DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

THE RECOVERY AND RECYCLING APPLICATIONS FOR MUNICIPAL SOLID WASTES GENERATED IN IZMIR METROPOLITAN AREA

by
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September, 2005
İZMİR

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We have read the thesis entitled **"THE RECOVERY AND RECYCLING APPLICATIONS FOR MUNICIPAL SOLID WASTES GENERATED IN IZMIR METROPOLITAN AREA"** completed by **Ebru TUNÇ** under supervision of **Prof. Dr. Ayşe FİLİBELİ** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

The rapid and uncontrolled increase in the population of the world and the changes in the life styles of people have brought with them some problems. The management and disposal of municipal solid wastes are one of these important problems and this has caused the rise in environmental consciousness in recent years. Various studies and researches have been done and specific legislations have been prepared for the most effective and convenient municipal solid waste management system.

The realized studies have showed that recovery and recycling applications play an important role on determining a convenient municipal solid waste management system. In addition, because of the insufficient landfill areas and problems occurring during the collection and transportation, municipal solid wastes should be recovered by sorting at source. Natural sources can be preserved, energy sources can be economized, the life of the landfill areas can be extended, the economy of the country can be contributed by selling the recyclable materials and the environmental knowledge of people can be improved by the help of the improvements in studies about recovery and recycling of municipal solid wastes.

The purpose of this study is to investigate the recycling and recovery implementations in Izmir Metropolitan Area to illustrate the progress on the management of municipal solid wastes in Turkey during the harmonization studies for the membership of Turkey to European Union.

Keywords: Recycling, recovery, municipal solid wastes, Izmir Metropolitan Area

İZMİR METROPOLİTAN ALANDA OLUŞAN KENTSEL KATI ATIKLARIN GERİ KAZANIM VE GERİ DÖNÜŞÜM UYGULAMALARI

ÖZ

Dünya nüfusundaki hızlı ve kontrol edilemeyen artış ve insanların yaşam tarzındaki değişimler beraberinde bazı problemler getirmiştir. Evsel katı atıkların yönetimi ve bertarafı bu önemli problemlerden biridir ve bu, çevresel bilincin son yıllarda artmasına sebep olmuştur. En etkili ve uygun evsel katı atık yönetim sistemi için çeşitli çalışmalar ve araştırmalar yapılmış ve spesifik yönetmelikler hazırlanmıştır.

Gerçekleştirilen çalışmalar uygun bir evsel katı atık yönetim sisteminin belirlenmesinde geri kazanım ve geri dönüşüm uygulamalarının önemli rol oynadığını göstermiştir. Bununla beraber, depolama alanlarının yetersizliğinden ve toplama ve taşıma sırasındaki problemlerden dolayı evsel katı atıkların kaynağında ayrı toplanarak geri kazanılması gerekmektedir. Evsel katı atıkların geri kazanım ve geri dönüşüm çalışmalarının arttırılması ile; doğal kaynakların korunması sağlanır, enerji kaynaklarından tasarruf edilir, depolama alanlarının ömrü uzatılır, satılan geri kazanılabilir nitelikteki malzemeler sayesinde ülke ekonomisine katkıda bulunulur ve insanların çevre bilinci arttırılır.

Bu çalışmanın amacı, Türkiye'nin Avrupa Birliği'ne üyeliği için yapılan uyum çalışmaları süresince, Türkiye'deki evsel katı atık yönetimindeki gelişmeleri örneklemek amacıyla İzmir Metropolitan Alan içerisinde yapılan geri kazanım ve geri dönüşüm çalışmalarını incelemektir.

Anahtar sözcükler: Geri dönüşüm, geri kazanım, evsel katı atıklar, İzmir Metropolitan Alan

CONTENTS

CHAPTER ONE
INTRODUCTION

The growth of the world's population, increasing urbanisation, rising standards of living, and rapid developments in technology have all contributed to an increase in both the amount and the variety of solid wastes generated by industrial, domestic and other activities (UNEP, 1991). The problems of dealing with greater volumes of - often more dangerous – waste materials are particularly acute in developing countries where these changes have not been met by improvements in waste-management technologies (Wilson & Balkau, 1990). Even municipal solid waste has become a health hazard in many developing countries as a result of careless handling and a failure to organise appropriate solid waste management plans. For this reason, numbers of studies have been done to improve new disposal technologies and also more specific legislations have been prepared to control the management of the municipal solid wastes and to prevent the pollution on environment.

It’s undeniable that an effective and sustainable municipal solid waste management system can be achieved by applying the standards as stated in the legislations on both national and international level. Legislations are one of the key factors on realizing the disposal technologies. Timely and full implementation of existing waste legislations is a prerequisite to ensure effective waste management. According to this purpose, the relevant EU directives and Turkish legislations about municipal solid wastes were studied carefully in this study.

One should note that municipal solid waste often receives the most attention from policy-makers, partly due to the fact that collection and treatment of those wastes are generally a responsibility of public authorities. Besides, municipal solid waste is an important waste stream for a number of reasons including its heterogeneity. Because the composition of municipal solid waste is very complex and includes variety of waste types like; organic waste, recyclable waste, hazardous waste, batteries and accumulators and etc. that should be disposed in the right way separately. The socio-cultural and economical structure of the society and the cities’ own properties play an

important role on the generation and composition of the municipal solid wastes. This study clarifies the composition of municipal solid waste and also illustrates the different municipal waste compositions of EU countries and Turkey.

This study also presents the collection and transportation of municipal solid wastes that is an obligation for local authorities. A systematic collection scheme and safely transfer are the most important components in an effective solid waste management system. Different collection systems for separate waste streams were investigated and also the transfer options were given in this study. The implementation of the separate collection scheme contributes to achieve in recycling and recovery of municipal solid wastes. According to this purpose, the benefits of separate collection system for municipal solid wastes were evaluated in this study.

Municipal solid waste management is an important environmental health service, and is an integral part of integrated solid waste management system. The hierarchy on solid waste management is prevention, reuse, recycling, waste recovery through physical, biological or chemical processes and finally landfilling. The selection and application of the appropriate techniques and technologies are important criterions to achieve in the management of specific waste streams and to minimize the environmental impacts of waste by taking into account the economic and social considerations. After minimizing the generation of the wastes at source, recycling and recovery of the produced solid wastes form the most important and essential part of the municipal solid waste management applications. This study elaborates on the components of municipal solid waste management systems. This study also evaluates the requirements for the recycling and recovery of municipal solid wastes in a waste management system of a city.

In addition, to illustrate the current situation in Europe, the recycling and recovery implementations of Germany and France were given as two main systems applied in EU countries. Plus, the recycling and recovery applications for municipal solid wastes in Turkey were investigated in this study to compare with the implementations in EU countries.

In accordance with the harmonization studies for the membership of Turkey to European Union, environmental problems such as the management of municipal solid wastes become one of the most important subjects in Turkey. There is an incremental progress on environmental studies consisting of legal orders, effective waste management systems and implementation of these systems in Turkey. Izmir Metropolitan Area was chosen in this study to explain the improvements in Turkey on environmental sector in recent decades. The aim of the study is to investigate the recycling and recovery methods implemented in Izmir Metropolitan Area especially after the new legislations came into force.

CHAPTER TWO
LEGISLATION CORRESPONDS WITH THE MUNICIPAL SOLID WASTES

2. Legislation on Waste

Legislations play an important role in determining the quality of life in a society. Because of that people have prepared different legislations for years to overcome the increasing municipal solid waste problem.

The economical development and progress that fast increase in parallel to usage of natural resources by application of science and technology into the industry, also brought many problems such as increasing of population, decreasing of natural resources, increasing of fossil fuel consumption, management of produced wastes, beside the environmental problems that gradually increase together with them and do not recognize any limit. Most of the wastes are uncontrolly thrown to the areas without taking any measures because of the work related to the waste management as also in all developing countries (Antipolis, 2000; Boada, Haya, Monfort,& Parpal, 2003; Smith, Brown, Ogilvie, Rushton,& Bates, 2001).

Integrated solid waste management (ISWM) is defined by Tchobanoglous et al. (1993) as the selection and application of appropriate techniques, technologies, and management programs to achieve specific waste management objectives and goals. Waste hierarchies are usually established to identify key elements of an ISWM plan. The general waste hierarchy accepted by industrialized countries is comprised of the following order:

- Reduce
- Reuse
- Recycle
- Recovery of waste transformation through physical, biological, or chemical processes (e.g., composting, incineration)
- landfilling

After waste prevention and re-use, the waste management hierarchy accords the highest preference to recycling and recovery as an effective long-term solution. There are a number of different options available for recycling and recovery of municipal solid wastes. Recycling and recovery methods of municipal solid wastes should comprise the relevant legislations and directives to be implemented. Otherwise, they wouldn't have long term application areas (Stokoe,& Teague, 1995).

The new decade offers an opportunity – and at the same time shows the necessity – to proceed with the implementation and consolidation of environmental regulations. Focused action is required as soon as possible, especially in developing countries.

2.1 Waste Management Policy in EU

As European society has grown wealthier it has created more and more rubbish. Each year in the European Union alone they throw away 1.3 billion tonnes of waste - some 40 million tonnes of it hazardous. This amounts to about 3.5 tonnes of solid waste in a year for every man, woman and child, according to European Environment Agency statistics. Add to this total a further 700 million tonnes of agricultural waste and it is clear that treating and disposing of all this material - without harming the environment - becomes a major headache (EUROPEN, 1999; European Commission, 1999).

Between 1990 and 1995, the amount of waste generated in Europe had increased by 10% according to the Organisation for Economic Cooperation and Development (OECD, 1999). Most of what they throw away is either burnt in incinerators, or dumped into landfill sites. But both these methods create environmental damage. Landfilling not only takes up more and more valuable land space, it also causes air, water and soil pollution, discharging carbon dioxide (CO_2) and methane (CH_4) into the atmosphere and chemicals and pesticides into the earth and groundwater. This, in turn, is harmful to human health, as well as to plants and animals.

By 2020, the OECD estimates, European society could be generating 45% more waste than they did in 1995 (OECD, 1999). The EU's Sixth Environment Action Programme identifies waste prevention and management as one of four top priorities. Its primary objective is to decouple waste generation from economic activity, so that EU growth will no longer lead to more and more rubbish.

The European Union's approach to waste management is based on three principles (EUROPEN, 1999; European Commission, 1999):

- *Waste prevention:* This is a key factor in any waste management strategy. If we can reduce the amount of waste generated in the first place and reduce its hazardousness by reducing the presence of dangerous substances in products, then disposing of it will automatically become simpler. Waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging.

- *Recycling and reuse:* If waste cannot be prevented, as many of the materials as possible should be recovered, preferably by recycling. The European Commission has defined several specific 'waste streams' for priority attention, the aim being to reduce their overall environmental impact. This includes packaging waste, end-of-life vehicles, batteries, electrical and electronic waste. EU directives now require Member States to introduce legislation on waste collection, reuse, recycling and disposal of these waste streams.

- *Improving final disposal and monitoring:* Where possible, waste that cannot be recycled or reused should be safely incinerated, with landfill only used as a last resort. Both these methods need close monitoring because of their potential for causing severe environmental damage. The EU has recently approved a directive setting strict guidelines for landfill management. It bans certain types of waste, such as used tyres, and sets targets for reducing quantities of biodegradable rubbish. Another recent directive lays down tough limits on emission levels from incinerators. The Union also wants to reduce emissions of dioxins and acid gases

such as nitrogen oxides (NO_x), sulphur dioxides (SO_2), and hydrogen chlorides (HCL), which can be harmful to human health.

It should be noted that the Community framework is only the backbone of waste management practice. It necessarily needs complementary action by Member States and local authorities.

2.1.1 Relevant Legislation for Municipal Solid Wastes in EU

Waste management policy in EU enshrines the principles of sustainable development in the familiar waste management hierarchy, which underpins policy in this area. The hierarchy of waste management options places the greatest preference on waste prevention. Where wastes cannot be prevented, the order of preference decreases in order re-use, recycling, recovery of energy and finally (as the least preferred option) the disposal in landfills of stabilized wastes from which no further value can be recovered (D'Sa, 2004; European Commission, 1999; Yöntem, 2002).

As part of the suite of measures to improve the sustainability of municipal solid waste management, several directives are prepared to introduce requirements on EU member states. To achieve this objective, directives have introduced targets for reducing the amount of municipal solid waste disposed of to landfills. Relevant directives for municipal solid wastes in EU are as follows:

a. Directive 75/442/EEC on Waste (Waste Framework Directive)
b. Directive 94/62/EC on Packaging and Packaging Waste
c. Directive 2004/12/EC Amending Directive 94/62/EC on Packaging and Packaging Waste
d. Directive 2000/76/EC on The Incineration of Waste
e. Directive 1999/31/EC on the Landfill of Waste
f. Directive 91/157/EEC on Batteries and Accumulators Containing Certain Dangerous Substances

g. Directive 91/689/EEC on Hazardous Waste, as Amended by Directive 94/31/EC
h. Directive 2002/96/EC on Waste Electrical and Electronic Equipment

2.1.1.1 Directive 75/442/EEC on Waste (Waste Framework Directive)

Council Directive 75/442/EC (WASTE Framework - 15 July 1975) laid down the basic principles on the collection, disposal, recycling and processing of waste on a national basis as opposed to a local basis (Official Gazette, 27.7.1975)

The Directive establishes a framework for the management of waste across the European Community. It also defines certain terms, such as 'waste', 'recovery' and 'disposal', to ensure that a uniform approach is taken across the EU (D'Sa, 2004; Yöntem, 2002). It requires Member States to:

- give priority to waste prevention and encourage reuse and recovery of waste
- ensure that waste is recovered or disposed of without endangering human health and without using processes which could harm the environment
- prohibit the uncontrolled disposal of waste, ensure that waste management activities are permitted (unless specifically exempt)
- establish an integrated and adequate network of disposal installations
- prepare waste management plans
- ensure that the cost of disposal is borne by the waste holder in accordance with the polluter pays principle
- ensure that waste carriers are registered

The legislation requires that anyone who treats, keeps, deposits or disposes of waste needs a waste management license (unless exempt or excluded), which is issued by the Environment Agency. Waste management licenses include conditions relating to operations at the site and the Environment Agency monitors activities to ensure compliance with the license conditions. A key objective of the licensing

system is to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which harm the environment.

The content of the directive can be summarized as below (Official Gazette, 27.7.1975):

- These measures apply to all substances or objects which the holder disposes of or is obliged to dispose of in pursuance of the national provisions in force in the Member States. They do not apply to radioactive waste, mineral waste, annual carcasses and agricultural waste, wastewater, gaseous effluents and wastes that are subject to specific Community Regulations.

- Member States must prohibit the uncontrolled discarding, discharge and disposal of waste. They shall promote the prevention, recycling and conversion of wastes with a view to their reuse. They shall inform the Commission of any draft Regulations which may involve the use of products which can give rise to technical difficulties and excessive disposal costs and which may encourage decreasing as regards the quantities of certain wastes, the treatment of waste for the purpose of their recycling or their reuse, the use of energy deriving from certain wastes or the use of natural resources which may be replaced by reclamation materials.

- The measures provide for cooperation between the Member States with a view to setting up an integrated, adequate network of disposal installations (taking account of the best technologies available) which would enable the Community itself to dispose of its wastes and the Member States individually to work towards that aim. That network would have to enable waste to be disposed of in one of the closest installations that guaranteed a high level of environmental protection.

- Member States shall ensure that all holders of wastes shall hand them over to a private or public collection agency or to a disposal company, or else shall themselves conduct the disposal in compliance with the requirements of the current measures.

