cleaner production, ecodesign or life cycle assessment.

Although classified as ‘others’, the above mentioned tools have slightly administrative character.

3.2. Legislation

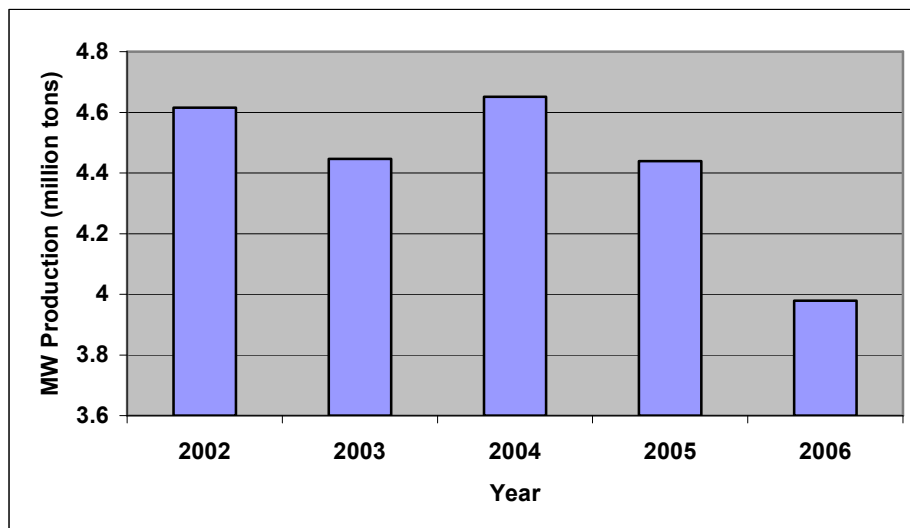
The sphere of biodegradable municipal waste (BMW) management is governed by the Czech legal system and the EU Directives and Regulations that will be further described in more detail.

To introduce the topic, this chapter provides brief characteristic of past and current situation of waste management and the production of municipal waste in the Czech Republic.

3.2.1. Municipal Waste in the Czech Republic

The production of municipal waste (MW) in the Czech Republic reached its peak in 2004, when it amounted to 4,7 million tons. Since then, however, it pursued decreasing trend as illustrated on the chart below, falling to less than 4 million tons in 2006 (Ministry of Environment, 2007).

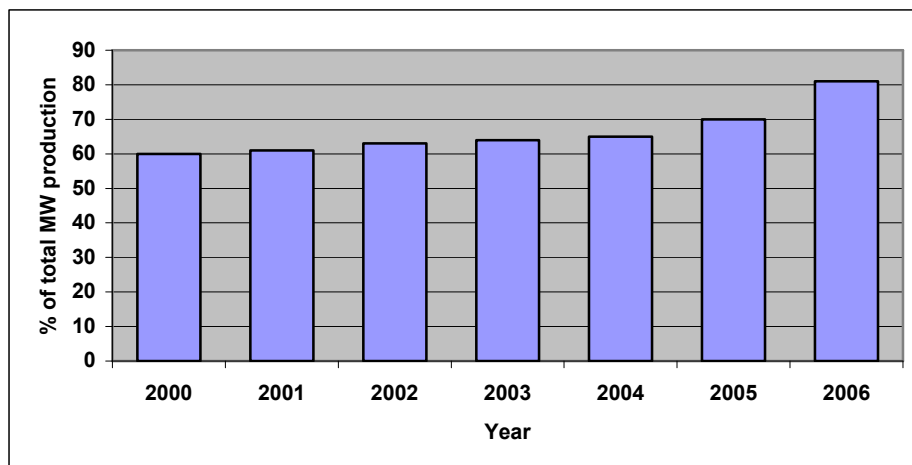
Graph 1: Production of municipal waste in the Czech Republic 2002-2006



Source: VÚV T. G. M. - CeHO

Unfortunately, the majority of municipal waste is still landfilled or burnt, whereas the share of landfilling has been growing significantly: from 60% in 2000 to 81% in 2006 (Ministry of Environment, 2007).

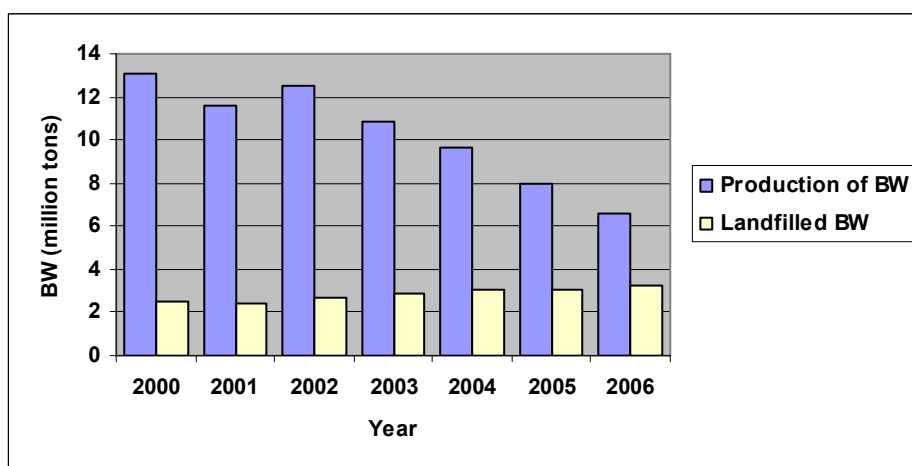
Graph 2: Share of landfilled municipal waste in the Czech Republic 2002-2006



Source: VÚV T. G. M. – CeHO

Approximately 41% of total municipal waste is formed by biologic waste. The biodegradable part of mixed waste rots and gives rise to the so-called landfill gas that escapes to the atmosphere. Landfill gas is composed mainly of greenhouse gasses, methane and CO₂ and Czech landfills produce about 17% of total methane emissions (Ministry of Environment, 2007). Moreover, landfill gas contains also small quantities of other chemical substances, usually highly toxic.

Graph 3: Landfilling of biodegradable waste in the Czech Republic 2000-2006



Source: Druhá hodnotící zpráva o plnění Plánu odpadového hospodářství ČR 2005 - 2006

As we can see, the amount of landfilled biodegradable waste is gradually increasing in spite of the fact, that the total production has fallen significantly in comparison with preceding years. The growth of BW production to landfill ratio is caused by increased utilization and recycling of waste on one hand and by the existence of sufficient number of cheap landfilling facilities on the other hand.

3.3.2. EU Legislation

Before 1970, the EU had no joint policy regarding the waste management. Several countries realized rare solutions and this situation existed until 1975 when the Waste Framework Directive (75/442/EEC) came into force and introduced the concept of waste hierarchy.

From the point of view of organic waste management, the most important EU law regulations are described below:

The Waste Framework Directive 75/442/EEC with amendments (Directive 91/156/EEC, Directive 91/692/EEC and Commission Decision 96/530/EC) establishing framework for the management of waste across the European Union. The directive specifies operations, which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses.

Landfill Directive (99/31/EC) was introduced in 1999, identifying the targets to reduce land filling of biodegradable municipal waste. The directive sets up strict limits for the member states on the amount of biodegradable municipal waste that is allowed to be disposed in landfill:

- 75% of the amount produced in 1995, by 2006
- 50% of the amount produced in 1995, by 2009
- 35% of the amount produced in 1995, by 2016

Two specific strategies have been suggested to achieve these targets. First, recycling of separated organic waste by aerobic (composting) or anaerobic treatment (digestion in

biogas plants) and second, pre-treatment of residual waste before landfill by incineration or mechanical-biological pre-treatment.