- Companies or establishments treating, storing or dumping waste for another party must obtain an authorization from the competent authority which concerns, in particular, the types and quantities of waste to be treated, the general technical requirements and the precautions to be taken. The competent authorities may routinely check compliance with those authorization conditions. The same monitoring by the competent authority is reserved for transport, collection, storage, dumping or treatment companies working on their own account or for third parties.

- The cost of disposal of waste must be borne by its holder, who will hand over his waste to a collector or company and/or else by earlier holders or by the producer who has generated the waste in accordance with the "polluter pays" principle.

- The competent authorities appointed by the Member States in order to implement the current measures shall draw up at least one management plan governing, in particular, the types, quantities and origins of the wastes to be upgraded or disposed of, the general technical requirements, all of the special arrangements concerning specific wastes, and the appropriate locations and installations for the disposal.

2.1.1.2 Directive 94/62/EC on Packaging and Packaging Waste

The Community first introduced measures on the management of packaging waste in the early 1980s. Directive 85/339/EEC covered the packaging of liquid beverage containers intended for human consumption only but it was too vague to bring about the effective harmonisation of national policies. As a consequence, diverging national legislation appeared in several Member States.

Only some EU Member States introduced measures on packaging and packaging waste management with a view to reducing their environmental impacts. Serious Internal Market problems arose when cheap secondary materials from countries with recycling schemes that provided funding for collection and recycling appeared on the markets of other Member States where no such schemes were in place. Collection

and recycling activities that relied on cost recovery through the sale of secondary raw material were threatened by collapse.

For this reason, economic operators and Member States approached the Commission to introduce comprehensive legislation on packaging. In 1992, the Commission came forward with a Proposal for a Council Directive on Packaging and Packaging Waste. Following a prolonged discussion in the European Parliament and the Council of Ministers, Directive 94/62/EC was adopted (Official Gazette, 31.12.1994).

Packaging waste is an important focus of EU environmental and waste management policy, where it is defined as a priority waste stream covered by EC Directive 94/62/EC on Packaging and Packaging Waste. This Directive aims to harmonise national measures in order to prevent or reduce the impact of packaging and packaging waste on the environment and to ensure the functioning of the Internal Market. It contains provisions on the prevention, re-use, recovery and recycling of packaging waste (Arc21, 2003; European Commission DGXI.E.3, 2001; Official Gazette, 31.12.1994).

The Directive covers all packaging placed on the market in the Community and all packaging waste, whether it is used or released at industrial, commercial, office, shop, service, household or any other level, regardless of the material used (EUROPEN, 1999; Official Gazette, 31.12.1994).

Member States must introduce systems for the return and/or collection of used packaging to attain the targets that are given in Article 6 of the directive. These targets were changed when Directive 2004/12/EC came into force and new targets are written in Section 2.1.1.3 of this study. The incineration of waste at plants with energy recovery is regarded as a means of realizing these objectives (Pro- Europe, 2004).

Directive 94/62/EC lays down essential requirements as to the composition and the reuse, recovery and recycling of packaging; the Commission is to promote the preparation of European standards relating to the essential requirements (Official Gazette, 31.12.1994).

The Directive provides Member States with a degree of latitude in terms of the measures that can be adopted to meet the obligations and provisions of the Directive. As a result, different Member States have established different systems to comply with the Directive requirements (Official Gazette, 31.12.1994).

In practice organisations have been established in each country to comply with the obligations, imposed by the national legislation, on behalf of the affected businesses. Individual businesses generally have the option of transferring their obligations to an external organisation, i.e., a compliance scheme, or fulfilling their obligations themselves. In principle, therefore, compliance schemes have an essential role to play in coordinating the activities necessary for the recycling and recovery of waste packaging, and interfacing between the different stakeholders, including industry, reprocessors, and municipalities (Official Gazette, 31.12.1994).

2.1.1.3 Directive 2004/12/EC Amending Directive 94/62/EC on Packaging and Packaging Waste

On 7 December 2001, the European Commission issued a proposal to revise the Directive 94/62/EEC on Packaging and Packaging Waste. The Commission proposal provided for an increase of the recovery and recycling targets, a clarification of the definitions of “packaging” and “recycling”, and introduced material-specific minimum recycling targets.

After two readings within the co-decision procedure, the Conciliation Committee (between Parliament and Council) completed the revision of the Packaging Waste Directive in December 2003 – permitting Member States to count incineration for recovery targets. The act was formally adopted by the Council and the European

Parliament at the end of January 2004 and came into force on 18 February 2004 (Official Gazette, 18.02.2004).

Directive 2004/12/EC amending Directive 94/62/EC on packaging and packaging waste is briefly summarized below:

- Packaging means all products of any materials used for containing, protecting, handling, delivery and presentation of any type of goods, from the producer/seller to the user or consumer. Thus, apart from conventional packaging, even film over-wrap around a CD case, paper or plastic carrier bags, disposable plates and cups (but not disposable cutlery), cling film, aluminium foil, labels and staples, are all forms of packaging.

- The Directive's main essential requirements for packaging require that the weight and volume of any packaging is the minimum to ensure safety, hygiene and customer acceptance; is designed and marketed so as to permit re-use, recovery or recycling; and is manufactured so as to ensure that any noxious and hazardous substances are minimised in emissions, ash or leachate during incineration or landfill.

- Article 6 lays down the recycling targets. Thus, by 31 December 2008, a minimum of 60% (increased from 50% for the old directive) by weight of packaging waste must be recovered for further use or incinerated with energy recovery. Also, between 55% and 80% (increased from minimum 25% and maximum 45% for the old directive) of all packaging waste must be recycled. The targets for recycling of materials contained in packaging waste increase to 60% from 15% for glass; 60% from 15% for paper and board; 50% from 15% for metals; 22.5% from 15% for plastics; and 15% for wood.

2.1.1.4 Directive 2000/76/EC on the Incineration of Waste

The aim of this Directive is to prevent or reduce, as far as possible, air, water and soil pollution caused by the incineration or co-incineration of waste, as well as the resulting risk to human health (Official Gazette, 28.12.2000).

When the proposal for this Directive was introduced the Community's waste incineration system was covered by Directives 89/369/EEC and 89/429/EEC (new and existing municipal waste-incineration plants) and 94/67/EC (incineration of hazardous waste).

This Directive is intended to fill the gaps existing in those legislations. Apart from the incineration of non-toxic municipal waste its scope extends to the incineration of non-toxic non-municipal waste (such as sewage sludge, tyres and hospital waste) and toxic wastes not covered by Directive 94/67/EC (such as waste oils and solvents). At the same time it is intended to incorporate the technical progress made on monitoring incineration-process emissions into the existing legislations, and to ensure that the international commitments entered into by the Community are met in terms of pollution reduction, and more particularly those laying down limit values for the emissions of dioxins, mercury and dusts arising from waste incineration (protocols signed in 1998 under the aegis of the United Nations' Economic Commission Convention on long-distance cross-border atmospheric pollution). The proposal is based on an integrated approach: limits for discharges into water are added to the updated limits for emissions to atmosphere (Yöntem, 2002).

2.1.1.5 Directive 1999/31/EC on the Landfill of Waste

The Landfill Directive 1999/31/EC aims to ensure high standards for the disposal of waste in the European Union and to stimulate waste prevention via composting and biogasification of biodegradable waste as well as recycling (Official Gazette, 16.7.1999). The directive includes provisions to reduce the landfilling of biodegradable waste in order to avoid the environmental damage caused by releases of breakdown products (landfill gas, including methane, and leachate). Article 5 of

the directive includes targets for the diversion of biodegradable wastes from landfill, requiring the promotion of waste sorting, material recycling and energy recovery (Official Gazette, 16.7.1999). Several Member States have already introduced limits for the biodegradable waste that is permitted to go to landfill.

For those Member States which have not introduced such guidelines, achieving the targets in the directive will present a challenge to local authorities and the waste-management industry. Alternative waste-management routes must be developed for biodegradable wastes which realise environmental benefits in a cost-effective manner. The most practicable of these is composting, both centralised and by the householder (European Commission, 2000).

According to the directive (Official Gazette, 16.7.1999), Member States must fulfill following requirements;

- A national strategy for a phased reduction in the total amount of biodegradable waste going to landfill must be set up in order to reduce EU methane emissions. Landfill gases from both new and existing landfills must be collected, treated and used, or it must be flared.

- Liquid waste, waste that is explosive etc., infectious hospital and clinical waste, whole and shredded used tires are to be prohibited from landfills.

To help meet the targets in the landfill directive, the European Commission is currently considering introducing further measures to encourage the adoption of alternatives to landfill for managing biodegradable wastes (European Commission (2001) Biological treatment of biowaste – Working document 2nd draft).

2.1.1.6 Directive 91/157/EEC on Batteries and Accumulators Containing Certain Dangerous Substances

Covering only 7% of all portable batteries placed on the EU market annually, existing EU legislation fails to adequately control the risks posed by batteries in the waste stream and to create a homogeneous framework for battery collection and recycling. Its limited scope has led to inefficiencies in national battery collection and recycling schemes, as well as confusion among consumers as to what to recycle and what not. The result is that today almost half of all portable batteries sold still go to landfilling or incineration (D'Sa, 2004; Yöntem, 2002).

Consequently, on 21 November 2003, the European Commission adopted a Proposal for a new Battery Directive, which will require the collection and recycling of all batteries placed on the EU market. It aims to prevent spent batteries ending up in incinerators or landfills and therefore to recover the various metals used in batteries. The collection and recycling of these valuable metals will also contribute substantially to saving natural resources in line with the new thematic strategy on the sustainable use of natural resources (Official Gazette, 26.03.1991).

For all types of batteries, the producers would be responsible for costs related to the collection, treatment and recycling. For spent portable batteries, the collection costs could be shared with the national, regional or local authorities. For spent industrial and automotive batteries, producers could conclude agreements on financing with their users (Official Gazette, 26.03.1991).

Current legislation provides measures for the upgrading and controlled disposal of spent batteries and accumulators. Member States must prohibit the marketing of batteries and accumulators containing a certain percentage of mercury and are required to draw up programmes to reduce the heavy metal content of batteries and accumulators.

Member States must also encourage the separate collection of batteries; while batteries and accumulators must be marked in such a way as to indicate separate collection, recycling requirements and heavy metal content (Official Gazette, 26.03.1991).

2.1.1.7 Directive 91/689/EEC on Hazardous Waste, as Amended by Directive 94/31/EC

The objective of the directive is management, recovery and correct disposal of hazardous waste. This directive has more stringent rules than those found in the Waste Framework Directive (Official Gazette, 31.12.1991).

The directive defines waste as hazardous, if it appears on the hazardous waste list and if it has one or more of the properties such as explosive, flammable, irritant, toxic and carcinogenic as listed in Annex III of the directive (D'Sa, 2004; Official Gazette, 31.12.1991; Yöntem, 2002).

According to the directive (Official Gazette, 31.12.1991), following requirements must be fulfilled by Member States;

- If technically and economically possible and if hazardous waste is already mixed with other waste, separate hazardous waste from other waste.
- Apply the permit, authorization, registration and inspection requirements under the Waste Framework Directive to the Hazardous Waste Directive.
- Keep record of waste form its generation up to its final disposal, including any intermediate transfer.
- Ensure that hazardous waste is packaged and labeled during its collection, transport and temporary storage.

2.1.1.8 Directive 2002/96/EC on Waste Electrical and Electronic Equipment

The objective of the directive is to prevent the generation of electrical and electronic waste and to promote reuse, recycling and other forms of recovery in order to reduce the quantity of such waste to be eliminated, whilst also improving the environmental performance of economic operators involved in its treatment (Official Gazette, 13.02.2003).

The directive's objective is also to approximate the laws of the Member States on restricting the use of hazardous substances in electrical and electronic equipment in order to contribute to the recovery and elimination of equipment waste and the protection of human health (D'Sa, 2004; Official Gazette, 13.02.2003).

This directive (Official Gazette, 13.02.2003) applies to the following categories of electrical and electronic equipment:

- large and small household appliances;
- IT and telecommunication equipment;
- consumer equipment;
- lighting equipment;
- electrical and electronic tools (with the exception of large-scale stationary industrial tools);
- toys, leisure and sports equipment;
- medical devices (with the exception of implanted and infected products);
- monitoring and control instruments;
- automatic dispensers

Member States are to encourage the design and production of electrical and electronic equipment which take into account and facilitate dismantling and recovery, in particular the reuse and recycling of waste electrical and electronic equipment.

Member States are to minimize the disposal of waste electrical and electronic equipment (WEEE) as unsorted municipal waste and are to set up separate collection systems for WEEE. Producers must make provision for the collection of waste which is not from private households. Member States must ensure that all waste electrical and electronic equipment is transported to authorised treatment facilities (Official Gazette, 13.02.2003).

2.2 Waste Management Policy in Turkey

Turkey began addressing environmental concerns during the 1970s. In 1978 the Prime Ministry Undersecretariat for Environment was founded as an extension of a state ministry responsible for the coordination of all national and international activities concerning the environment. The Undersecretariat was the institution expected to set Environmental policy, to coordinate and prepare regulations, and to cooperate with other ministries. However, the adaptation of environmental policies was not able to keep pace with Turkey's industrial development. This issue was not considered a priority for a long time. In August 1991, the Undersecretariat for the Environment was replaced by the Ministry of Environment. This change led to a diversification of the Ministry's responsibilities and an expansion of its staff, and empowered the administration with authority to implement and enforce policies for the protection and conservation of the environment (European Commission, 2002).

Today, the activities of the Ministry of Environment and Forestry cover issues such as appropriate land use, conservation of natural resources, protection of plant and animal species, prevention of pollution and raising public awareness. Setting environmental policies and strategies; coordinating environmental activities on local, national and international levels; issuing environmental licenses; collecting information; and organizing training activities are among the other duties of the Ministry. All these activities are conducted in close cooperation with other ministries, related institutions, local governments and non-governmental organizations (European Commission, 2002). The Environmental Law of 1982, which came into force in 1983, also endorsed many additional measures. The aim of

the law, which considers the environment as a whole, is not only to prevent and eliminate environmental pollution, but also to allow the management of natural resources and the land. According to the basic principles that govern the application of the Environmental law, as stated in the Constitution, citizens as well as the state bear responsibility for the protection of the environment. It is also stated in the Law that in all economic activities every measure should be taken to minimize pollution. In line with the Environment Law, several regulations have been issued since 1983.

Within the framework of sustainable development, Turkey today faces the challenge of balancing economic growth with environmental progress. A number of institutional and legislative elements of environmental reform have been put on the agenda as part of the environmental planning in the country. This will require strengthened environmental efforts and cooperation between the central government, municipalities and the private sector, which will create the necessary environmental infrastructure in urban and industrial areas (European Commission, 2002; Ministry of Environment & UNDP, 2002).

2.2.1 Relevant Legislations for Municipal Solid Wastes in Turkey

Turkey stated a national goal of being an EU member state. For this objective, Turkey has already started with the transposition and approximation studies of the EU Acquis (Yöntem, 2002). The Ministry of Environment and Forestry has the responsibility for the Environmental Sector, hence for the waste sector. The transposition studies of EU legislation in the waste sector are still going on and new applications will be done within the year of 2006. Existing legislations already correspond in part to the relevant EU waste directives.