3.3.3. Czech Legislation

In June 2003, Czech government adopted the Waste Management Plan (WMP) of the Czech Republic, setting targets and regulations for waste treatment in accordance with the principles of sustainable development. The validity period of the WMP is ten years, i.e. from 2003 till 2012.

WMP had identified the key problems of waste management in the Czech Republic as follows:

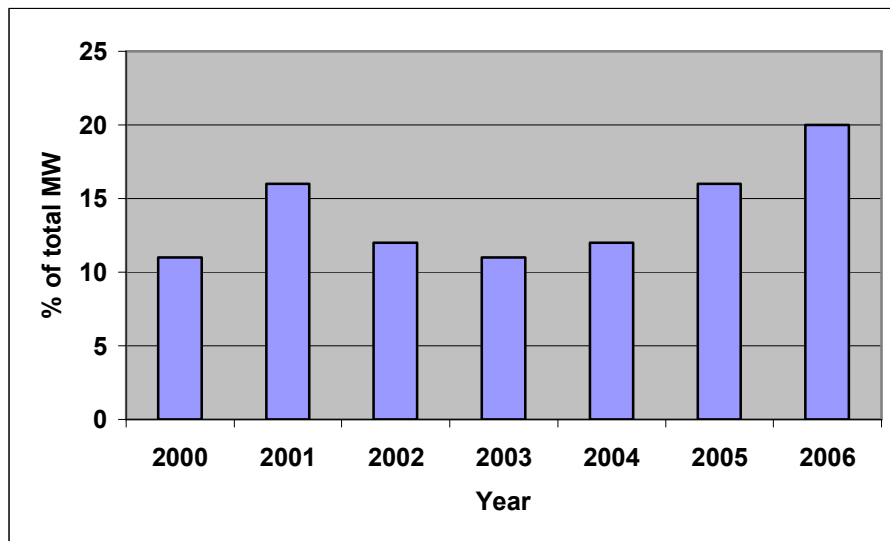
- waste hierarchy not respected, prevention of waste generation not executed, prevailing method of waste treatment still disposal (especially landfilling)
- missing economic stimulation as well as the information about the benefits and advantages of investments into waste prevention
- unsupported competitiveness of products made from waste, making it considerably difficult to increase material utilization of waste
- insufficient collection of wastes separated by kind, resulting in a low rate of returned waste to the production cycles as a substitution of input materials (primarily biodegradable and hazardous waste)

As a solution in terms of municipal waste, WMP determined three key goals:

Firstly, material utilization of municipal waste shall grow to 50% of the total production till 2010 (WMP binding part, article 6).

As we can see from the following chart, this goal will be difficult to fulfil, as the state of 2006 was only 20% of MW utilized.

Graph 4: Share of utilized municipal waste 2000-2006



Source: VÚV T. G. M. – CeHO

Secondly, in order to guarantee better recycling services for houses and flats, the priority of state financial support will be door-to-door collection of separated waste (WMP binding part, article 4 e).

Thirdly, financing of new refuse incineration plants from state budget will be explicitly rejected (WMP binding part, article 4 i).

Additionally, WMP sets other objectives concerning explicitly biodegradable waste:

- to create conditions for gathering various kinds of biodegradable waste (generated in household, business or industry) separately from mixed municipal waste
- to prioritize composting and anaerobic decomposition of organic waste and to support the use of compost especially in agriculture, for reclamation of land, maintaining green areas
- the waste that cannot be used in this way shall be transformed to fuel or be energetically used

3.3. Organic Waste

This chapter describes the characteristics of organic waste, its sources, prospective uses and the particular hazards and opportunities it presents. Regarding the treatment methods, it concentrates mainly on composting techniques.

Organic waste is produced wherever there is human habitation and its amount is increasing significantly each year. The majority of biodegradable waste originates from plants, respectively from the soil. In order to sustain the natural nutrient cycle, it is necessary to return the organic matter back to land.

Unfortunately, biodegradable waste is usually disposed into garbage containers together with mixed municipal waste. Consequently, it is transported to landfills where it decomposes in anaerobic way. In his recently published work, Rouse describes the process to be accompanied by production of greenhouse gasses, especially methane. Secondary, it also produces leachate, the liquid that filters down through the layers of waste, picking up chemicals and metals on its way. It can be highly toxic and presents a serious environmental and health hazard if it reaches watercourse (Rouse, 2008).

The production of methane and its outflow was the main motive to accept the EU Directive in 1999. This Directive requires EU member states to gradually decrease the quantities of biologic share in landfills, which can only be reached by biodegradable waste separation, collection, suitable treatment and further utilization.

One of the methods of organic waste treatment that provides sustainable alternative to land filling is composting. Rouse further explains that it brings a number of advantages, as the most important ones should be mentioned the improvement of soil conditions and the reduction of organic mass disposed in landfills (Rouse, 2008). Moreover, the nutrient value of quality compost may replace high amount of industrial fertilizers, which has not only economic effect but also ecologic benefits of natural recycling and returning the biologic mass to the beginning of biologic cycle.

3.3.1. Main Forms of Organic Waste

Organic waste may be divided basically to household kitchen and garden waste, commercially produced organic waste, agricultural waste and human and animal waste. Based on the above mentioned, Rouse presents following categories (Rouse, 2008).

Household waste

Household waste, also called domestic waste, is usually made up of food scraps (cooked or uncooked) and garden waste (grass cuttings and trimmings from bushes). In practice, kitchen waste is often mixed with non-organic materials that cannot be composted. Therefore, it will be worthwhile if this type of waste can be separated at source to enable the recycling process.

Commercially produced organic waste

This type of waste is generated at institutional buildings, such as schools, hotels and restaurants and it concerns mainly food leftovers. It has to be taken into account that the volume of waste produced is quite high and that the control of quality and composition is rather difficult. Thus, a convenient treatment method is to use the waste as a fuel during complex energy production processes, for example combustion in a biogas station etc.

Agricultural waste

This is the waste, which remains after the processing of crops (e.g. maize stalks, rice husks, etc.). There is a wide variety of applications for this residue, but in general, agricultural waste is treated by farmers themselves and is rarely mixed with municipal waste.

Animal and human waste

Animal and human waste can be added to organic waste for composting which is then called co-composting. However, using these materials is followed by further difficulties

since strict control is required to avoid the risk of spreading diseases. On the other hand, it gives compost much higher nutrient value.

3.3.2. Methods of Organic Waste Treatment

Among the methods of organic waste treatment we classify above all composting and anaerobic digestion. Besides, organic waste may be fermented into ethanol or transformed into fuel by pyrolytic or thermolytic processes (Slejška, 1999). Alternatively, organic waste may also be used for feeding purposes.

Composting

Compost is a product of controlled aerobic decomposition of organic matter created by aerobic micro organisms, insects and worms. Defined by Rouse, it is a stable, dark brown material similar to soil; it contains plant nutrients including nitrogen, phosphorus and potassium and also a range of minerals and micro organisms beneficial to plant growth. Basically, the main benefit of compost is its function as a soil conditioner (Rouse, 2008).