Relevant directives for municipal solid wastes in Turkey are as follows:

a. Law on Environment Numbered 2872 (Official Gazette on 11 August 1983)
b. Law on Municipalities Numbered 5272 Amending Law on Municipalities Numbered 1580 (Official Gazette on 24 December 2004)

c. Law on Great Municipalities Numbered 5216 Amending Law on Great Municipalities Numbered 3030 (Official Gazette on 10 July 2004)

d. Regulation on Solid Waste Control (Official Gazette on 14 March 1991)

e. Regulation on Packaging and Packaging Waste Control (Official Gazette on 30 July 2004)

f. Regulation on Hazardous Waste Control (Official Gazette on 27 August 1995)

g. Regulation on Medical Waste Control (Official Gazette on 25 May 1993)

h. Regulation on the Control of Spent Batteries and Accumulators (Official Gazette on 31 August 2004)

i. Regulation on Construction and Demolition Waste (Official Gazette on 18 March 2004)

2.2.1.1 Law on Environment Numbered 2872

In 1991, Environmental Law 2872 was published by the Ministry of Environment in Turkey. The Law and its legal outcome of the "Solid Waste Control Regulation" which was published in the official gazette of Turkey on 14 March 1991, encompass the full range of the solid waste management.

In 1983, the Ministry of Environment issued The Environment Law 2872 which is a basic law indicating the environmental problems and the required regulations to be published and followed for all types of the waste management. The main aim of the law 2872 has been to co-ordinate all the activities related to the protection of natural environment. The law 2872 has many sections and articles about the solid waste and the management issues (Official Gazette, 11.8.1983).

The Environmental Law 2872 was completely investigated with respect to the relevant EU directives after the year of 2004 and the renovated Environmental Law will come into force as soon as possible. This new law defines the relevant and responsible sides clearly, it also determines the responsibilities and designates the punishments.

2.2.1.2 Law on Municipalities Numbered 5272 Amending Law on Municipalities Numbered 1580

The aim of this law is to regulate the establishment, department, management, duty, authority and responsibility of municipality. This law comprises all municipalities (Official Gazette, 24.12.2004).

According to this law municipalities are responsible for duties about collection, transportation, reuse, recovery, recycling, landfilling and disposal of solid wastes.

2.2.1.3 Law on Great Municipalities Numbered 5216 Amending Law on Great Municipalities Numbered 3030

The aim of the law is to regulate the legal situation of the management of great municipalities and to coordinate all duties in an ordinary and beneficial way. This law includes the great municipality and district municipalities in the border of the great municipality (Official Gazette, 10.07.2004).

According to this law, the great municipality has some duties about solid wastes as mentioned below;

- To protect the environment, agricultural areas and water sources in accordance with the sustainable development.
- To determine the areas for landfilling of solid wastes and has to take measures on the transportation of the solid wastes to prevent the pollution on the environment.
- To prepare the waste management plan of the great municipality.
- To prepare systems and fulfill their duties for the separate collection of solid wastes at source and reuse, recovery and recycling of this wastes and then landfilling of them and finally disposal of solid wastes.
- To set up the facilities for the recoverable wastes separated at source and landfilling areas for the disposal of solid wastes.

The law gives the duty of collection and transportation of solid wastes to the district municipalities, inside the metropolitan area, according to the principles mentioned in the waste management plan of The Great Municipality.

2.2.1.4 Regulation on Solid Waste Control

The Regulation on Solid Waste Control is the first regulation about solid wastes in Turkey. This regulation defines the responsible sides about solid wastes for the first time. Industries, municipalities and consumers are defined as responsible sides having some obligations about solid waste management. The regulation consists of all types of solid wastes as organic wastes, recyclable wastes, hazardous wastes, radioactive wastes, hospital and clinical wastes together.

The regulation covers all stages of solid waste management within ten sections (Official Gazette, 14.03.1991; Yöntem, 2002).

- **The First Section** of the regulation deals with the definitions, aims and concepts of the solid waste.
- **The Second Section** covers the principles of generation, disposal and collection of solid waste, training of people for the participation to waste minimisation and recycling programmes.
- **Section Three** gives the basic principles for the minimisation and recycling of plastic and metal wastes indicating details of quota and deposit applications of the packaging materials.
- Rules for sorting the solid waste at source, collection and transportation of them separately are given in **Section Four**.
- **Section Five** deals with the technical properties of sanitary landfills including site selection, preparation of the sanitary landfill area, system for the collection and removal of the leachate and the methane gas, co-disposal of sludges of treatment plants with municipal solid wastes, precautions to be taken for the

prevention of the negative impacts of the sanitary landfills, and the operation and licensing procedures.

- **Section Six** is about the composting of solid waste and the technical properties and the quality criteria of the compost to be used in agriculture.
- Incineration for solid wastes is the topic covered in **Section Seven**. This section gives the technical and operational details of the incinerators to be used for the incineration of the municipal solid wastes as well as the emission limits of the gases generated and the specifications of the wastes which are forbidden to be incinerated in these incinerators.
- **Section Eight** deals with the administrative, licensing and control procedures and criteria for solid waste facilities such as the landfills, incinerators and the composting facilities.
- **Section Nine** indicates the conditions of using treatment plant sludges in the agricultural activities.
- Other concepts related to solid waste management such as the follow up of the application of the regulation, composition and the responsibilities of the commissions are given in **Section Ten**.

The regulation also includes the lists of the packaging materials and targets set to recycle them and give this obligation to the industry that produce and develop products to be offered to the market by filling/packing in the packaging (Official Gazette, 14.03.1991).

The most important principles of the regulation can be summarised as the encouragement of the minimization and sorting of the solid wastes at source, collection of the batteries and medicines separately, prevention of the open dumps and giving the specifications of the solid waste facilities.

2.2.1.5 Regulation on Packaging and Packaging Waste Control

According to the transposition studies of EU legislation, The Regulation on Packaging and Packaging Waste Control has some similarities on The Directive 94/62/EC on Packaging and Packaging Waste.

The purpose of this regulation (Official Gazette, 30.07.2004) is;

1. To provide production of packaging with certain environmental criteria, requirements and characteristics,
2. To prevent direct and indirect release of packaging wastes causing environmental damage,
3. First of all to prevent formation of packaging wastes and to reduce the amount of those, which cannot be prevented, by means of reuse, recycling and recovery methods,
4. To establish necessary technical and administrative standards in the management of packaging wastes and to determine principles, policies and programs and legal, administrative and technical basis in this regard.

The Regulation on Packaging and Packaging Waste Control includes some definitions that are need for the management of packaging wastes.

This regulation includes all the packaging and packaging wastes offered in the domestic market regardless of the materials used (plastic, metal, glass, paper-cardboard, composite etc.) and the resource of the waste (domestic, commercial, industrial and all kinds of offices). This regulation also comprises all the packagings made of any material without looking at their types and usage areas (Official Gazette, 30.07.2004).

The regulation gives some targets for the recovery and recycling of packaging wastes. It also defines the types of the packaging wastes which have to be reused, recovered and recycled. The main principle of the regulation is to develop the

systems for separate collection of packaging wastes at source and to meet the targets by the help of these recycling applications. According to this regulation Ministry, Civil Administration, Municipalities, Marketers, Sales Points and Packaging Producers/Importers have some responsibilities for the implementation of the regulation (Official Gazette, 30.07.2004).

The responsible economic enterprises have the liability to recover at least 60% of their packaging wastes in terms of weight, within seven years after the date when this regulation is put into force (Official Gazette, 30.07.2004). Within this general aim and within the said time period, recovery rates as regards the years in terms of weights of packaging wastes are presented in Table 2.1 (Official Gazette, 30.07.2004).

Table 2.1 Recovery rates in terms of weights of packaging wastes

	Recovery Rates (%)						
Packaging Type	2005	2006	2007	2008	2009	2010	2011
Glass	32	35	38	45	50	55	60
Plastic	32	35	38	45	50	55	60
Metal	30	33	36	43	50	55	60
Paper/Cardboard	20	27	35	40	45	50	60
Composites*							

*The heaviest type of material existing in the composition of the unit composite packaging determines the recovery rate of that composite.

The economic enterprises that have been assigned responsibility by this regulation can come together and form a non-profit legal entity in order to achieve the recovery targets, to meet related expenditures, to carry out training and other related activities. Upon authorization of the said legal entity by the Ministry, economic enterprises, which sign contracts with this entity, which carry out their responsibilities therein and which contribute to the expenditures, can transfer their responsibility of collection and recovery to this entity. The Ministry shall audit the activities of the institutions, to which it has granted the authority of recycling and recovery on behalf

of the economic enterprises and shall monitor the collection, recycling and recovery targets and amounts (Official Gazette, 30.07.2004).

After this regulation came into force, ÇEVKO Foundation (Environmental Protection and Packaging Waste Recovery and Recycling Trust) is authorized by The Ministry to reach the recovery rates for all types of packaging materials as mentioned in the regulation. Also CAMSIAD, established by the economic enterprises having activities only on glass sector, is authorized by the Ministry to achieve the recovery targets only for glass.

Municipalities are responsible for the formation and organization of separate collection at source systems on their borders. Municipalities prepare the waste management plans for their systems and make other responsible communities, organizations or consumers implement this plan.

2.2.1.6 Regulation on Hazardous Waste Control

Turkey has become party to International Basel Convention on the Control of the Transboundary Movements of Hazardous Wastes and Their Disposal on 20 September 1994. By taking this Convention as a base the National Hazardous Waste Management Legislation was prepared and published in official gazette on 27 August 1995.

Legislation contains a list of general types of waste to be controlled under this list there exist all wastes possessing a Turkish code number, probable constituents likely sources of arising, probable hazards and legally accepted disposal methods (Official Gazette, 27.08.1995).

The Regulation includes:

- Controls on the import of hazardous wastes
- Encouragement of the minimisation of hazardous waste at source

- Requirements for producers to register with, and for collection and disposal contractors to obtain licenses from the Ministry.
- Powers for the Ministry to:
  - ⇒ ensure co-operation and co-ordination
  - ⇒ determine waste characteristics and define hazardous wastes
  - ⇒ approve plans and locations for plants
  - ⇒ license treatment and disposal plants
  - ⇒ establish a commission for waste management
- Powers for Governors to:
  - ⇒ ensure waste management plans are applied within their provinces
  - ⇒ convey applications for treatment and disposal plants from municipalities to the Ministry
  - ⇒ issue licenses to firms operating waste transports in their province
- Powers for municipalities to develop or have developed on their behalf, treatment and disposal plants for hazardous wastes.

2.2.1.7 Regulation on Medical Waste Control

The methods of collection and disposal of medical wastes without endangering environment and human health is regulated by this regulation, which was put into force and published in the Official Gazette on May 25, 1993.

The Regulation specifies the principles and criteria for the collection, storage, transportation, burning and organized storage of medical wastes. The producers of medical wastes (hospitals, clinics, homes, etc.) are responsible for the collection and temporary storage of their waste and the local governments are responsible for their transportation and disposal (Official Gazette, 25.05.1993).

2.2.1.8 Regulation on the Control of Spent Batteries and Accumulators

The purpose of this regulation is to arrange legal and technical principles to determine principles, policies and programs for used batteries and accumulators from their production to their final disposal (Official Gazette, 31.08.2004)

This regulation regulates the labeling and marking of all battery and accumulator products, the reduction of harmful substances in their production, their collection, transportation and disposal apart from residential (household) and other wastes after their usage, the prohibitions, limitations and obligations about their import, transit passage, and export, the measures to be taken, the controls to be made, and the responsibilities to apply (Official Gazette, 31.08.2004).

This regulation does not cover (apply to) the instruments which contain batteries permanently subject to the purpose of industrial use; batteries placed inside medical devices used in scientific and medical fields and having vital importance; pacemakers; batteries or accumulators within instruments which need to operate permanently and uninterruptedly and which have to be removed only by experts.

In addition, the management of production wastes arising from the production and disposal facilities of batteries or accumulators is outside the scope of this regulation. Such wastes shall be subject to the Regulation on the Hazardous Wastes Control Regulation or the Solid Waste Control Regulation according to the characteristics they (might) have.

2.2.1.9 Regulation on Construction and Demolition Waste

The purpose of this regulation is to regulate technical and administrative principles and main rules to obey about source reduction primarily, collection, temporary storage, transportation, recovery and disposal of construction and demolition waste without causing environmental pollution (Official Gazette, 31.08.2004).

The main principles for the management of construction and demolition waste are as follows:

- To minimize the waste at source
- The people and organizations that are responsible for the management of these wastes are obligated to minimize the harmful affects of wastes on the environment and human health.
- Construction and demolition wastes must be recovered and recycled as an infrastructure material.
- These wastes shouldn't mixed and must be separated at source
- The producers of construction and demolition wastes must arrange financing for the disposal of these wastes.

CHAPTER THREE
MUNICIPAL SOLID WASTE GENERATION AND CLASSIFICATION

3.1 Definition of Municipal Solid Wastes

Waste includes all items that people no longer have any use for, which they either intend to get rid of or have already discarded.

Definitions of municipal solid waste vary from country to country, but the definition used in this study is that given by the landfill directive (Official Gazette, 16.7.1999), namely:

'Waste from households, as well as other waste which, because of its nature or composition, is similar.'

Municipal waste is generated by households, commercial activities and other sources whose activities are similar to those of households and commercial enterprises. It does not include other waste arising e.g., from mining, industrial or construction and demolition processes.

Municipal waste is made up to residual waste, bulky waste, secondary materials from separate collection (e.g., paper and glass), household hazardous waste, street sweepings and litter collections. It is made up of materials such as paper, cardboard, metals, textiles, organics (food and garden waste) and wood.

A positive correlation tends to exist between a community's income and the amount of solid wastes generated. Wealthier individuals consume more than lower-income ones, which results in a higher waste generation rate for the former. The processes of accelerated population growth and urbanization translate into a greater volume of wastes generated (Boada, Haya, Monfort,& Parpal, 2003).

Higher incomes and economic growth also tend to have an impact on the composition of wastes. Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials – metals, plastics, glass, textiles, and so on – in the waste stream. Higher volumes of wastes and a changing composition have a profound impact on waste management practices (Dalamagas,& others, 2002). It also points out the policy changes that developing countries need to make. More wastes being generated and with a higher content of inorganic materials could have a significant impact on human health and the environment. If those additional wastes resulting from population and economic growth are not collected, treated and disposed of properly, health and environment in the world will further deteriorate.

The composition of municipal solid wastes is very heterogeneous as mentioned above. But in this study, only the recyclable wastes are investigated because the recovery and recycling methods of municipal solid wastes are the main principle of this study. So, only biowastes and packaging wastes, which form the composition of municipal solid wastes and can be recovered and recycled, are described and mentioned in this study.

3.2 Packaging Wastes

According to The Directive 94/62/EC on Packaging and Packaging Waste, the definition of packaging is mentioned below and this definition is also similar to the one on The Regulation on Packaging and Packaging Waste Control of Turkey.

'Packaging' shall mean all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable' items used for the same purposes shall also be considered to constitute packaging (Arc21, 2003; European Commission DGXI.E.3, 2001; EUROPEN, 1999).

Packaging consists only of:

- **sales packaging or primary packaging**, i.e. packaging conceived so as to constitute a sales unit to the final user or consumer at the point of purchase;

- **grouped packaging or secondary packaging**, i.e. packaging conceived so as to constitute at the point of purchase a grouping of a certain number of sales units whether the latter is sold as such to the final user or consumer or whether it serves only as a means to replenish the shelves at the point of sale; it can be removed from the product without affecting its characteristics;

- **transport packaging or tertiary packaging**, i.e. packaging conceived so as to facilitate handling and transport of a number of sales units or grouped packaging in order to prevent physical handling and transport damage. Transport packaging does not include road, rail, ship and air containers.

A range of materials, principally paper and cardboard, plastic, glass, metal and wood, are used in packaging applications. This diversity reflects their characteristics and qualities, with respect to different producer, product, transit and consumer or user requirements. These materials and their typical packaging applications are described briefly in Table 3.1 (Arc21, 2003).