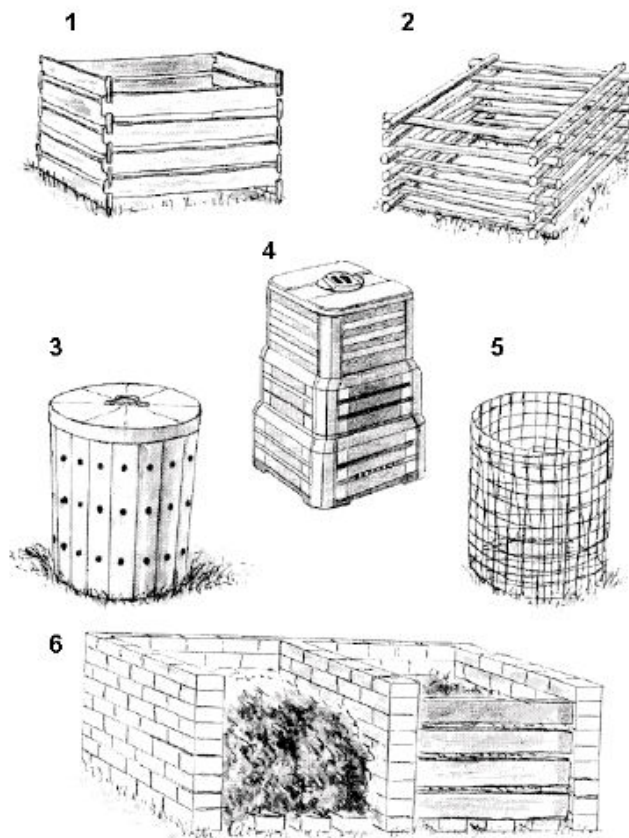
Composting is probably the oldest and the most widespread technology of organic waste utilization. In principle, as Slejška explains, it consists in controlled aerobic microbial decomposition of biomass and terminates by stabilization and creation of humus substances (Slejška, 1999).

There are many methods of making compost, ranging from small-scale home composting techniques to large-scale industrial plants that require significant capital investment. Technologies may be selected according to a number of criteria, including the volume of raw materials available, budget, land availability, the cost of labour etc. Slejška distinguishes three levels of biodegradable waste composting: household composting, community composting and communal (industrial) composting (Slejška, 1999).

Household composting

Household composting is the easiest and the cheapest method of processing biodegradable waste; the waste is treated at source so that no further manipulation is needed. The waste generator gains for his or her purposes quality natural fertilizer, compost. Besides, kitchen waste has an ideal composition that guarantees perfect conditions for composting.

Household composting may be exercised in open piles or rows, or in closed containers as illustrated on following picture:



Containers used for household composting

- | | |
|--------------------------------------|------------------------------------|
| 1 composter made from boards | 4 composter from recycled plastics |
| 2 composter made from round timber | 5 wire cloth composter |
| 3 wooden composter with air channels | 6 bricks composter |

Source: Kotoulová, Z., Váňa, J.: *Příručka pro nakládání s komunálním bioodpadem*, p. 3

Another type of household composting is *vermico-composting*. It makes use of the ability of rain worms to transform plant remains into organic fertiliser of high quality, vermico-compost. It can be exercised on balcony, terrace or in garage which makes it is suitable for people who do not have their own garden. Upon observing the right principles of vermico- composting, the content of compostainer does not produce any unpleasant odors (Ekodomov, 2007).

Community composting

Community composting is an intermediate stage between household and communal composting. It may be pursued in the area where there exists certain community of inhabitants without opportunity for household composting (blocks of flats, panel buildings). The essential presumption for community composting is the initiative of inhabitants who are motivated to use of biodegradable waste from their households and who are also prepared to make certain effort to reach this goal. Larger cumulation of waste is likely to make the composting process easier and faster and to positively effect the quality of compost.

Compared to household composting, community composting is realized usually on the piece of land that belongs to the community, to the municipality or that is rented or is provided for the given purpose.

In general, community composting is run by defined group of inhabitants who set their own rules for organic waste collection and treatment. Within the community, responsible person is usually appointed to take care of the compost, to check the proper composition of waste, to supervise the composting process and to take-off the completed compost (Ekodomov, 2007). Afterwards, the compost is not sold out but given to the participants for their own need. Remaining compost may be used for improvement of common green areas.

In addition, community composting brings not only ecological gains but also social profit. It supports and develops mutual communication among the inhabitants who live in the same environment but mostly do not know each other.

Beyond the already mentioned benefits, community composting may serve as a therapy method. In the Czech Republic there is currently running program Growing with Compost (cooperating also with Czech University of Life Sciences,) focusing on the introduction of community composting as a therapeutic technique. As a part of this project, there have been established several composting demonstration sites, such as the one near Týn nad Vltavou in South Bohemia, called Saint Agnes Centre. It provides workplaces for adults with learning difficulties and runs workshops with different activities, including also gardening. The demonstration site composts garden waste from their own kitchen and garden. It is run by the clients of the centre and the compost is used in the gardening works and potting mixtures.

Communal composting

Communal composting is generally running in fully automatised operation. It is carried out either on piles or in bioreactors. The process is organized by municipality and the method is determined by local conditions. The emerging costs of manipulation and treatment of biowaste are for the most part covered by savings in landfilling or combustion fees. Additionally, the produced compost may be applied on current maintenance of public green vegetation.

Anaerobic Digestion

Regarding anaerobic digestion, Rouse argues that technically it is a fermentation process in the absence of oxygen with the help of anaerobic micro organisms. This phenomenon occurs naturally at the bottom of ponds and marshes and gives rise to marsh gas or methane, which is a combustible gas. Moreover, it also takes place naturally in landfill sites and contributes to harmful greenhouse gases (Rouse, 2008).

Therefore, if anaerobic digestion is employed as a treatment method, it is necessary to capture and use methane, for instance, in a biogas digester.

Biogas is a source of energy with one of the lowest relative carbon footprints of all. Methane can be burnt cleanly on simple stoves, producing mainly carbon dioxide and water, making it a very clean household fuel. As with all organic waste processing

techniques, one of the challenges of using digesters is to ensure the quality of raw materials. Contamination from plastic, sand and soil can reduce the effectiveness of the plant, and chemical contamination could compromise the micro organisms, as well as contaminate the resulting compost.

3.3.3. Benefits of Composting

Based on the Information Sheet of the project Growing with Compost, the most important benefits of composting can be divided into three groups according to the environmental, economic and social point of view.

Environmental benefits

Reduction of organic waste in landfill

Biodegradable waste represents quantitatively significant share of communal waste and the disposal method may influence the environment both positively and negatively.

When land filled, organic mass creates greenhouse gasses that contribute to global warming and climate changes. Moreover, as fallout of landfills there usually appears liquid made by the rotting process (so called leachate) that irreversibly pollutes underground waters.

None the less, the prevailing part of biodegradable waste is predetermined for material or energetic utilization since it contains plant nutrients and organic substances that can be stabilised and returned to the natural cycle.

Prevention of soil erosion

As a result of long-lasting agricultural cultivation of land, the organic content of soil is gradually decreasing. Therefore, the soil becomes less able to absorb water, which in turn leads to erosion, lower productivity and higher risks of floods.

On the other hand, compost has the potential not only to improve the situation but also to benefit the farmers economically, since less irrigation and less inorganic fertilisers are needed.

Land reclamation

The high biologic activity in compost may be used to treat contaminated land and to restore soil after heavy industrial use. Composting microbes are very efficient at breaking down chemical contaminants in the soil (so called bioremediation process).

Economic benefits

Employment and training

Community composting can assist in creating job opportunities that meet local social and economic needs. By offering training and occasion to productively use personal skills it can play an important role in preventing people from leaving the community.

Regeneration

Regeneration has two aspects, the first one is to attract investment and funds into local area, and the second is to ensure that it stays in the community rather than being spent on resources and services from outside. Concretely, using composting as a social enterprise providing jobs, training, horticultural or agricultural activities and products means that the regeneration money circulates longer within the local economy.

Social benefits

Education and awareness rising

For public education and awareness raising there exist different opportunities. One option is to include the topics of sustainability, environmental protection together with composting into national curriculum in schools. Additionally, having a community composting project or initiative can also be a way to bring the environmental issues to the attention of people.

Social inclusion

Many community composting projects work with people who might otherwise have very limited interaction with the world outside their homes, such as people physically or

mentally disabled or long-term unemployed. In this case, community composting is used as a therapeutic method.