Table 3.1 Summary of packaging materials and their applications

Material	**Typical Application**
Aluminum	Aluminum is used primarily for two main packaging products, namely: ▪ drinks cans ▪ foil packaging
Steel	Steel packaging falls into two broad categories: ▪ Household packaging, in the form of, for example, paint tins, food and drink cans, and aerosol products. These are generally made from tinplated steel. ▪ Commercial and industrial packaging, in the form of, for example, drums, steel strapping and baling wire. These are generally made from uncoated steel.
Paper and Cardboard	Paper and cardboard are widely used as packaging materials, principally because they are economic, lightweight, easy to use and store, and can be easily compressed. Paper and cardboard packaging includes two main sectors: ▪ Corrugated – primarily transit packaging, but reaching households as packaging around e.g. electrical goods and flat packed furniture. ▪ Solid carton board – primarily consumer packaging (frozen food, cereals, shoe boxes etc).
Glass	Glass has a long history of use as packaging as containers and bottles. It appears to enjoy an image of quality, which companies use to brand their products.

Table 3.1 (continued)

Material	Typical Application
Plastic	"Plastic" is a generic term, encompassing a wide range of plastics, including, for example: low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polyvinylchloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET). Each has specific packaging applications, reflecting their particular qualities, with around 60% of plastic packaging used for in food applications. For example, PET is widely used for soft/fizzy drink bottles. For frozen foods, PET, LDPE and HDPE are widely used, whereas for refrigerated foods PP, PS, or PVC are used. Wide use is also made of plastics in medical applications.
Composite Packaging (Mixed Materials)	Packaging can sometimes have the benefits of being more resource and energy efficient than single material packaging, but combining materials makes recycling difficult. Recycling these materials is hindered by the lack of facilities and technology necessary to separate materials to avoid contamination. Tetrapak is an example for the composite packaging.
Wood	Wood is used mainly for transporting packaged products. There are two distinct components: ▪ Pallets – representing two-thirds of the wood packaging sector. ▪ Cases and crates – representing one-third

We need packaging because most of the things we use at home and at work are produced somewhere else so that they have to travel to get to us. Consumers benefit from packages because they protect products as they travel, whether fast food or refrigerators, no matter how far they have to go (Pro-Europe, 2004). A well-designed package is attractive and appealing to consumers, and inspires confidence of product safety. In addition;

- Packaging provides a physical barrier between a product and the external environment thereby ensuring hygiene and reducing the risk of product wastage due to contamination.
- Some forms of packaging prolong the life of food.
- Some packaging is also needed for safe and efficient transportation.
- Packaging is also used to provide customers with information and instructions, for which there are some legal requirements.

Packaging is an essential requirement but it causes wastes stem from the use of sales, outer and transport packaging. These packaging wastes should be reused, recycled, recovered and disposed in accordance with the purpose of the laws and regulations. Packaging wastes form an undeniable percentage of the municipal solid wastes in terms of weight and especially volume. They have an economical value as well. It's essential to reuse, recover and recycle the packaging wastes because of the sustainable waste management, natural source protection.

3.3 Biowastes

The last decade has seen a significant increase in the volume of biowaste diverted from landfill and turned into humus rich compost, closing the recycling loop. Biowaste refers to any organic waste that is capable of undergoing anaerobic or aerobic decomposition and includes the following (Boada, Haya, Monfort,& Parpal, 2003):

- Food waste
- Garden waste
- Kitchen waste
- Bio solids (sewage sludge)
- Manure
- Sawdust

Biowaste represents generally up to 50% of the solid waste stream and this number changes depending on the social and economical structure of the city, low income societies have higher percentage of biowaste. When disposed of to landfill it generates methane and toxic leachate, which adversely impacts on our environment, but when used as a resource will enhance the quality of our most precious resource, our soils (European Commission, 2000, 2001).

Biowastes in municipal solid waste are usually made up of food scraps, either cooked or uncooked and garden waste such as grass cuttings or trimmings from bushes and hedges. Domestic kitchen waste is often mixed with non-organic materials such as plastic packaging, which cannot be composted. It is beneficial if this type of waste can be separated at source – this makes recycling of both types of waste far easier (Boada, Haya, Monfort,& Parpal, 2003).

3.4 Municipal Solid Wastes in European Union Countries

The quantity of municipal solid waste (MSW) generated in the Community every year amounts to almost 200 million tonnes (Eurostat, 2001). The percentages concerning the waste amounts of the member states are shown in Figure 3.1. Depending on local conditions, food and drink habits, climate, and degree of industrialisation, between 30% and 40% of MSW consists of food and garden waste, and another 20% to 30% consists of paper and cardboard waste. Totally, between 60% and 70% of MSW can be considered as biodegradable waste if paper and cardboard are taken as biodegradable (Environment Agency [EEA], 1999). The average composition of municipal solid waste in EU countries is shown in Table 3.2.

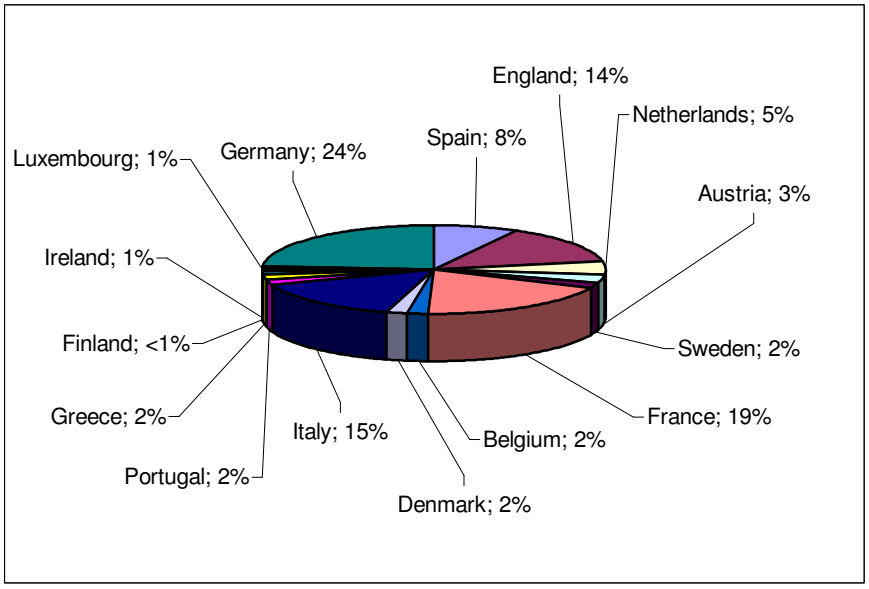

Figure 3.1 Municipal solid wastes in EU countries (ISWA, 2001)

Incineration and landfilling are the two most common management practices for dealing with MSW in the whole of the Community. For instance, around 65% of MSW are still landfilled, although in some Member States this percentage exceeds 90% (EEA, 1999).

Table 3.2 Average EU municipal solid waste composition, derived mostly from OECD data, 1999.

Component	Fresh Weight (%)
Paper	29
Putrescible*	32
Plastic	8
Glass	11
Metal	5
Textiles	2
Fines	5
Miscellaneous combustible	6
Miscellaneous non combustible	2

* Food & garden waste is together known as ‘putrescible’ waste.

The management of specific waste streams represents an important element of the general EU Waste Management Strategy by helping to reduce the impact of waste on the environment, by ensuring that waste is treated in an environmentally sound manner. Action on a specific waste stream is occasioned by its volume, its hazardousness, its treatment properties and its effects on the ecosystem.

All 25 EU member states are collectively bound by several pieces of legislation on waste management. These directives require each country to meet certain standards by specific dates. Despite the council directives, each country has different waste management policies, methods and standards depending on the economical, social and political structure of the country.

3.5 Municipal Solid Wastes in Turkey

The responsible authorities for solid waste management in Turkey are the Ministry of Environment and Forestry, Industry and Trade, Interior Affairs, Public Works and Settlement; municipalities; the chambers of trade and industry; and the Turkish Standards Institute.

Municipalities' receiving solid waste services, 12.70 million tonnes summer, 12.67 million tonnes in winter and 25.37 million tonnes of yearly average of solid waste were collected from 2977 municipalities in 2002 (State Institute of Statistics, 2002). From these results daily amount of solid waste is calculated as 1.32 kg/capita-day in summer, 1.34 kg/capita-day in winter and 1.34 kg/capita-day for yearly average and the amount of household solid wastes per capita is calculated as 0.7 – 1 kg a day (State Institute of Statistics, 2002).

The changes in the disposal methods implemented in Turkey depending on the years are shown in Table 3.3 and these numbers show the developments in Turkey for each year (State Institute of Statistics, 2002). From the data taken from the State Institute of Statistics, the percentage of the application areas of solid wastes in Turkey in 2002 is also shown in Figure 3.2.

Table 3.3 The changes in the disposal methods implemented in Turkey depending on the years, State Institute of Statistics

	1994	1996	2001	2002
Municipality dumping sites (%)	92,75	92,65	64,1	69
Burning in open area (%)	1,16	1,96	1,37	0,9
River disposal (%)	2,84	1,69	0,4	0,8
Controlled landfill (%)	3,25	3,75	33	27,8
Composting plant (%)	0	0,45	1	1,5
The number of Sanitary Landfill	2	6	12	12
The number of Compost Plant	0	0	3	4

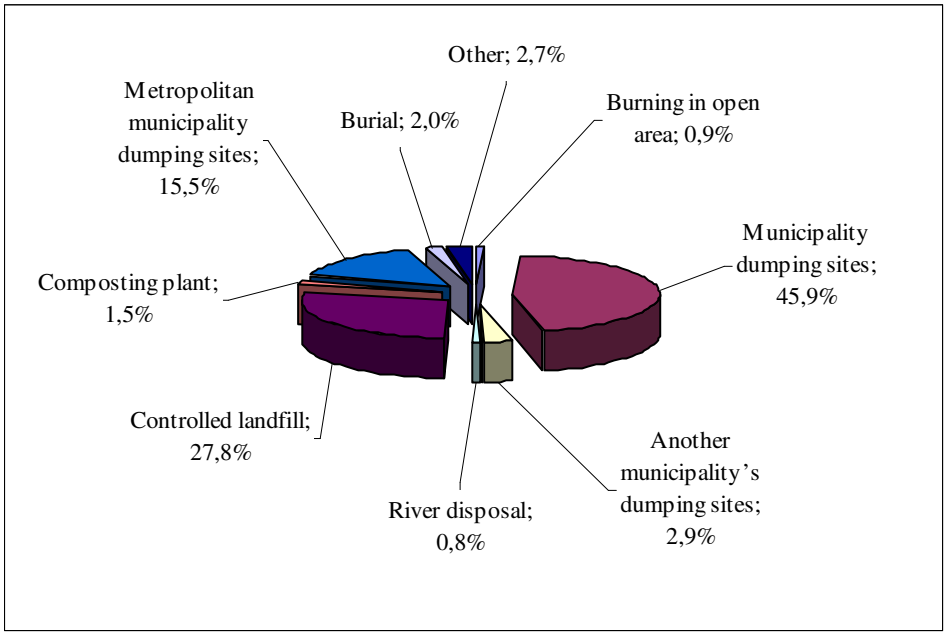

Figure 3.2 Distribution of solid waste management applications in Turkey, 2002, State Institute of Statistics

The State Institute of Statistics conducted the only comprehensive and nationwide study about the composition of household solid waste in 1993. The result of this study is shown in Figure 3.3 (State Institute of Statistics, 1993).

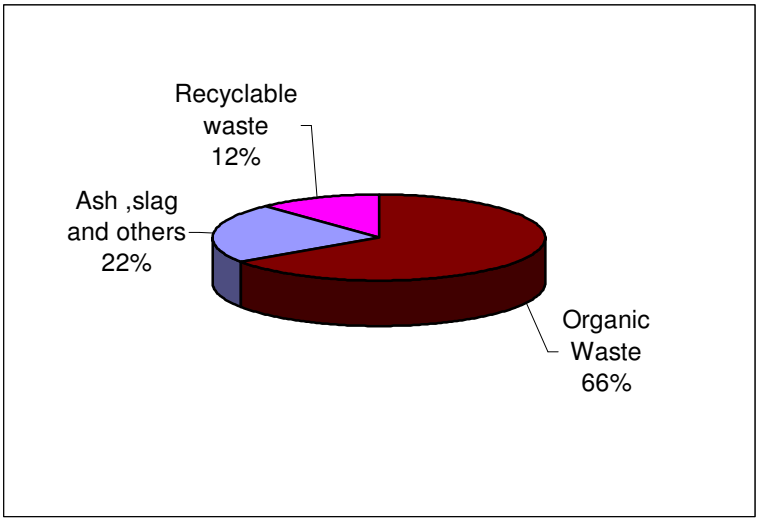

Figure 3.3 The composition of municipal solid wastes in Turkey, 1993, State Institute of Statistics

The types of industrial waste in Turkey, as a developing country, are not much different from the types of waste encountered in developed countries. In Turkey, the manufacturing sector generates over 13 million tons of industrial waste annually and approximately 2.5 million tons of it is hazardous (State Institute of Statistics, 2002). Approximately 57 % of this amount is disposed. Approximately 30 % of the disposed wastes are taken to municipal dumping grounds and the remaining 70 % are disposed of in uncontrolled and unregulated manner. By this way, close to 5 million tons of industrial waste are being dumped, each year, into the receptor environment, in disregard of environmental and human health, and, thus, causing an important problem (Ministry of Environment & UNDP, 2002).

According to the Hospital Waste Composition Research conducted by the State Institute of Statistics in 1995, 3.3 kg of medical wastes are generated per hospital bed in Turkey. This corresponds to approximately 170.000 tons of medical waste production per year. Medical wastes need to be incinerated in accordance with the Regulation. When incineration is not possible, other solutions should be applied. Particularly in large cities, there are appropriate systems built and operated for the separate collection and lawful disposal of medical wastes (Ministry of Environment & UNDP, 2002).

Various studies and researches indicate that 12-15 % of household solid wastes are of recyclable quality and it can be estimated that the annual amount of recyclable solid waste in Turkey exceeds 3 million tons (Ministry of Environment & UNDP, 2002). But these recyclable wastes are mostly decomposed in street or untidy storage areas by the street collectors. The importance of recycling projects has been realized and applied in different parts of Turkey by some local managements and non-governmental organizations such as ÇEVKO Foundation for almost 15 years. But these studies, especially about separate collection at source, became an obligation and increased all over Turkey, after the Regulation on Packaging and Packaging Waste Control came into force.

Municipal waste volumes are increasing, following the increase in the country's population and changes in lifestyle, from 15 million tonnes in 1991 to 25.37 million tonnes in 2002. Composting plants have been installed in some cities while in other centres disposal practices vary from landfilling to dumping in quarries, streams and even the sea. Strategies on the management of municipal waste need to be developed and technical support should be provided.

CHAPTER FOUR
COLLECTION AND TRANSPORTATION METHODS OF MUNICIPAL SOLID WASTES

4.1 Collection Methods of Municipal Solid Wastes

When most people think about garbage, what they visualize is the collection of their waste. Collection is the only part of waste management which virtually everyone sees and is involved with.

Collection is also by far the largest cost element in most municipal solid waste management systems. Collection and street sweeping together comprise the single largest category of expenditure in many municipal budgets. Failure or inadequacy of collection, especially in developing countries where there is frequently considerable human fecal waste in the municipal solid waste, can lead to threats to public health (Boada, Haya, Monfort,& Parpal, 2003).

Waste collection should be considered as a system. What happens in one part of the system affects not only what happens at the treatment end, but also, other components of waste collection.

4.1.1 The Design of the Collection System

Before determining the collection system, the characterization of waste types, volumes and the service area should be identified. It's necessary to gather data to determine the community's collection needs. The assessment usually draws from a combination of different sources (Boada, Haya, Monfort,& Parpal, 2003):

- Historical data from the community.
- Data from similar communities.
- Published typical values.