Physical and Mental Well being

Last, but not least, there have been noted the positive impacts composting may have on people's physical and mental health. It creates opportunities to get outdoors in the fresh air and to make some meaningful effort. Another, but just as important benefit is the provision of fresh local fruit and vegetables, grown using the compost.

Eventually, it is a widely observed phenomenon that people enjoy being in a landscape with natural elements. This impression positively influences the state of body (lowers blood pressure, creates feeling of calm) which is used in the so-called horticultural therapy, for example, growing plants or maintaining gardens in order to release mental distress.

3.2.3. Risks of Composting

Composting of waste is connected with risks of technologic, economic and qualitative nature.

Technological risks

From the point of view of technology, composting of organic waste is nearly risk free. Every type of composting method can be adjusted to the local conditions so that it benefits the surrounding environment.

However, regarding communal composting, it is difficult to ensure that collected biologic waste is as less as possible contaminated by the undesirable mixtures of other kinds of waste. This can be reached by systematic public education and by regular controls.

Concerning the household and community composting, the question arises how to maintain permanent interest of inhabitants in this activity. Again, the answer may be further adult education, consulting and help, or economic motivation.

Qualitative risks

During the composting process, there emerges a risk of constant failure to comply with the technical standards, which consequently disables further distribution of compost. The existing norms regulating the output of compost are very strict and thus, the compost of inadequate quality is categorized as a hazardous waste. It is necessary to eliminate this kind of risk by long-term monitoring of chemical composition of waste and to optimize the material structure of compost.

Economic risks

For communal composting, the most significant threat is the economic inefficiency of composting facility. Ideally, the costs of composting should be lower than the costs of organic waste disposal to landfills. However, this is not always the case due to very low fees for land filling resulting in weak competitiveness of compost.

Additional problem is the issue of potential output because compost does not have a ready-made market in many areas. On the other hand, Bromley assumes that applying basic marketing principles can help producers to identify and stimulate markets for their compost. It is necessary to understand the marketing environment (including competition, legislation and environment) and to consider the four Ps: product (to define the type and quality of compost), price (devising pricing which appeals to the market and which makes profit), place (locating the business), promotion (awareness raising, packaging etc., Bromley, 1995).

Compost may be distributed into the agricultural sector but it requires government support. Otherwise, compost utilization may be targeted at formation and maintenance of public green areas, reclamation of non-agricultural land or the sale of packed compost and substrates to gardeners.

It should be emphasised, that composting of organic waste cannot get along without state assistance. In other words, suitable subsidy policy and legislative support for composting reduce significantly the economic risks that the composting facilities have to face.

4. RESEARCH

4.1. Characteristics of Selected Town – Chrudim

Chrudim is a regional town in the Pardubice region. It is situated 110 kilometres east of Prague, the population is around 23 300 inhabitants (Czech Statistical Office, 2007) and it is administratively divided into four parts. The town covers a total area of 3 315 hectares, the major part has the character of agricultural land (75%) and the built-up area covers around 175 hectares (5%) (Návštěvník.cz, 2005).

Significant share of inhabitants live in their own houses with a garden, as can be seen from the following figures: single-family houses occupy an area of 7.47 hectares; however, including gardens and neighbouring grounds the area is 86.11 hectares. (Návštěvník.cz, 2005). Additionally, there is the so-called gardeners` colony alongside the river Chrudimka where the inhabitants of blocks of flats have their small gardens.



Source: <http://www.navstevnik.cz/o-chrudimi/zakladni-informace/>

4.2. Waste Management System in Chrudim

The system of collection, separation, utilization and removal of municipal waste is administered by Generally Binding Public Notice of Chrudim no. 6/2008.

For the purposes of waste gathering and separation, the following containers and facilities are available:

- standardized collection vessels (dustbins and containers of capacity 110 and 1 100 litres) are used for disposing of mixed municipal waste, i.e. residual waste that is left after sorting utilisable and hazardous waste (garbage, ash, disposable packages, kitchen waste etc.)
- containers for the collection of separated waste (glass, plastic and paper) that are situated throughout the urban area
- a waste collection yard, where hazardous waste, as well as other kinds of household waste (furniture, clothes or garden waste) may be disposed of
- mobile collection of hazardous waste (exercised twice a year at designated points)

Waste collection is run by Technical Services of Chrudim. According to their statistics, the average number of emptied vessels is around 9 750 dustbins and 465 containers monthly. In total, yearly disposal in landfill in Nasavrky (village 14 kms south of Chrudim) is around 8 000 tons of household waste.

Regarding biodegradable waste, it can be disposed of in the waste collection yard. This is free of charge for the inhabitants of Chrudim for up to 100 kilograms (exceeding this amount would be charged for at a rate of 1 CZK/kg) and this service is primarily used for grass cuttings and leaves from gardens and public green areas. The organic waste is then processed in the industrial composting facility in Dražkovice (a village about 10 km from Chrudim).

Every person with permanent residence in Chrudim pays for the waste collection service. The rate has been established as the sum of the two following amounts:

- 220 CZK, set by the Act on Local Fees
- 250 CZK, calculated according to the real municipal costs of collection and transport of unsorted communal waste during the preceding year (in 2007 this amounted to 9 788 004 CZK)

In total, the final amount of waste collection fee per calendar year was set at 470 CZK per head by Generally Binding Public Notice of Chrudim no. 3/2007 that entered into force on 1. 1. 2008.

4.3. Case Study: Community Composting in Chrudim

The community composting project was launched in Chrudim by the ecological organization Paleta in January 2006. It was the first project of this kind in the Czech Republic and it had two goals. Firstly, to distribute the information about organic waste management and to promote composting as a treatment method. The second objective was to start the actual running of community composter in a selected area of the panel building block U Stadionu.

As further described in the final report of the project, the separation of biodegradable waste and its composting was promoted during various events with an ecological or environmental nature, offering a practical demonstration of compostainers, collection containers and biodegradable materials such as bioplastic rubbish bags. Furthermore, thirteen directors of kindergartens and primary schools were contacted and the majority confirmed their interest in separating biologic waste in their schools, on condition that the city applied a comprehensive policy for biologic waste management.

During the preparation period, two meetings with inhabitants of the area took place, providing detailed information about the possibility to join the community composting scheme and introducing various kinds of composting methods, special bins designed for biowaste etc.

The practical part of the project started at the end of July 2006, when the composter was installed at the selected panel building next to the containers for glass, paper and plastic. It was clearly marked and accompanied explanatory instructions and photos. Additionally, contact details of the volunteer from the Paleta center, who supervised the compost and conducted regular inspections, were also stated there. Finally, an informative board was placed in front of the composter to educate passers-bys about the importance and benefits of composting.

The costs of the project were partly covered by Chrudim town council (the purchase of custom-made composter) and partly by the ecological organization Paleta (information materials, meetings etc.).

Weak Points of the Project

During the first year only ten families joined despite an intensive information campaign. One of the reasons was probably the fact that the panel buildings are quite big (approximately 80 flats in one house) and people do not know each other very well, there is no community and neighbourhood relationships are not very developed. Moreover, the majority of the inhabitants are retired people who do not want to change their customary practices of waste disposal and thus they are not interested in composting at all.

However, neither the families with older children were persuaded and surprisingly not even the young families or women on maternity leave. The profile of the average participating family was a working mother (waste separation is almost always initiated by a woman) with children of age 7-15.

The expectations are that the area will consequently rejuvenate and younger families, that consider waste separation as a part of every-day life, will join.

Benefits of the Project

For the main, the topic of composting and biologic waste separation in households and schools in Chrudim has been retrieved. Since the beginning of the project, the ecocenter Paleta has answered more than thirty enquiries regarding composting.