4.1.2 Collection Systems for Municipal Solid Wastes

4.1.2.1 Curbside or alley collection

A common point of collection in both developing and industrialized countries is at the curbside or the alley; the resident places full waste containers at the curb or in the alley behind the residence and retrieves them empty (Boada, Haya, Monfort,& Parpal, 2003).

4.1.2.2 "Just-in-time" collection

Some cities use "just-in-time" collection systems, where residents bring out their wastes at the time the collection vehicle reaches a certain spot and signals its presence (Boada, Haya, Monfort,& Parpal, 2003). This system reduces the health hazards associated with wastes on streets and roadsides, and prevents unauthorized waste picking.

Just-in-time collection only works when households typically have someone at home to carry out the waste at the proper time. To enhance reliability, the collectors can ring a bell or announce their presence from a loudspeaker upon arrival in an area.

4.1.2.3 Special collections

Special materials, such as bulky items, white and brown goods (old appliances and electronics), furniture, leaves, construction materials and tree stumps, must often be collected separately, due to their size and the fact that they are generated irregularly (Boada, Haya, Monfort,& Parpal, 2003).

4.1.2.4 Separate Collection of Municipal Solid Wastes

There is an increasing recognition of the benefits of collecting waste in separate fractions, allowing easy diversion of glass, metal and paper for recycling, and

biodegradable waste for composting or anaerobic digestion. The collection of separated fractions of waste is determined mainly by the waste quality and quantity. Waste morphological characteristics specify the implementation of adequate municipal solid waste recovering and disposal technologies. There may be several ways of collection of separated fractions of waste.

Separate collection of waste has an important effect on the awareness of householders of the impacts of the waste that they create. This can lead to reduction of waste at source.

Separate collection of recyclable wastes at source: Separate collection systems have high investment costs at the beginning but it has lots of benefits when it is applied for the long term. The reasons for implementing a separate collection at source system are clear:

- Benefiting from selling recyclables.
- Reducing disposal facilities dimensions and lowering net disposal costs.
- Producing higher quality compost with the remaining organic matter.
- Obtaining higher recycling rates because of uncontaminated recyclables.
- Preserving natural sources, in terms of raw materials and energy.
- Adapting to local and national regulations.
- Attaining social cohesion and community commitment.

There are a variety of methods of source separate collection for recyclable wastes:

Curbside collection: The waste is picked up at the point of generation with a plastic bag in this system. This system is very convenient for the beginning of the separate collection at source applications because people can participate in the application easier without changing their routines. But it is an expensive method because there is a lot of instrument for the application of the system like plastic bags, collection vehicles and employers (ÇEVKO, 2005).

Drop-off facilities: The use of one or more drop-off facilities consisting of a centrally-located facility with bins or large containers to receive and store recyclables. This system is a little difficult to apply for the waste producers because they have to separate the various materials into different bags and bring these materials to the drop-off facilities. On the other hand, it is cheaper than the curbside collection because there is no need to plastic bags or collection vehicles and also one or two employees are enough for a facility.

Buy-back facilities: They are similar to drop-off facilities because participants must transport their recyclables to the facility. The difference is that residents that use a buy-back facility are paid in cash for the items they bring to the site.

It is not always advantageous for local government recycling, because in many case if residents get cash from their recyclables, they prefer not to give them to the local government. On the other hand this system is the most expensive one compared to the other systems because each packaging producer or economic enterprises need to set up their own systems and collection centres to collect the recyclable materials. Besides, the recyclable materials collected at different points can be reused by the collectors and this can cause unhealthy conditions.

Separate collection of organic wastes at source: The successful diversion of biodegradable wastes from landfill relies on the separation of these wastes at source. Whilst the biodegradable fraction can be extracted from mixed wastes, this is laborious and produces a contaminated product. Separation at source offers the opportunity of a high-quality clean feedstock for composting and the prospect of an uncontaminated product. A ‘clean’ waste collected via separate collection is more likely to meet compost standards and be suitable for sale or use, bringing associated environmental benefits (Boada, Haya, Monfort,& Parpal, 2003; European Commission, 2000).

Furthermore, the compostable fraction of waste is often one of the most polluting of the waste stream, and implementing such a scheme diverts waste from the

traditional disposal routes such as incineration and landfill. As one of the largest fractions of household waste, diverting organic waste from landfill can also significantly contribute to meeting local recycling targets.

4.1.3 Set-out Containers

Most collection systems depend on some kind of set-out container. In industrialized countries, there are separate containers for each type of waste but in developing countries the most important criterion on determining the container type is its cost.

The most convenient system is to use different containers for different material type. These kinds of containers are designed carefully according to the type of packaging materials and that makes the system very expensive. Figure 4.1 is an example for the separate container system in Japan (ÇEVKO, 2005).

Figure 4.1 Set-out containers for separate collection in Japan

Besides, one big container having different partitions for each packaging material type can be used and these type of containers are cheaper and also don't cover a lot of place. Figure 4.2 is an example for these types of containers in Turkey (ÇEVKO, 2005). In this container system, standard containers can be used for other municipal wastes excepting packaging wastes.

Figure 4.2 Set-out containers for separate collection in Turkey

On the other hand only one container can be used for commingled recyclable materials and these mixed recyclable materials can be sorted after they are taken to the sorting facilities.

4.1.4 The Efficiency of the Collection System

The main principles for the efficiency and continuity of the separate collection system are as follows;

- The collection costs
- The collection methods
- The collection frequency
- The collection vehicle
- The collection route
- The collection day
- The collection time

4.2 Transfer Methods of Municipal Solid Wastes

Once a local government has collected the solid waste, it may need to store the waste at an interim location prior to recycling or final disposal. If such storage is necessary, it usually occurs at a transfer station. A transfer station is a facility where waste is transferred from the smaller collection vehicles to larger transport vehicles, such as tractor trailers, railroad gondola cars, or barges. These vehicles then transport the waste to the disposal site (Boada, Haya, Monfort,& Parpal, 2003).

4.2.1 Evaluating Local Needs for Waste Transfer

The benefits of constructing a transfer station must be compared to the costs of developing and operating the facility (Boada, Haya, Monfort,& Parpal, 2003). Such benefits include:

- Lower collection costs because crews spend less time traveling to the site.
- Reduced fuel and maintenance costs for the vehicles.
- Increased flexibility in selecting the disposal facility.
- The opportunity to recover recyclables or compostables at the transfer station.
- The opportunity to shred or bale materials before disposal.

Transfer station cost-effectiveness depends on the distance between the disposal site and the generation area.

4.2.2 Types of Transfer Stations

Several factors influence the design of a transfer station (Boada, Haya, Monfort,& Parpal, 2003), such as:

- Required capacity and amount of waste
- Types of waste received
- Processes required
- Types of collection vehicles using the facility
- Types of transfer vehicles that can be accommodated at the disposal facilities
- Site topography and access.

CHAPTER FIVE
MUNICIPAL SOLID WASTE MANAGEMENT

Integrated Waste Management, IWM, is a tool to determine the most energy-efficient, least-polluting ways to deal with the various components and items of a community's solid waste stream. The integrated waste management hierarchy is based upon the material and energy that is embodied in solid waste and that is associated with its recycling and disposal (Dalamagas, & others, 2002; European Commissions, 2004; Stokoe, & Teague, 1995). The twin goals of IWM are to:

- retain as much as possible of that energy and those materials in a useful state , and
- avoid releasing that energy or matter into the environment as a pollutant

Integrated waste management sets up a hierarchy of approaches and technologies for managing solid waste in order to meet these goals. The very highest option in the hierarchy for solid waste management is, don't create the solid waste in the first place, and is termed “source reduction.” The other higher level integrated waste management options are reuse, recycling and composting in order. Materials retain their value for longer periods of time if they are handled within these “top four” levels of the IWM hierarchy (Boada, Haya, Monfort, & Parpal, 2003; Stokoe, & Teague, 1995). The components of integrated solid waste management hierarchy can be summarized as below:

- source reduction
- reuse
- collection
- transportation
- recycling
- composting
- recovery
- landfilling

Municipal solid waste management is an integral component of integrated solid waste management system and development of municipal solid waste management plan requires coordination of public, municipalities and waste management companies.

5.1 Waste Generation Prevention

Good waste management begins with preventing waste being generated in the first place — after all, what is not produced does not have to be disposed of. Hence, waste prevention and minimisation should have top priority in any waste management plan. Where waste material is produced, planners and managers must always choose the optimal treatment option with the lowest possible risks to human health and the environment.

Prevention is a cornerstone of EU environmental policy. It is explicitly mentioned in the 5th Environmental Action Programme as one of the main objectives to be pursued in EU policy. Similarly, Directive 94/62 on Packaging and Packaging Waste establishes prevention of the environmental impact of packaging as one of its twin objectives (the other being the functioning of the internal market), and sets prevention of the production of packaging waste as its first priority.

Even though implementation of prevention activities seems to focus exclusively on source reduction, two types of waste prevention can be identified (Boada, Haya, Monfort, & Parpal, 2003):

- Quantitative waste prevention (amount reduction)
- Qualitative waste prevention (toxicity and hazard reduction)

5.1.1 Benefits of Source Reduction

a) **Saves natural resources:** Waste is not just created when consumers throw items away. Throughout the life cycle of a product-from extraction of raw materials to transportation to processing and manufacturing facilities to manufacture and use-waste is generated. Reusing items or making them with less material decreases waste dramatically.
b) **Reduces toxicity of waste:** Selecting non-hazardous or less hazardous items is another important component of source reduction. Using less hazardous alternatives for certain items (e.g., cleaning products and pesticides), sharing products that contain hazardous chemicals instead of throwing out leftovers, reading label directions carefully, and using the smallest amount necessary are ways to reduce waste toxicity.
c) **Reduces costs:** The benefits of preventing waste go beyond reducing reliance on other forms of waste disposal. Preventing waste also can mean economic savings for communities, businesses, schools, and individual consumers.

5.2 Reuse of Municipal Solid Wastes

Reuse is using a product more than once, either for the same purpose or for an alternate purpose. Reuse does not require reprocessing and, therefore, has lower energy requirements than recycling (Golding , 1998).

The reuse of packaging is, according to Directive 94/62/EC on Packaging and Packaging Waste, one of the priority instruments which should be used in order to prevent the generation of packaging waste. But the directive recognizes that reuse is an optional decision by those responsible for placing packaging on the market. The decision will be based on considerations such as market demand, environmental benefit and economics.

During the last years, many reuse systems have been replaced by the growing use of one-way packaging (particularly plastic bottles and composite packaging), which

in turn greatly contribute to the overall generation of packaging waste and which are difficult to recycle.

The reuse of packaging requires the packaging not only to be suitable for a number of rotations / refills, but also that there is a system in which reuse can be achieved with safety for the products and for those involved in the reuse processes (Golding , 1998).

Reuse packaging is mainly a domain within beverage packaging. Some smaller reuse systems within diary products, sweet preserves and vinegar/oil exist in some EU member states. Reuse packaging for non-food products is even smaller and is mainly used as refill packaging in small independent retailer's or green shops.

5.3 Recycling of Organic Wastes

Recycling is the process of separating a given waste material from the waste stream and processing it so that it may be used again as a raw material for a product, which may or may not be similar to the original product. The benefits of recycling are as follows:

- Conserves resources for the future.
- Prevents emissions of many greenhouse gases and water pollutants.
- Saves energy.
- Supplies valuable raw materials to industry.
- Creates jobs.
- Stimulates the development of greener technologies.
- Reduces the need for new landfills and incinerators.

Recycling turns materials that would otherwise become waste into valuable resources. In addition, it generates a host of environmental, financial, and social benefits.

Organic waste can be treated by either of two biological processes – aerobic and anaerobic. Aerobic processing, more commonly known as composting, is recycling of the organic fraction of waste in the presence of air and anaerobic processing is a recycling process as well but it occurs in the absence of air.

5.3.1 Composting Process

Composting involves the aerobic biological decomposition of organic materials to produce a stable humus-like product. The decomposition occurs because of the action of naturally occurring microorganisms such as bacteria and fungi. Small invertebrates, such as earthworms and millipedes, help to complete the process. Composting can convert organic waste into rich, dark colored compost, or humus, in a matter of a few weeks or months (Boada, Haya, Monfort, & Parpal, 2003; European Commission, 2000, 2001).

The microorganisms that start and finish the process off are called mesophiles. These grow when the compost is cool. However, microbiological activity generates heat and when the temperature rises in the heap beyond a certain point, mesophiles can no longer keep growing. At this stage organisms called thermophiles take over and the temperature rises even more. Once the easily foods are digested, the temperature of the heap gradually falls and the mesophiles take over once more. At the end of the process, the material in a composting heap become so degraded that any further change is extremely slow. The compost is than said to be mature and is now a rich earthly material that has a vast range of uses (Boada, Haya, Monfort, & Parpal, 2003).

The stabilized compost is screened before being used for plant growing purposes. The screen overflow (residuals) is recycled as structural material for the composting process or land filled if the content of visible impurities is high. The leachate is used for watering the composting mass or is discharged.

All organic matter will eventually decompose; however, some materials are more suitable for composting than others. The raw materials which are most appropriate for composting include:

- Vegetable and fruit waste from public food markets or food industries;
- Yard waste;
- Sawdust;
- Bark;
- Household or restaurant kitchen waste (uncooked is preferable);
- Sewage plant slugs (in a small percentage);
- Human excreta and animal manure;
- Farm waste;
- And crop residues such as banana skins, corn stalks and husks.

Many of these organic materials are easily found in municipal solid wastes. Most composting schemes use mainly garden waste, although some schemes also use separately collected vegetable and fruit waste from kitchens and some can use small quantities of paper.

Successful composting depends on source separation of organic material to avoid contamination of the final product. Levels of contaminants in non-source segregated composts, such as glass, hypodermic needles and plastic and metal fragments prevent the marketing of the compost. If the final compost is qualified enough, the following potential uses can be distinguished by using compost in agriculture:

- It improves water drainage
- It increases water holding capacity.
- It acts as a pH buffering agent
- It helps regulate temperature
- It aids in erosion control
- It improves air circulation by increasing the void space.
- It improves the soil's organic matter content

5.3.2 Anaerobic Digestion

Biomethanisation is a biological process in which organic matter is decomposed by anaerobic organisms (organisms that grow in the absence of air), producing methane gas as a major by-product (Boada, Haya, Monfort, & Parpal, 2003). The three basic steps of the process are:

- Pre-processing: Organic material is separated from the waste stream, shredded and mixed into slurry.
- Decomposition: The slurry is placed in anaerobic digesters for a 5 to 30 day period for generation of methane gas.
- Treatment: Methane gas is refined to meet market specifications.

In general, any organic matter can be methanised. It is essential that toxic substances are minimised in feedstock, and certain materials should never be fed to digesters because they will arrest or kill the process. These include:

- Toxic materials that inhibit digestion
- Bioagents
- Disinfectants

Long straw and non-biodegradable materials should be avoided as they can cause blockages in the system. So it is highly recommended to use only organic waste as raw material for biomethanisation, and not mixed urban waste. The sorting of the organic matter inside the facility is always incomplete and the risk of mechanical blockage is high.

5.4 Recycling of Packaging Wastes

Recycling of materials is an important way to reduce waste streams and consequently to decrease environmental pollution; however, it can also be a remarkable way to benefit from urban waste.