Moreover, the feasibility of community composting in panel blocks has been verified and the prototype of a community composter was examined (it is now being used for similar projects in different cities).

The project was included in the database of examples of good practice of Healthy City and serves as a model for other participating towns.

Experience from the Project

The experience from the pilot project of community composting may be summed up in following points:

The most favourable conditions for community composting are likely to be in the area of single-family houses or in blocks of panel buildings with a younger average age of the inhabitants.

Nevertheless, the most crucial factor is the presence of an enthusiastic volunteer, who would be ready to take care of the composter and the whole process of compost creation. A great deal of energy and time is necessary to inform the inhabitants about the aim of the project and to persuade them to join. Therefore, it may be more convenient for the town to support a flexible NGO in this kind of activity than to run such a project on its own.

4.4. Survey

A survey was conducted during the 2008 summer holidays based on questionnaire research. In order to avoid any misunderstanding of the questions and a low response rate, the data collection was carried out personally in the form of a standardized interview. Thus, the respondents were not limited by the offered answers, on the contrary, they were encouraged to add their own comments, remarks and suggestions.

For the purpose of gathering as much information as possible, the questionnaires contained many open questions.

The sample of respondents was chosen randomly from the city quarter Chrudim III, with the aim of identifying two different profiles:

Firstly, the people living in single-family houses, which in this area are commonly joined by small gardens and therefore have the potential for home composting (the area bordered by streets Svatopluka Čecha, Vrchlického, Koželužská and Dostálava).

Secondly, the people living in smaller blocks of flats (usually six flats in one building), who do not have a garden at their disposal (the area bordered by streets Dr. Václava Peška and Víta Nejedlého).

4.5. Objectives of the Survey

The first objective of the survey was to acquire information regarding the average waste behaviour of inhabitants in the selected areas. In particular, the questions were formed to determine:

- the number of households that do not sort waste at all and their reasons for not separating
- the kinds of waste that are sorted the most
- the approximate quantity of waste generated per week
- their feelings about the provision of a financial package for households that sorted their waste

The second objective concerned biodegradable waste in particular. The question were aimed to find out:

- how big was the share of organic waste that was thrown into dustbins and subsequently into landfill sites
- how many respondents separated biodegradable waste (either to compost it or to dispose it at the waste collecting yard)
- in case of not separation, how did they treat biodegradable waste
- what kind of motivation would persuade the inhabitants to compost their organic waste
- what their attitude towards community composting and a regular system of organic waste collection was

Last, but not least, the survey aimed to have a slightly educational character. The purpose was:

- to provide information about the kinds of waste that may be separated and about the ways of utilization
- to emphasise the benefits of composting and to explain the negative effects and the risks involved in organic waste landfilling
- to explain what kinds of waste do and do not belong in compost
- to introduce and explain the term community composting and to inform about the project already running

5. RESULTS

5.1. Survey Findings

Prior to commenting on the survey findings, it should be mentioned that the final results might have been influenced by several factors.

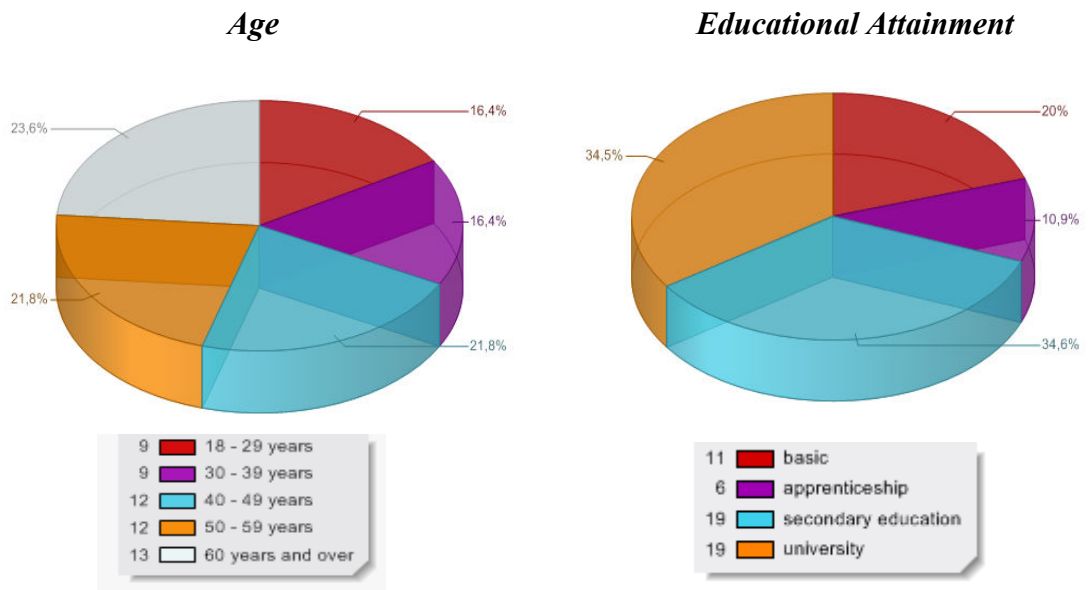
Primarily, the number of respondents was limited due to the research method chosen and the fact that it was carried out personally. Further, it has to be taken into account also that during the summer holidays young families leave for vacations, while older people more often stay at home. To partially avoid the uneven representation of age groups, the research was conducted repeatedly during weekdays.

On the other hand, the goal of the survey was to investigate the situation in the two selected areas of Chrudim and therefore, the characteristic features of the persons interviewed correspond with the profile of the inhabitants living there. Moreover, the personal approach proved to be beneficial and enabled not only a clear explanation of the questions but also interaction with the respondents.

The data acquired during the survey were processed by using the online research software Easy Research [www.easyresearch.cz].

5.2. General Characteristic of Respondents

The total number of participating respondents was 55, out of that 34 women (61.8%) and 21 men (38.2%). The age structure and the educational level of respondents are shown on the diagrams below.

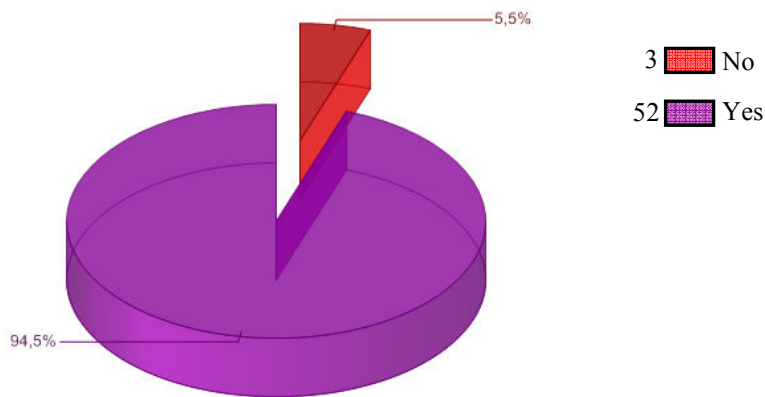


According to the type of housing, 56% of respondents live in single-family houses and 44% live in block of flats (as already mentioned, the survey concerned only small blocks of flats, where there is higher probability of developed neighbourhood relationships). Some of the deductions will be based on the comparison of these two groups of inhabitants.

5.3. Common Waste Behaviour

Out of all the households visited, only 3 claimed that they do not separate any waste at all. The reasons for not separating were in all three cases the same: lack of time and lack of interest.

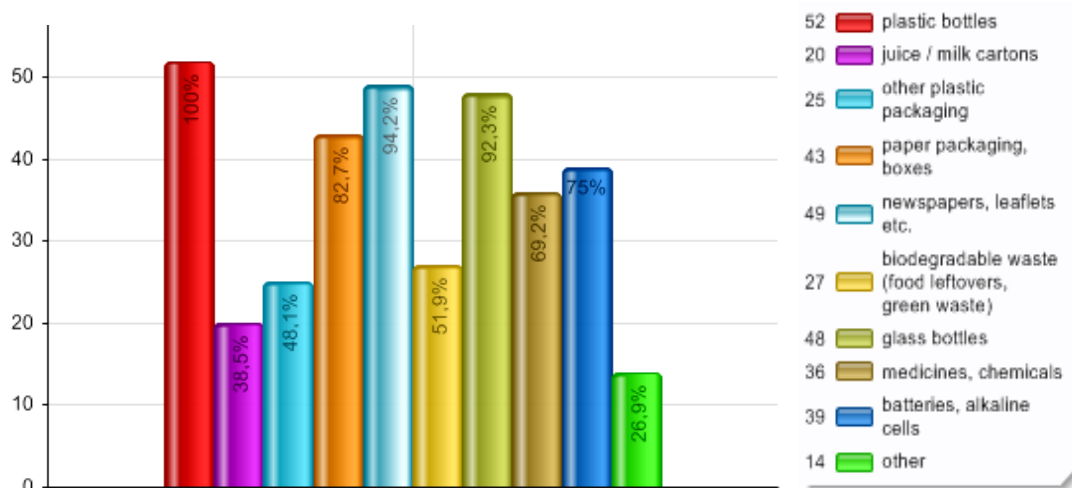
Do you separate waste (any kind) in your household?



The remaining 94.5% of respondents sort regularly at least some kinds of waste; all of them separate plastic bottles and prevailing part also recycle newspapers (94%), glass bottles (92%) and paper boxes (82%).

Conversely, the least separated kinds of waste are carton packaging used for juice or milk (38.5%), other plastic packaging, i.e. yoghurt cups or plastic wrappings of food (48.1%) and biodegradable waste (51.9%). The results are illustrated on the diagram below.

Which of the following kinds of waste do you sort?



In addition to the offered options, several households mentioned also separation of aluminium, iron, used oil or clothing (classified as other).

As we can see, all the rates are quite high with only three figures falling under 50%, indicating rather ecological behaviour of the respondents.

The approximate quantity of waste generated per week was based on the estimation that full wastebin (capacity 100 litres) weighs approximately 20 to 25 kgs, depending on the content. The average volume of waste produced per week is 13.53 kgs per household and the median value equals 15 kgs.

Waste Produced (kg)	3	4	5	7	8	10	15	20	25	Average	13.53
										Median	15
Answer Frequency	2	2	9	1	1	11	8	17	4	Minimum	3
										Maximum	25

The approach to financial privileges for waste-sorting households is a bit surprising: 71% of respondents agree, while 29% disagree, including the households that recycle a lot.

The reasons against, according to the spontaneous answers, are mainly the difficulty in control of such financial privileges and the possible negative impacts and risks of waste being thrown into side ditches or on illegal landfills in order to avoid paying the penalty or to benefit from the support.

Other opinions are that waste separation is driven by good feeling of acting ecologically and not by the financial benefits. However, lot of people agree, that the current system in Chrudim should be modified, for example not to pay waste collecting fee for new-born babies etc.

5.4. Organic Waste Treatment

In order to analyse the ways of organic waste treatment, the first question aimed to find out how big is the share of organic waste that is thrown into dustbins and subsequently landfilled.

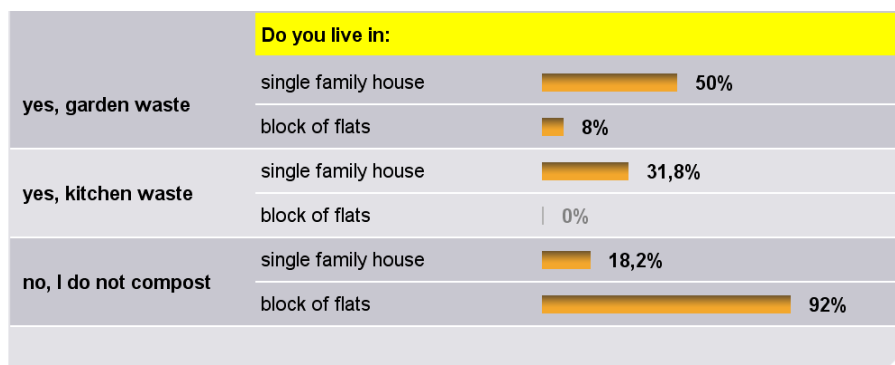
The average share is approximately 26% of the total waste produced per week, median value of 30%. Based on the average volume of waste produced per week (13.5 kgs) the average organic volume generated per week equals almost 3.5 kgs.

Organic Share (%)	0	5	10	20	25	30	40	50	55	60	70	Average	26,18
												Median	30
Answer Frequency	9	6	8	2	1	9	4	13	1	1	1	Minimum	0
												Maximum	70

Regarding the overall indicators of organic waste treatment, 35.6% of respondents compost garden waste, 13.5% composte also kitchen waste and 50.9% do not compost at all. In case of not composting, the respondents stated that they throw biologic waste into dustbin and about 10% of them bring garden waste to the waste collecting yard but only during the season (grass cuttings, leaves).

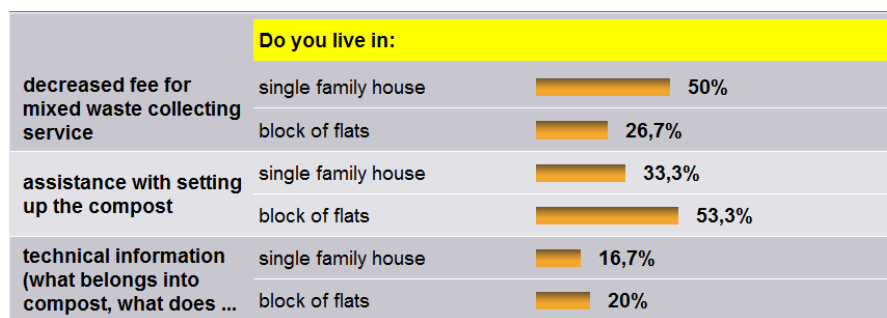
However, when we look at the same question from the point of view of the respondents' housing, we can observe significant shift. People living in single-family houses compost garden waste in 50% of cases and kitchen waste in almost 32% of cases. On the other hand, 92% of the inhabitants of blocks of flats do not compost at all.

Do you compost biodegradable waste?



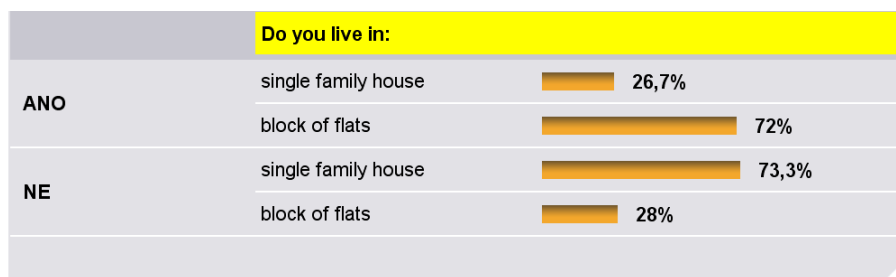
Further, the willingness to start composting under certain conditions was inquired. The most effectual kind of motivation to persuade the inhabitants to compost organic waste would be decreased fee for municipal waste collecting service (for 50% of persons living in single-family houses), assistance with setting up the compost (for 53% of persons living in block of flats) and technical information about composting (for both groups almost 20% in total).

What would be the motivation for you?