Recycling of packaging materials from the municipal solid waste stream generally involves the following steps (Boada, Haya, Monfort, & Parpal, 2003; European Commission DGXI.E.3, 2001):

- Separate collection of recyclable materials from individual households and transporting to a place for further treatment
- Sorting, baling and bulking for onward transfer to reprocessors (e.g. at a Sorting Facility)
- Reprocessing to produce marketable materials and products

The success of a recycling programme will be achieved only if the reasons for participating are understood and accepted by the public. The public and local officials must be regularly reminded of the environmental, economic and social reasons for implementing the recycling system, and to do so, a continuous publicity and promotion plan should be developed.

In industrialized countries, the largest hurdle to recycling is developing sufficient demand for recycled products to make it cost-effective. For example, demand for recycled plastic is limited since it can not be used to make food containers because of the danger of contamination. In addition, many consumers have reservations as to the consistent quality and dependable supply of products made from recycled materials.

Recycling is also common in developing countries. Most of the recycling is performed by scavengers who pick through the waste stream (either at the point of collection, transfer or disposal) to recover high value materials. In some low-income countries, scavengers recycle as much as 10 percent of the waste stream, and

sometimes these activities are encouraged as a source of income and an effective means of waste reduction (European Commission DGXI.E.3, 2001). However, scavenging may pose health and safety problems for the people (often children) sorting through wastes at landfills.

Segregation of materials before they are disposed of by households, using separate bins at the curb for different materials, or separation at a special facility, can be safer than scavenging at landfills.

Sorting Facilities for Packaging Materials

To manage large urban recycling programmes, many communities consider implementing sorting facilities, which are designed to process large volumes of recyclable material in the most efficient and cost-effective manner. The objective of these facilities is to receive, sort, process and store recyclable materials efficiently and safely.

Although final product quality is poorer, it is possible to put the waste from a mixed collection system through a sorting process at the beginning of the facility, to separate the organic matter. Another possibility is to operate a sorting facility at the landfill, transfer station or compost plant but the final product quality is very low at that kind of facilities.

A sorting facility can be operated by manually or mechanically. Manual sorting is the only proven feasible alternative for some special treatments, such as mixed colored glass, but it can be dirty, dangerous for human health and expensive. Mechanised sorting equipment is becoming available and may provide improved handling efficiency at an acceptable quality. It is a cleaner system than the manual one, and can be cheaper on the long run. A picture of a manual sorting facility is given in Appendix A.

5.5 Energy Recovery from Municipal Solid Wastes

While there is an obvious need to minimize the generation of wastes and to reuse and recycle them, the technologies for recovery of energy from wastes can play a vital role in mitigating the problems (Municipal solid waste-Technical development status, n.d.). Besides recovery of substantial energy, these technologies can lead to a substantial reduction in the overall waste quantities requiring final disposal, which can be better managed for safe disposal in a controlled manner while meeting the pollution control standards.

Most of the municipal solid wastes are a mix of house-hold wastes, street wastes, commercial & institutional wastes, etc. containing organic as well as inorganic matter and offer good possibilities for recovery of energy in its organic fraction for gainful utilisation through adoption of suitable processing and treatment technologies (Bontoux, 1999). Such recovery of energy from municipal solid wastes offers a few additional benefits such as:

- The total quantity of waste gets reduced by nearly 60% to over 90%, depending upon the waste composition and the adopted technology;
- Demand for land, which is already scarce in cities for landfilling is reduced;
- There is a net reduction in environmental pollution if the system is processed under control.

CHAPTER SIX
CURRENT APPLICATIONS FOR RECOVERY AND RECYLING OF MUNICIPAL SOLID WASTES

6.1 Current Applications for Recovery and Recycling of Municipal Solid Wastes in Some EU Countries

All 25 EU member states are collectively bound by several pieces of legislation on waste management. These directives require each country to meet certain standards by specific dates. On the other hand, each member state has different legislation with respect to the relevant EU directives and depending on their legislation every country implements their own recovery systems.

There can say two main recovery and recycling schemes, having different details for each one, are implemented in EU countries. The first system is applied in the countries like France, Belgium, Portugal, Spain, and Czech Republic. In this system municipalities are a part of the system and they have responsibilities on the application of the system. The costs for the recovery and recycling of packaging materials are shared between municipalities, waste management companies and economic enterprises so the system becomes very economic. The second system is applied in the EU countries like Germany, Austria and Luxembourg. Waste management companies and economic enterprises are responsible for the application and financing of this system and sometimes this can cause the system more expensive than the first one (O. C. Neyim, personal communication, 9 September 2005).

6.1.1 Germany

6.1.1.1 Recycling of Packaging Wastes in Germany

6.1.1.1.1 Legislation and voluntary agreements: The EC Packaging Directive is implemented into German law by the Ordinance on the Avoidance and Recovery of

Packaging Waste (Packaging Ordinance) of 21 August 1998 (Federal Law Gazette, August 21, 1998). The previous Ordinance on the Avoidance of Packaging Waste dated 12 June 1991, which was adopted before the EU-Directive came into force, was amended with the aim:

- to harmonise with the EC Packaging Directive
- to strengthen competitive structures
- to reduce the number of "free-riders"

6.1.1.1.2 Packaging waste management systems: There exist different compliance schemes for sales packaging and other packaging in Germany. The requirements for sales packaging can either be met by participation in an approved system of by self-compliance. While the DSD is the only approved system for sales packaging several different systems for commercial and industrial packaging are established.

Duales System Deutschland (DSD): In September 1990, the "Duales System Deutschland GmbH" was founded by retailers, consumer, goods industry and packaging industry. DSD operates as a public limited company with about 600 shareholders who comprise companies of trade, consumer goods industry and packaging industry (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).

The DSD organizes the collection and sorting of sales packaging. Collection and sorting is carried out by contractors which may be local authorities of private waste management companies. The recovery of the collected and sorted sales packaging is guaranteed mainly by associations of packaging producers and material converters.

The system is financed by "Der Grüne Punkt" (green dot) which is stamped on non-reusable packaging if the license fee has been paid. The amount of the license fee depends on the material, weight and on the volume or surface of the packaging. The revenues from license fees cover the collection, sorting and recycling and recovery of the packaging. The DSD is the only organisation which has established a nationwide system for the collection of sales packaging. There are efforts to establish

alternative systems working less expensive than the DSD (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).

Interactions between DSD and local authorities: To ensure that the interests of the public waste management are taken into consideration, the DSD has to meet the following obligations as shown below laid down in the Packaging Ordinance (Federal Law Gazette, August 21, 1998). The Ordinance stresses that the required co-ordination shall not conflict with the awarding of contracts for waste management services on a competitive basis

- the system shall be coordinated with existing collection and recovery systems run by the public authority
- the public waste management authorities may demand the take-over or joint use, for a suitable fee, of facilities required for collecting and sorting materials
- the system has to bear a share of the costs for waste consultancy and for the creation, provision, maintenance and cleaning of areas for the siting of large containers
- the system has to be set up on a full-coverage basis

The Dual System was obliged to reach an agreement with around 450 local authorities responsible for waste management (municipalities and districts) in the year of 2003.

Packaging prevention: The first objective of the Packaging Ordinance is the prevention of packaging wastes. Unlike the regulations for recycling and recovery, this objective is neither quantified nor provided with concrete measures. The Ordinance only stipulates in a rather vague form that packaging should be manufactured in such a way that volume and weight are reduced to the minimum which is necessary to guarantee the safety and the hygiene of the packed product ((Federal Law Gazette, August 21, 1998, Article 12).

With regard to packaging prevention, the Packaging Ordinance showed the strongest effects on the use of grouped packaging. Distributors providing goods in secondary packaging are obliged to remove such packaging upon delivery to the final consumer or to give the opportunity to remove and return the secondary packaging free of charge on the premises of the point of sale. This obligation can not be passed on to third parties and thus constitutes a strong incentive to reduce the use of grouped packaging. It is estimated that as a result of the Packaging Ordinance up to 90 % of grouped packaging has disappeared from the market. (Staudt et al., 1997)

Collection and sorting: The collection and sorting is carried out by contractors of the DSD which may be public or private waste management enterprises or joint working groups. The DSD has 537 contractors of whom 104 are local authorities, 76 private companies with the participation of local authorities and the remainder being private companies (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001). Every contractor is responsible for the collection and sorting of all sales packaging materials in his contract area (districts or cities). The contractor has to collect the packaging material according to the quantities given in the Packaging Ordinance. The sorted materials have to comply with the technical specifications given by the DSD. The contracted waste management services may sub-contract collection and sorting to other companies.

Collection systems for glass and paper/cardboard were already established in most of the municipalities before the Packaging Ordinance came into force. As the Packaging Ordinance demands the co-ordination with the existing systems the DSD integrated and enlarged these systems. In Germany therefore a uniform collection scheme doesn't exist. A combination of curbside collection and bring systems is most widespread.

Following the collection, light packaging, glass and paper/cardboard has to be sorted. Sorting fractions and quality requirements are prescribed by the DSD in agreement with the guarantors. Sorting of light packaging is currently performed in sorting plants by mainly automatically sorting. Light packaging is sorted into the

fractions tin-plate, aluminium, plastics, beverage cartons and other composites. For plastics a further sorting is done according to the product-related fractions bottles, foils, jars and mixed plastics. Paper/cardboard is sorted according to four standard grades.

Treatment systems and outlet of recycling: To guarantee the recycling and recovery of the collected packaging materials according to the targets of the Packaging Ordinance, the DSD contracted several so-called guarantors who have committed themselves to recycle fixed amounts of packaging materials. Guarantors are either companies of the material-producing industry or waste management companies or associations of both groups.

Monitoring and control: The monitoring of packaging waste management and the national reports pursuant to Article 12 of the Packaging Directive is based on studies which are regularly performed by the GVM (Gesellschaft für Verpackungsmartkforschung) on behalf of the Federal Environment Agency (Federal Law Gazette, August 21, 1998).

Approval and monitoring of the DSD: The DSD is approved and monitored by the German Bundesländer. The approval depends on the fulfillment of the general requirements for systems pursuant to No. 3 of Annex I of the Packaging Ordinance (Federal Law Gazette, August 21, 1998). The competent authorities of the Länder may revoke their approval if the requirements of the Packaging Ordinance are not being met.

The DSD has to submit every year in verifiable form evidence of the quantity of licensed packaging and the quantities collected and consigned to recycling and recovery, broken down by packaging material (mass flow verification). At the request of the competent authority the mass flow verification has to be confirmed by an independent expert at the expense of the DSD.

To provide proof of the achieved recycling quota the DSD registers the amounts of sales packaging put on the market by their licensees as well as the collected, sorted and recovered quantities. The contractors of the DSD are obliged to register not only the sorting input but also the sorted quantities, stock-on-hand and sorting residues on a monthly basis and transfer these data to the DSD.

The sorted materials are either forwarded to the guarantors or marketed by the contractors themselves. In case of self-marketing the contractors have to provide proof to the guarantors that the materials have been forwarded for proper recycling. Together with the registered quantities of materials recycled by the guarantors these data are passed on to the DSD. From this the nationwide recycling and recovery quota is calculated in relation to the licensed quantities.

6.1.1.2 Recycling of Organic Wastes in Germany

In Germany, source separation of organic residues from households, gardens and parks (=biowaste) is one of the main measures in waste management. In 2001, the participation in source separation of biowaste was up to 60 - 75 % of all the inhabitants, depending on the region. It is not 100 % because only 80 % of the German municipalities decided to establish separate biowaste collection.

Composting: Between 1990 and 2001 the number of composting plants in Germany amounts to approximately 700 - 900. These 700 to 900 composting plants are producing approximately 4 million tons of compost products (ECN, 2005). The growth rate of composting plants decreased during the last years on account of a considerable stagnation of source separated biowastes. Changes in waste disposal systems and fees are responsible for the stagnation.

Around 70 % of the German composting did join in the voluntary quality assurance system for compost and digestion residuals of the German Compost Quality Assurance Organisation BGK. These are the large and centralised plants and they show 70 - 80 % of the total capacity (ECN, 2005).

Anaerobic digestion: The number of anaerobic digestion plants is lower than the number of the composting plants in Germany (ECN, 2005). On the other hand, most of these anaerobic digestion plants use agricultural wastes like manure, only a few co-digest biowaste.

Legal framework for the organic waste stream and compost production

Biowaste Ordinance: Biowaste Ordinance (BioAbfV) from 1998 covers the application treated and untreated bio-wastes and mixtures that are applied on land used for agricultural, silvicultural and horticultural purposes as well as suitable raw material, quality and hygiene requirements, treatment and investigations of such bio-wastes and mixtures (ECN, 2005).

The Biowaste Ordinance regulates - with a precautious intention - the waste side (e.g. heavy metals) of the application; where as the Fertilizer Law regulates the nutrient part (ECN, 2005).

Voluntary standards RAL quality assurance system: On account of the very bad mixed waste compost image in the late eighties the German recycling industry started a quality initiative in composting which led to the foundation of the German Compost Quality Assurance Organisation (Bundesgütegemeinschaft Kompost BGK) in 1989. In 1991 a quality standard, a quality label and the RAL quality monitoring system for the composting of source separated organic residues from households and gardens was established. This BGK organisation is the carrier of the RAL compost quality label. It is recognised by the RAL, the German Institute for Quality Assurance and Certification as being the organisation to handle monitoring and controlling of the quality of compost in Germany. In 2000 an additional quality assurance system for digestion residuals was introduced (ECN, 2005).

6.1.2 France

6.1.2.1 Recycling of Packaging Wastes in France

6.1.2.1.1 Legislation and voluntary agreements: In France the management of packaging waste is defined by two main ordinances (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001):

- The Household Packaging Waste Decree (Lalonde Decree) N° 92-377 of April 1st, 1992, applying to waste arising from abandoned packaging (implementing Law No 75-633 of 15 July 1975 regarding the disposal of waste and recovery of materials).
- The Decree No 94-609 of 13 July 1994 implementing Law No 75-633 of 15 July 1975 concerning waste disposal and material recovery and in particular concerning packaging waste for which the holders are not households.

French packaging legislation also consists of:

- The Decree (No 96-1008) on waste management plans for household waste. This defines the minimum content of plans to be drawn up by each Department, in view to co-ordinate the actions needed by both public and private bodies to ensure the disposal of waste and any other waste which , because of its “nature”, can be treated in the same plants as household waste. This Decree includes the quotas set by the European Packaging Directive (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).
- The Decree (N° 98-638) of 20 July 1998 concerning consideration for environmental requirements in the design and manufacture of packaging (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).

According to the Law 75-633, any person who produces or holds waste is bound to take care of its disposal, or have it taken care of by a third party, in an “environmentally adequate way”(Official Gazette, 1975, Article 2). The 1992

amendment to the Act introduced the concept of "final waste" which means "waste which is no longer suitable for treatment under the technical and economic circumstances of the time".

6.1.2.1.2 Packaging waste management system: When the producers (or importers) do not intend to comply by themselves with the recovery requirements for their waste arising, they must conclude a contract with an accredited organism. This contract must lay down the type of packaging, the anticipated volume of the waste to be taken back each year as well as the fee due to this organisation or company (Official Gazette, 1992, Article 5). Companies and/or organisations are accredited by a joint decision of the Ministers of the Environment, Economy, Industry, Agriculture and Local Authorities for a period of six years. The candidate accredited company must mention the objectives it intends to meet (Official Gazette, 1992, Article 6).

Three organisations have been accredited to date: Eco-Emballages which covers the largest part of the households packaging waste and Adelphe, created in January 1993, who was during the first three years of its activities, assigned with the task of taking back glass bottles from wine and spirits before extending its activities to all packaging materials. Cyclamed is a voluntary system aiming at treating expired medicines and their packaging. It was accredited for the first time in 1993. But the main accredited organization is Eco-Emballages which is also the authorized Green Dot Organization in France (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).