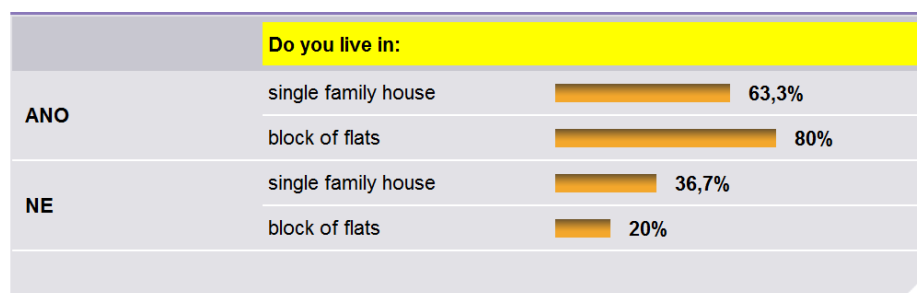
Naturally, community composting has higher potential in the area of block of flats, where the persons interested have almost no chance to compost. As can be seen on the diagram below, 72% inhabitants of blocks of flats would join; while 73% of inhabitants of single-family houses were not interested (this relatively high ratio can be explained by the existence of compost in their own gardens).

Would you be interested to join community composting?



The persons living in single-family houses as well as the inhabitants of blocks of flats would appreciate and use the regular service of collecting biodegradable waste (63.3%, respectively 80%).

Would you be interested in regular collection of biodegradable waste?



Surprisingly, for most of the respondents it is more acceptable to pay an extra fee for regular collection of organic waste (62%) than to make an effort to take care of community composter (27%), even if they would otherwise participate in community composting.

5.5. Educational Aim

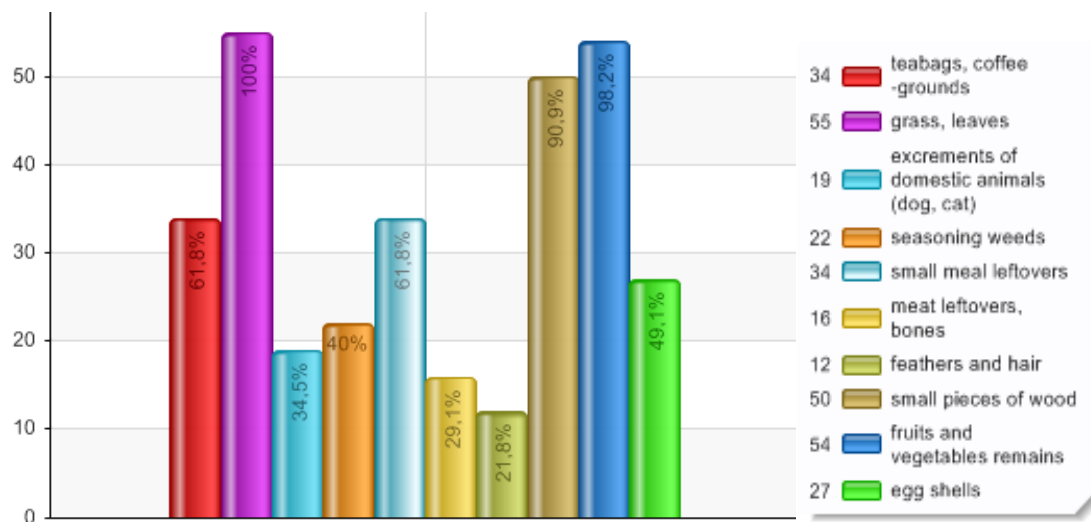
In order to broaden the knowledge about waste management, the survey also comprised a small information campaign associated with answering the questions of respondents.

This approach proved to have many positive results and distributed particular information, for example, majority of respondents did not know that carton packaging used for milk or juice may also be separated and recycled into the yellow container for plastics.

Moreover, for many people it was surprising to learn about the ways of utilization of plastic bottles that are processed in nearby Lázně Bohdaneč to manufacture filling material for sleeping bags or interlocking pavement of resistant plastic etc.

To explain what kinds of kitchen and garden waste are suitable for composting, the respondents were to decide on following question:

In your opinion, which of the following items may be composted?



In majority cases, the answers were correct, except the relatively high percentage for seasoning weeds (40%), excrements of dogs or cats (34.5%) and pieces of bones and meat (29.1%) that do not belong to the compost.

About half of the respondents also believe that egg shells are not suitable to be composted, but contrary is the case, the egg shells in compost present valuable source of calcium.

5.6. Hypotheses Verification

First expectation was that the biodegradable share in mixed waste reaches in average 30% of total weekly production of waste. As can be seen from the research outputs, the average volume of organic waste being thrown into dustbin reached 26.17%, which is in the tolerance that was set on 5%.

Secondly, it was assumed that decreased fee for waste collection would persuade minimally 40% of people to start composting their organic waste. In case of the

inhabitants of single-family houses, 50% would be convinced while only 26.7% respondents from blocks of flats would consider financial motivation as the most important reasons, 53.3% of them would rather appreciate assistance with setting up the compost.

5.7. SWOT Analysis

SWOT analysis describes the situation in Chrudim from the point of view of organic waste management and potential for home and community composting support.

Strengths

- activities of ecologic centre Paleta, success of community composting project
- participation in Healthy City program
- high number of persons composting in their gardens
- composting of green waste in industrial facility in nearby village
- willingness of majority inhabitants to behave ecologically

Weaknesses

- absence of local government conception for organic waste management
- missing support for composting or other processing of biodegradable waste
- insufficient education of the public
- common practise of burning green waste
- existence of illegal dumpings

Opportunities

- modification of the system of waste collecting fees
- increase of land-filling fees
- cooperation with kindergartens and primary schools in composting projects
- use of State Fund of Environment programs
- introduction of seasonal regular collection of organic waste

Threats

- negative effects of radical increasing of land-filling fees-vandalism
- impacts of improper biodegradable waste treatment on the environment and the health of inhabitants
- reluctance of inhabitants to change their habits

6. CONCLUSION

This chapter will summarize and interpret the results of the survey and outline possible solutions and recommendations for the development of organic waste management in the selected town, Chrudim.

6.1. Interpretation of the Results

Generally, the basic expectation was confirmed, because almost all the people interviewed behaved ecologically to some extent. In particular, 95% of households separate at least a few kinds of waste and as can be seen from the ratios of items sorted only three figures fell under 50%.

Comparing the kinds of waste that were separated the most, it can be assumed that the absolute majority of people had already learned to recycle plastic bottles and they also separated newspapers, paper boxes and glass bottles in large numbers. It is interesting to note that the most sorted kinds of waste were the most space occupying items, which implies that people actually try to save space in their dustbins.

Additionally, the volumes of waste generated per week per household were inspected: the average quantity of mixed waste was 13.5 kg, but the minimum value was only 3 kg (in case of households with high ratio of recycling). The average share of organic waste was 26% of total weekly production, which equals approximately 3.5 kg of waste.

Based on the comparison of the two groups of inhabitants, living in single-family houses and in blocks of flats, several deductions can be drawn:

- Obviously, the type of housing has a significant impact on recycling organic waste habits. Particularly, in blocks of flats biological waste is usually untreated; while in the area of single-family houses the share of utilization is rather high (50% of inhabitants compost garden waste, 32% compost kitchen waste also).
- Regarding community composting, this has a bigger potential in the area of block of flats, where the people interested have almost no chance to compost

(72% of inhabitants would participate). Therefore, such an interest should be used to start community composting projects.

- The persons living in single-family houses as well as the inhabitants of blocks of flats would appreciate and use the regular service of collecting biodegradable waste (63.3%, respectively 80%).
- Surprisingly, for most of the respondents it is more acceptable to pay an extra fee for the regular collection of organic waste (62%) than to make an effort to take care of community composter (27%), even if they would otherwise participate in community composting. This supports the idea that community composting should be initiated and exercised by a flexible NGO and volunteers.

To conclude, the most effective type of motivation that would persuade the inhabitants to separate and treat organic waste would be a decreased fee for the waste collecting service (for 50% of persons living in single-family houses) and assistance with setting up the composting (for 53% of persons living in block of flats). Technical information about composting would be appreciated by both groups (almost 20% in total).

6.2. Recommendations

The proposed solution is to modify the current system of fees for waste collection so as to charge households for the volume of waste generated rather than paying a fixed yearly amount per head. In reality, a certain fee will be paid for every dustbin emptied and thus the inhabitants will be responsible for how often (and how much in total) they pay.

The actual implementation can be based on existing similar projects operating in other cities or abroad. For instance, one way is to issue special labels to be stuck on the dustbins each time they required collection. To ensure the motivation and cooperation of inhabitants, it is necessary to accompany such a modification with an attractive adjustment of prices.

This system, however, might be difficult to apply in the area of blocks of flats or panel houses, where people use several dustbins together. Though, another way could be a deduction from the waste collection fee under the condition of active participation in community composting. Additionally, strict control of illegal dumping and high penalties would have to be enforced.

In this connection, the systematic support of composting projects would be set out by local government to supply the participating communities with the necessary equipment, especially the community compostainers. To finance such support, an application will have to be made for money from State Fund of Environment.

Alternatively, there is the option of regular collection of biodegradable waste, for example by using a special type of waste vessel, a so-called compostainer. This service would have quite a big response from the inhabitants, but concerning the average volume of waste generated (3.5 kgs per week), it would not be used to its full capacity. Moreover, every household would need a compostainer which would substantially increase the costs of the program together with the costs of waste collection and transport.

Instead, containers for large volumes of biologic waste (mainly grass cuttings and leaves) may be provided during the season (from spring to autumn) in designated places and with higher frequency than now.

To sum up, support for home and community composting will bring benefits for the inhabitants in the form of lower fees for waste collection and by creating compost for their own use. Secondly, the municipality will make savings from the less intense waste collection and decreased costs of land fill of the municipal waste. Furthermore, the compost generated in the industrial composting facility may be used to improve the soil in the public green areas. And thirdly, the benefits for the environment will be presented mainly by the reduced negative impact of biodegradable mass land fill and the return of organic substances back to soil.

In all accounts, the crucial role will be played by a permanent information campaign and public education to keep and possibly develop the interest of people and to broaden their knowledge about waste management methods.

Motivation for composting is closely linked with practical demonstrations and technical assistance, mainly in the beginning. For this reason, it is advisable to cooperate with NGO members and volunteers who will make the effort to actively encourage the inhabitants to start composting and to organise and supervise the community projects.

In order to continue mutual beneficial communication it will be necessary to provide the volunteers with training, to ensure the visible appraisal of their work and the goals reached and also to maintain feedback from all the participating parties.

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8. SUPPLEMENTS

Supplement 1: Research Questionnaire in English

1. Do you separate waste (any kind) in your household?

- yes
- no

→ **1a. What is the reason for not separating?:**

2. Which of the following kinds of waste do you sort?

- plastic bottles
- juice / milk cartons
- other plastic packaging
- paper packaging, boxes
- newspapers, leaflets etc.
- biodegradable waste
- glass bottles
- medicines, chemicals
- batteries, alkaline cells
- other:

3. What is the approximate quantity of waste produced in your household per week? (kg)

4. Of which approximately biodegradable waste (kitchen waste, garden waste)? (%)

5. Do you compost biodegradable waste?

- yes, garden waste
- yes, kitchen waste
- no, I do not compost

→ **5a. What do you do with kitchen waste, leaves, grass cuttings?:**

6. Would you be willing to start composting under certain conditions?

- yes

→ **6a. What would be the motivation for you?**

- decreased fee for mixed waste collecting service
- assistance with setting up the compost

- technical information (what belongs into compost, what does not, processing methods)
- other reasons:
- no

7. Would you be interested to join community composting?

- yes
 - 7a. Would you be willing to take care of community compost? yes
 - no
- no

8. Would you be interested in regular collection of biodegradable waste?

- yes
 - 8a. Would you be willing to pay extra fee? yes
 - no
- no

9. In your opinion, which of the following items may be composted:

- | | |
|--------------------------------------------------------------------|--------------------------------------------------------|
| <input type="checkbox"/> teabags, coffee-grounds | <input type="checkbox"/> meat leftovers, bones |
| <input type="checkbox"/> grass, leaves | <input type="checkbox"/> feathers and hair |
| <input type="checkbox"/> excrements of domestic animals (dog, cat) | <input type="checkbox"/> pieces of wood |
| <input type="checkbox"/> seasoning weeds | <input type="checkbox"/> fruits and vegetables remains |
| <input type="checkbox"/> small meal leftovers | <input type="checkbox"/> egg shells |

10. Do you agree that waste separating households should be financially privileged?

- yes
- no

DATA FOR STATISTICAL EVALUATION

Sex:

- male female

Age:

- 18 - 29 years 50 - 59 years
 30 - 39 years 60 years and over
 40 - 49 years

Do you live in:

- single family house block of flats

Supplement 2: Questionnaire in Czech

1. Třídíte odpad ve Vaší domácnosti (alespoň některý druh)?

- ano
- ne

→ 1a. Z jakého důvodu odpady netřídíte?:

2. Které z následujících druhů odpadu oddělujete?

- plastové (PET) láhve
- bioodpad (zbytky jídla, zeleň)
- krabice od džusu, od mléka
- láhve ze skla
- ostatní plastové obaly
- léky, chemikálie
- papírové obaly, krabice
- baterie, alkalické články
- noviny, letáky
- jiné:

3. Jaké přibližné množství odpadu Vaše domácnost vyprodukuje za týden? (kg)

4. Z toho přibližně biologický odpad (zbytky jídla, zeleň)? (%)

5. Kompostujete biologický odpad?

- ano, zeleň
- ano, kuchyňský odpad
- ne, nekompostuji

→ 5a. Co děláte s kuchyňským odpadem, listím, posekanou trávou?:

6. Byl/a byste ochoten/ochotna za určitých podmínek kompostovat?

- ano

→ 6a. Co by Vás motivovalo?

- možnost snížení poplatku za svoz směsného odpadu
- pokud by Vám někdo pomohl začít kompostovat
- kvalitní informace, co do bioodpadu patří a jak s ním dále nakládat
- jiný důvod:
- ne

7. Měl/a byste zájem podílet se na komunitním kompostování?

ano

→ 7a. Byl/a byste ochoten/ochotna se o komunitní kompost starat? ano

ne

ne

8. Uvítal/a byste pravidelný svoz bioodpadu?

ano

→8a. Byl/a byste ochoten/ochotna platit zvláštní poplatek? ano

ne

ne

9. Myslíte si, že do kompostu patří:

čajové sáčky, káva

zbytky masa, kosti

tráva, listí, drobnější větve

peří a chlupy

trus domácích zvířat (pes, kočka)

kousky dřeva

kořenící plevelné rostliny

zbytky ovoce, zeleniny

malá množství zbytků jídla

skořápky od vajíček

10. Myslíte si, že třídění odpadů by mělo být finančně zvýhodněné?

ano

ne

ÚDAJE PRO STATISTICKÉ VYHODNOCENÍ

Jste:

muž

žena

Kolik je Vám let?

18 - 29 let

50 - 59 let

30 - 39 let

60 a více let

40 - 49 let

Bydlíte:

v rodinném domě

v činžovním domě