Eco-Emballages: The foundation of Eco-Emballages as a limited company on August 12, 1992 laid the basis of the integrated collection system for household packaging required by the Decree 92- 377. Officially recognised by the French authorities on 22 November 1992 for a period of six years, this approval was renewed in 1996 with more favorable reimbursement conditions for the local authorities' costs. Eco-Emballages has introduced in advance a new accreditation demand in 1998. This new accreditation conditions are valid for six years since January, 1st 1999 (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001).

Eco-Emballages is a multi-product, multi-material recovery organisation active only for household packaging waste. Its role is to arrange for an efficient transfer of funds from the producers of packaged consumer goods to local authorities in order to support selective collection and sorting of packaging waste.

Interactions between Eco-Emballages and adhering companies: The membership to Eco-Emballages gives rise to a six years contract. This enables producers to discharge their legal obligation to dispose of household packaging waste generated in the course of their activities. In return, the member must make a financial contribution to Eco-Emballages, calculated on each packaging and outer packaging.

The contract grants the members the right to affix the "Green Dot" symbol on the packaging of their products, as a symbol of their membership. The marking of all packaging participating in the Eco-Emballages system is mandatory. The contract is extended to all goods manufactured, imported, sold and/or distributed in France, intended for household used or liable to be used by households (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001). Optionally, commercial packaging equivalent to household packaging but used in establishments such as hotels and restaurants, other commercial activities, may also be brought within the scope of the contract. Among the contractual obligations of the parties, there are particularly:

- For Eco-Emballages, to respect the obligations laid down in the Decree and by public authorities, the obligation to maintain confidentiality as regards financial and commercial information communicated by the contracting party, the obligation to draw up and make available to its members a detailed annual financial statement.
- For the contracting party, the obligation to affix the logo on packaging of goods, the obligation to keep a special set of accounting records relating to the contributions due in respect of the contract, the providing, on request from Eco-Emballages, of samples of packaging.

Interactions between Eco-Emballages and local authorities: In France, the local authorities are responsible for collecting and treating household waste. On the 28th of April 1998, the Minister of Country Planning and Environment published a circular recommending a selective collection national objective of 50% of the household waste (Cheremisinoff, 1996; European Commission DGXI.E. 3, 2001). This circular also recommends the revision of the Departmental waste plans in the view of increasing recycling and composting targets.

Eco-Emballages is concluding 6 years programme contracts with interested local authorities but these last have the opportunity to denounce contracts annually.

The municipalities have the choice to operate the collection by themselves or to entrust it to one or several operators. They have also the choice to decide on their own collection and/or recycling/recovery pattern. In the contract with Eco-Emballages, local authorities commit themselves to set up a selective collection programme for at least 3 of the 5 different materials defined in the contract (Paper and cardboard, glass, plastic, metals and aluminium). Materials collected and sorted must comply with minimal technical prescriptions (PTM) defined for each material to benefit from the Eco-Emballages' take-back guarantee. If sorted waste does not fit with these PTM, the municipality does not receive contributions offered by Eco-Emballages and must bear the disposal costs. Eco-Emballages guarantees that the sorted materials will be taken back by the reprocessing companies and contributes in different ways in the settlement of selective collection schemes notably by:

- paying a financial support per ton of sorted material which aims compensating selective collection and sorting costs
- offering take-back guarantee for the materials in accordance with the PTM
- financially supporting communication and awareness campaigns towards citizens
- technical assistance in the management of pilot projects

Packaging prevention: The responsible person is the packaging manufacturer (or his representative established in the European Community or in another State from the European Economic area) (Official Gazette, 1992, Article 8). The public administration can ask the packaging manufacturer to provide a technical documentation relative to the conception and manufacture of the packaging (Official Gazette, 1992, Article 9). The packaging meeting harmonised European Standards of which the references have been published in the Official Bulletin of the French Republic are considered to correspond to the requirements of the Decree (Official Gazette, 1992, Article 8).

Reuse of packaging wastes: No specific target is defined in the French legislation for reuse of packaging. The Decree No 92-377 provides the opportunity for producers or importers to organise a deposit system. Actually, no packaging producer has chosen this option. According to estimates made by Adelphe in 1993, most re-usable household packagings in France are used in the Wine sector.

Collection and sorting: Negotiations occur between the local authorities and Eco-Emballages for the choice of the collection system and the subsequent treatment of the packaging collected but the final choice is always the competency of the municipality. The representatives of one of the five regional branches of Eco-Emballages discuss logistics and organisational aspects on the spot. The organisation of collection may vary quite a lot between municipalities according to the collection pattern and the number and nature of waste streams they want to collect.

Treatment systems and outlet of recycling activity: In order to guarantee the take-back to local authorities, the "Green Dot" organisms have concluded agreements with five main take-back "guarantor" organisations which have been formed for glass, steel, aluminium, paper-cardboard and plastics. Each organisation also looks after the composites whose main constituent it represents.

"Green Dot" organisations negotiate with these organisations agreements establishing takes back conditions and prices of sorted materials from local

authorities. These organisations give a financial and logistic commitment to accept the materials sorted by local authorities at a minimum guaranteed price. Eco-Emballages also financially supports the transportation costs of the materials.

The take-back guarantee only concerns sorted materials which conform to minimum technical specifications. These define notably the characteristics, nature, the composition of the materials, their packaging, minimum quantities accepted and the minimum frequency of removal. Eco-Emballages can check the conformity of sorted waste bales leaving the sorting centre or entering the recycling operator.

Financing of the system

The system in use before April 1st 2000: Since 1993, most packaging participating in Eco-Emballages have been paying approximately one centime irrespective of the material or weight. Indeed, the licence fee paid by the subscriber was calculated on the basis of the number of packages put onto the French market in one year. Licensees could choose between weight and volume, irrespective of material. In the case of rigid hollow containers such as glass or plastic bottles, for instance, the Green Dot fee was calculated only on the basis of volume.

The system in use after April 1st 2000: In its accreditation demand of 1998, Eco-Emballages expressed the wish to revise its fee calculation basis in order to keep in balance the amounts paid by Eco-Emballages to the local authorities for each material and the amount of fees charges for that material. Other reasons were simplifying the calculation method and incorporating the prevention requirements.

Monitoring and control

Control performed by authorities: Public control concerns following aspects:

- The compliance with the packaging regulation and the achievement by packaging producers of their mandatory recycling and recovery targets for waste of packaging they put on the market.
- The annual control of the accredited organisations activities and verification of the fulfillment of the clauses of their accreditation act.

Control performed by Eco-Emballages: In its membership contracts, Eco-Emballages provides for the obligation for adhering companies to keep a special set of accounting records relating to the contributions due in respect of the contract. Eco-Emballages is allowed, at most twice a year, either itself or through its authorised agents, to make the audits necessary to ensure that the correct amount of contribution is paid (Official Gazette, 1992, Article 6).

6.1.2.2 Recycling of Organic Wastes in France

With a population of 61 millions people, agriculture and a food industry well developed in France. Composting is the most preferred recycling method for organic wastes in France (ECN, 2005).

Composting: In France, there are 65 composting facilities for non separate municipal solid wastes, 54 facilities for biowastes collected separately from other wastes, almost 215 facilities for green wastes and approximately 130 facilities for biosolids, municipal and industrial wastes together (ECN, 2005). All these composting facilities produce approximately two million tones of compost per year in France.

Anaerobic digestion: France number in 2005 only two anaerobic digestion facilities, digesting 0,15 million tones of municipal solid waste. Nine new facilities

are planned or in construction in the coming years, some of them with municipal solid wastes, the other ones with source separated biowastes. So, anaerobic digestion is only in the early stage in France (ECN, 2005).

Legal frameworks for the organic waste stream and the compost production

- National law July 1992 on waste management: Waste gets defined as a neither non-recyclable nor recoverable reject; the biodegradable fraction must aim at being processed through composting or anaerobic digestion. The modified version of 1995 sets priorities in the order; waste prevention, recycling and treatment. It also mandates strategies – to be put in place since 1 July 2002 - on valorisation of waste and minimisation of landfilling.
- The "Arrêté du 07/01/02 – rubrique No 2170" (and "rubrique No 2730" for animal by-products) gives administrative agreement procedures and technical prescriptions for composting plants that produces "fertilizers that are not wastes": limit values for odour emissions, etc. (ECN, 2005)
- Composts that are in compliance with the statutory standard NF U44-051 (up-dated at the end of 2005) are considered as "products" and are produced in plants covered by the "Arrêté du 07/01/02 – rubrique n°2170". This standard fixes limit values for heavy metals, PAH, impurities, organic matter, absence of pathogens, etc. for many soil improvers. Composts can be made from green wastes, source separated biowastes, MSW, manure, etc. but not from biosolids; composts form biosolids are covered by the statutory standard NF U44-095 (ECN, 2005).
- Composts that are not in compliance with the statutory standards NF U44-051 or U44-095 are considered as "wastes" and have to be managed within higher level of control and annual follow-up (ECN, 2005).

6.2 Current Applications for Recovery and Recycling of Municipal Solid Wastes in Turkey

The main characteristics of waste management in Turkey at present differ greatly from east to west. In the Eastern regions of Turkey, waste management systems are underdeveloped having as main features lack of collection bins, manual collection, lack of specialized vehicles, exclusive disposal at uncontrolled landfills and dumpsites most of which function simultaneously as facilities for the collection and initial separation of many materials such as paper, metal, glass and plastics (Eröztürk, Metin, Neyim& Toksöz, 2002).

In Western Turkey, the picture alters significantly. Disposal areas are better delimited and at large landfills some machinery (bulldozers) is available for work within the facility. The first sanitary landfills have been and continue to be built in Western Turkey. The collection system has evolved, using automatic collection with bins and waste collection vehicles rather than manual collection. Furthermore, in Western Turkey, the first organized material recovery programs with separation at source have been initiated (Dalamagas & others, 2002; Doğru, Eröztürk, Metin, Neyim & Tunçer, 2003).

6.2.1 Reuse of Packaging Materials in Turkey

There isn't any special system used for the reuse of packaging wastes in Turkey. Some special companies like Tuborg and Efes Pilsen have their own deposit systems for their glass bottles.

6.2.2 Collection and Sorting of Packaging Wastes in Turkey

Responsibility of collection of municipal waste produced in household is belong to municipalities as mentioned in The Law of Municipalities Numbered 5272 and The Law on Great Municipalities Numbered 5216. The collection activity usually

implemented by special waste collection companies having contracts with relevant municipalities and they are controlled by these municipalities.

Separate collection of the recyclable materials has been a fairly recent issue in Turkey. This has been dealt within the last ten years through a number of pilot programs implemented. Currently more than 60 municipal recovery programmes are being operated. These activities were done with respect to The Regulation on Solid Waste Control. After The Regulation on Packaging and Packaging Waste Control came into force, the activities about the collection of recyclable wastes at source increase rapidly in Turkey. As mentioned in the Regulation the accredited organizations are ÇEVKO and CAMSIAD and they are authorized by The Ministry of Environment and Forestry.

Municipalities are responsible for the formation and organization of separate collection at source systems on their borders. Municipalities prepare the packaging waste management plans for their systems and make other responsible communities, organizations or consumers implement this plan (Gözet, & Kurusakiz, 2002).

Collection scheme is similar in all of the municipal separate collection programs and based on the weekly, commingled collection by plastic bags. Commingled waste materials include plastic, glass, metal and paper. The collected packaging waste is either transported to Sorting Facilities or being handled by the individual private waste contractors.

6.2.3 Recycling of Packaging Wastes in Turkey

Material recycling is an activity that has existed in Turkey for decades. Municipalities often allocate to contractors the recovery of materials from their landfills. Material recovery is also practiced by scavengers outside of landfills and dumpsites. These people also separate and collect the recyclable materials from the containers in the streets before it is even collected and recovered by the municipalities. They then sell the recovered materials into the existing materials

market. Often they sell to larger collectors that then resell the materials to recycling plants.

The activities done by scavengers are all uncontrolled and unhealthy, also unwanted images are obtained in the street and even in the landfill area. Some of the material recovery applications of scavengers in landfill areas are shown in Figure 6.1 – 6.2 and 6.3 (ÇEVKO, 2005).

Figure 6.1 Material recovery applications in landfill area, Turkey

Figure 6.2 Material recovery applications in landfill area, Turkey

Figure 6.3 Material recovery applications in landfill area, Turkey

To date, significant initiatives have been taken in the field of recovery and recycling of materials. In majority, it is the private sector that realizes these programs. The public sector, primarily through municipalities, since 1993, has begun initiating recovery material programs. This is when the first organized separation at source pilot projects was initiated. By December of 2003, the separate collection at source was applied in 75 municipalities in Turkey and the number of houses which are serviced reaches to 279.290 and the number of residents are almost 1.200.000. (ÇEVKO, 2005)

6.2.3.1 ÇEVKO (Environmental Protection and Packaging Waste Recovery and Recycling Trust)

ÇEVKO Foundation has been established in 1991, by the 14 leading packaging, detergent and beverage industrial companies of Turkey. The objective of ÇEVKO is to contribute and play a leading role in the establishment of Packaging Waste Recovery System in Turkey, while complying with the related European Union Legislations and with the Principles of Integrated Waste Management. The Principles of Shared Responsibility among the Consumer, Industry, Local and Central Government are the guiding principles of the activities of ÇEVKO.

Municipalities, industry and consumers are the three key players of this integrated waste management system. ÇEVKO works closely with these three key players. ÇEVKO's aims are:

- Helping municipal authorities in setting up separate household solid waste collection and recovery systems
- Implementing education and awareness raising programs to improve public participation in environmental programs
- Coordinating the industrial responsibility in packaging waste recycling

After The Regulation on Packaging and Packaging Waste Control came into force, ÇEVKO is authorized by The Ministry of Environment and Forestry. Afterwards all the volunteer activities about separate collection at source turned to an obligation in Turkey. 9 pilot cities which were Istanbul, Izmit, Izmir, Ankara, Manisa, Konya, Marmaris, Antalya and Bursa were chosen for the pilot project depending on their having sanitary landfill areas. Then at these cities the separate collection at source projects were started at homes, markets, hotels and school by the year of 2005. Sorting facilities were established for the separation of collected packaging wastes. Today, eight sorting facilities, which are located in Kadıköy-Istanbul, Bakırköy-Istanbul, Bursa, Uzundere-Izmir, Harmandalı-Izmir, Adapazarı, Yalova, Düzce, are in function and new ones are in project level (ÇEVKO, 2005).

6.2.3.2 Financing of the system

The costs of collection, recycling, recovery and disposal of the packages are the responsibility of the economic enterprises which are packaging producers and marketers (Official Gazette, 30.07.2004, Article 9 and 10). Economic enterprises that have been assigned responsibility by this Regulation can come together and form a non-profit legal entity in order to achieve the recovery targets, to meet related expenditures, to carry out training and other related activities. Upon authorization of the said legal entity by the Ministry, economic enterprises, which sign contracts with

this entity, which carry out their responsibilities therein and which contribute to the expenditures, can transfer their responsibility of collection and recovery to this entity. Authorized institutions and economic enterprises included in this system are jointly responsible for achieving the recovery targets (Official Gazette, 30.07.2004, Article 17).

The separate collection schemes applied at homes, markets, hotels and school are mostly financed by the municipalities who receive some financial and technical support from authorized institution (ÇEVKO). Beside the authorized institution also responsible to finance the education of people and children and all other public relations works. On the other hand, municipalities can have waste management companies for the collection and recovery of packaging wastes.

6.2.3.3 Monitoring and control

Ministry has a control system on packaging producer, economic enterprises, licensed facilities, authorized institutions and municipalities. All of them are responsible to inform the activities they carry out and the contracts between each other annually. (Official Gazette, 30.07.2004, Article 20, 23, 24 and 25)

ÇEVKO has a control system between economic enterprises which are the membership of ÇEVKO and the waste management companies that have licensed facilities and contracts with ÇEVKO.

6.2.4 Recycling of Organic Wastes in Turkey

Recycling activities for organic wastes has started in the years of 1990 in Turkey. There is not much application about the recycling of organic wastes in Turkey but composting is the most applied system.

6.2.4.1 Composting in Turkey

Composting is the essential recycling process for organic wastes in Turkey but it doesn't reach to the European standards for years because of the insufficient economical and technical situation of Turkey. There isn't any separate collection system for organic wastes in Turkey and composting process is done with commingled municipal solid wastes including both organic and inorganic wastes together. That affects the quality of final compost because it becomes impossible to separate the organic wastes from others after the process started.

One the other hand, all the technologies for composting are taken and copied from the European countries. But those technologies aren't projected for the solid waste characterization of Turkey which has high water content in summer and high ash content in winter so that causes a decrease in the compost quality produced with these technologies in Turkey.

There are four composting plant in Turkey which are placed in Uzundere-Izmir, Menemen-Izmir, Kemerburgaz-Istanbul and Kemer-Antalya and these plants process the 1.5% of all the municipal solid wastes produced in Turkey. Compost is usually used for soil improver together with fertilizer in Turkey. But the marketing of compost isn't good enough and it isn't well known by the farmers. That's why the farmers use chemical fertilizers instead of compost.

6.2.4.2 Legal framework for the organic waste stream and the compost production

There isn't any special legislation for standardizing the composting quality but The Regulation on Soil Pollution Control has some articles about the quality of compost (Official Gazette, 30.07.2004, Article 6, 10). But the draft regulations are on the way depending on the harmonization studies with EU directives.

6.2.5 Energy Recovery from Municipal Solid Wastes in Turkey

Incineration technology is not common in Turkey and there is only one incineration plant for hazardous wastes in Izmit called Izaydaş Incineration Plant that produces electrical energy (Sagun, 2005). There is an incineration plant in Istanbul for the medical wastes and also an electrical energy production facility for the methane gas obtained from the sanitary landfill area of Istanbul. The energy recovered from the landfilled municipal solid waste is turned to electrical energy and used in the process and closer cities to the incineration facility.

CHAPTER SEVEN
MUNICIPAL SOLID WASTE MANAGEMENT IN IZMIR METROPOLITAN AREA

7.1. General Information about Izmir

Izmir is located in the Aegean province, which, of all the seven geographical regions of Turkey, enjoys the finest climate (Figure 7.1). In population it is the third biggest city in Turkey. It is located in an area whose magnificent history has made it a tourist centre. It lies at the centre of the most important land, air and sea communication network in the ancient Aegean region.

The population of 200,000 at the turn of the century has now grown to 3 370 866 in Izmir. The population in the metropolitan area is 2 886 439, 81% of the total population lives in the city and 19% lives in rural areas of Izmir (Governorship of Izmir, 2000). Izmir metropolitan area used to consist of 9 district municipalities but this number rose to 19 after the borders has increased in 2004. The highest population between the districts of metropolitan area is in Konak, 782.309, and the lowest population is in Güzelbahçe, 18.056. Only 9 district municipalities of Izmir are outside of the metropolitan area. The amount of population depending on the district municipalities of Izmir for the year 2000 is given in Table 7.1 (Governorship of Izmir, 2000). It can be seen from the table that depending on their population, Konak, Karşıyaka and Bornova are the three most important districts of Izmir Metropolitan Area.

At the beginning of the 20th century, Izmir was a centre of commerce and entertainment rivaling Istanbul and it is still one of the most important cities of Turkey on the field of commerce, tourism, communication from subway, maritime line and airline. All types of cottons and textiles, together with agricultural produce such as tobacco, grapes, figs, olives and olive oil are exported from Izmir to all over the world. Today the city retains its importance as the largest export harbour in Turkey.

Table 7.1 The population of district municipalities of Izmir Metropolitan Area, 2000

DISTRICT MUNICIPALITIES	URBAN POPULATION	RURAL POPULATION	TOTAL POPULATION
Balçova	66.877	0	66.877
Bornova	391.418	5.352	396.770
Buca	308.661	6.752	315.413
Çiğli	109.979	3.564	113.543
Gaziemir	70.035	17.657	87.692
Güzelbahçe	14.924	3.132	18.056
Karşıyaka	438.430	334	438.764
Konak	781.363	946	782.309
Narlıdere	54.107	0	54.107
Aliağa	38.225	18.967	57.192
Foça	14.604	21.503	36.107
Kemalpaşa	32.065	41.049	73.114
Menderes	21.885	49.336	71.221
Torbalı	54.848	40.997	95.845
Urla	41.184	8.085	49.269
Seferihisar	19.543	15.352	34.895
Selçuk	25.414	8.180	33.594
Menemen	60.124	54.333	114.457
Bayındır	18.705	28.509	47.214
Total	**2.562.391**	**324.048**	**2.886.439**

Izmir has a mediterranean climate which is hot and dry in summer, cold and rainy in winter and depending on the climate changes in the city, the waste composition varies every season.

There are 5 universities having 81.051 student and 6.366 academic staff capacity in Izmir (Governorship of Izmir, 2000). One of the most important properties of the city is its high education level. On the other hand a lot of cultural and social activities have a place in this city. Depending on those developments, the socio-cultural structure of the city has always an increasing curve. So the living standards and economical structure of the people live in Izmir is very high instead of other cities of Turkey. The developing standards of Izmir are always an advantage on the

management of solid wastes and the application of the new systems used in EU countries.

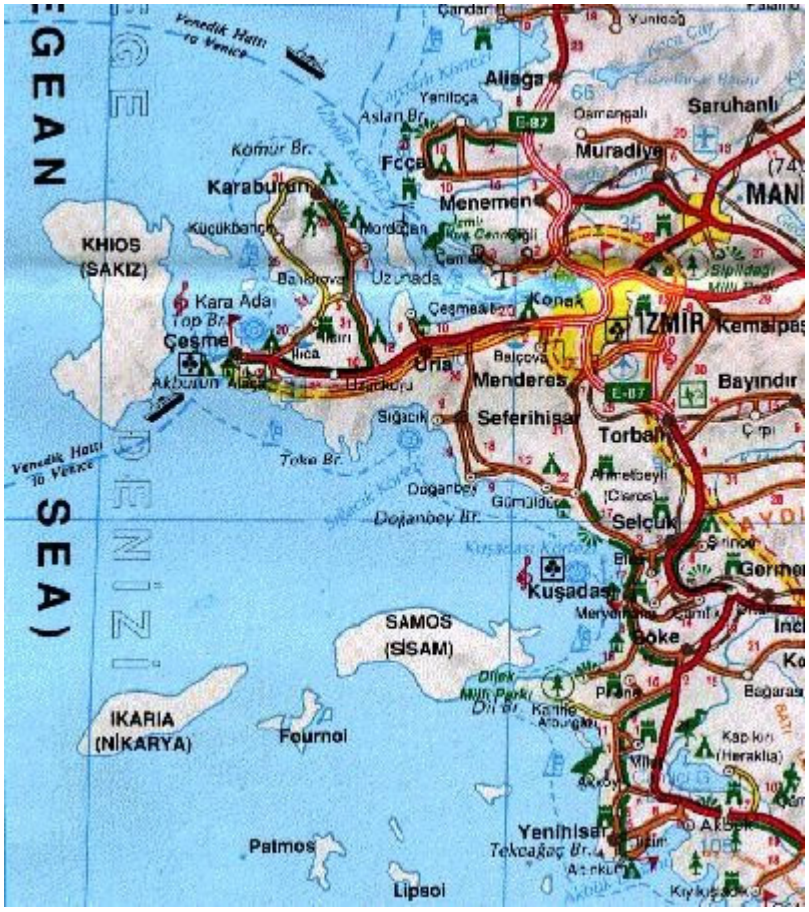

Figure 7.1 The map of Izmir city

7.2. Solid Wastes in Izmir Metropolitan Area

The increase in population and developed socio-cultural structure of Izmir city carry out huge amounts of solid wastes. These high quantities bring tremendous problems about the disposal of these wastes for municipalities. The Great Municipality of Izmir has a big role on determining the solid waste management for each district. It defines the management system and controls other district municipalities applying the system on the way it is supposed to be.

The amount of municipal solid wastes in Izmir depending on years between 1998 and 2004 is summarized in Table 7.2 (The Annual Activity Report of The Great

Municipality of Izmir, 1998-2004). It can be seen from the table that the increase of the population has a big role on the increase of the amount of solid waste each year.

Table 7.2 The amount of municipal solid wastes in Izmir

	Harmandalı Sanitary Landfill (kg/year)	Uzundere Compost Factory (kg/year)	Total Amount of MSW (kg/year)
1998	575.239.000	64.727.000	639.966.000
1999	654.756.000	55.217.000	709.973.000
2000	644.801.000	42.134.000	686.935.000
2001	689.867.000	63.727.000	753.594.000
2002	674.429.470	104.413.000	778.842.470
2003	642.124.350	70.099.320	712.223.670
2004	681.436.700	112.662.780	794.099.480

The success of the recovery method planning to be implemented is related to the composition of solid wastes produced in the application area. In accordance with that, the municipal solid waste composition generated in Izmir Metropolitan Area is given in Table 7.3 (Küçükgül, 2002). The municipal solid waste composition varies depending on the economical structure of the place. The societies having high income produce more amounts of recyclable wastes but on the other hand low income societies generate high amount of organic wastes. These ratios define the life styles of the people having different standards. Izmir has a cosmopolitan structure and all kind of people having different incomes live there. So the management of solid wastes and implementations for new schemes vary on each society based on their incomes.

Table 7.3 shows that the content of solid wastes produced in Izmir consists of organic materials at an average rate of 50 – 70 % and recyclable materials at an average of 20 – 40 %. The high organic content is appropriate for composting but for a high quality in compost separate collection is essential. On the other hand the ratio of recyclable materials is high in the total amount of solid waste and that is another reason to implement a separate collection scheme in the city.

Table 7.3 Municipal solid waste composition generated in Izmir Metropolitan Area (all figures are given as %)

Material Group	Low Income	Average Income	High Income	Commercial Zone	Industrial Zone
Organic Material	74,8	60,9	50,9	18,4	41,5
Paper-Cardboard	5,6	11,4	14,6	11,8	16,6
Glass-Bottle	2,7	4,8	6,9	14,8	3,1
Metal	1,5	2,2	3	9,3	4,8
Plastics	8,1	11,9	15,6	16,2	8,2
Combined Packaging Material	0,9	2	2,2	8,4	0,8
Foam Material	0	0,1	0	0,3	0,7
Large Dimensioned Plastic	0,2	0,3	0,8	7	0
Wood	0	0,2	0,2	0,1	0,1
Textile	3,7	2,5	1,9	8,2	22,9
Batteries	0	0	0	0,6	0
Stone, Porcelain	1,1	0,6	0,1	2,5	0,7
Diapers, Sanitary Pads	1,1	2,9	3,1	4,8	0,1
Others	0,2	0,4	0,6	2,6	0,5
TOTAL	100	100	100	100	100

7.3 Collection of Solid Wastes in Izmir

District municipalities of Izmir are responsible for the collection of municipal solid wastes. Municipal solid wastes are mostly collected from households with the use of metallic bins and containers. Typical sizes of these containers are 400 liters and 800 liters. Urban areas of the metropolitan area generally use 800 liters containers whereas 400 liters containers are typical of rural areas (Çoban, 2005). But the wideness of the streets where containers are placed also play an important role in determining the size of the container. The local municipalities usually supply these containers and bins, and the residents are required to bring their solid waste into these bins within any plastic waste bag supplied from the market.

The collection system used in Izmir is mostly container system but in some parts of district municipalities like Karşıyaka and Balçova plastic bags are used to collect the municipal solid wastes. The residents bring out their wastes in a plastic bag at the time (usually after 9 p.m. in the evening) the collection vehicle reaches a certain spot. This system reduces the health hazards associated with wastes on streets and roadsides, and prevents unauthorized waste picking.

The collection scheme of the district municipalities varies in each neighborhood according to the economical and socio-cultural structure of the place. The municipal solid wastes of economically developed neighborhoods are collected everyday but in neighborhoods having low income it's enough to collect the wastes two times in a week. Each district municipality has its own collection program.

The medical wastes from hospitals and health institutions are separately collected and transferred to Harmandalı Sanitary Landfill by The Great Municipality of Izmir. The average amount of medical wastes from 379 hospitals and health institutions is 10 tones / day (Çoban, 2005; The Annual Activity Report of The Great Municipality of Izmir, 2004). The medical wastes are collected in a special red plastic bag separately from other wastes inside the hospital and then stored in a special depot. The hospital and health institution managements are responsible to supply an air-

conditioned depot to store medical wastes before they are collected by the municipality as it is stated in the Regulation on Medical Waste Control. Then these wastes are collected with five specially designed non-compacting air-conditioned vehicles and one small specially prepared vehicle of The Great Municipality of Izmir and taken to Harmandalı Sanitary Landfill. The medical wastes are buried in lime pits in a special separated area of the landfill.

The Great Municipality of Izmir has "446 23 24 Medical Waste Line" serving overall the metropolitan area to collect the medical wastes of hospitals, health institutions, doctors' offices, laboratories and veterans. The collection scheme is determined according to the capacity of hospitals and health institutions (Çoban, 2005).

The industrial wastes are collected and transferred to the Harmandalı Sanitary Landfill by the producers of the wastes. District municipalities and The Great Municipality of Izmir don't have any special collection scheme for industrial wastes. Because depending on the Regulation on Solid Waste Control, industries are responsible to carry their wastes to the disposal areas shown by the great municipalities.

The municipal, medical and industrial wastes are carried to the Harmandalı Sanitary Landfill and stored in privately separated areas for each type of waste.

Finally, according to the information given above, there is a regular collection scheme implemented in Izmir Metropolitan Area for municipal, medical and industrial wastes on the control of the great municipality.

7.4. Transfer of Solid Wastes in Izmir

The municipal wastes collected from the metropolitan area with low tonnage vehicles having capacity between one and five tons are loaded on to high tonnage long vehicles having 35 tons capacity in three different transfer stations operated by

The Great Municipality of Izmir. These transfer stations are located in different parts of Izmir so as to prevent high transfer costs of district municipalities, the waste of time and also the traffic jam caused by these vehicles (Çoban, 2005). The locations of these transfer stations are shown in Appendix B.

Halkapınar, Gediz and Kısık are the three transfer stations of Izmir. All the municipal wastes collected from different pats of Izmir are carried there and then transferred to Harmandalı Sanitary Landfill with long vehicles.

The municipal solid wastes from some parts of Konak, Buca and Bornova are carried to Halkapınar Transfer Station, solid wastes from Buca and Gaziemir are carried to Gediz Transfer Station and the wastes of the towns in Tahtalı drinking water catchment basin are carried to Kısık Transfer Station so as to prevent the pollution of the river in Tahtalı (Çoban, 2005).

Gediz Transfer Station which was established by The Municipality of Konak has been taken over by The Great Municipality of Izmir. Then some lacking conditions of the establishment have been removed and renovation works have been completed and it has started on functioning in 2003. Kısık Transfer Station also had a renovation and has started functioning with full capacity in the year of 2003.

The amount of municipal solid wastes transferred to Harmandalı Sanitary Landfill is approximately 800 tons/day. Beside the amount of wastes transferred from Halkapınar, Gediz and Kısık Transfer Stations to Harmandalı Sanitary Landfill each year is shown in Table 7.4 (The Annual Activity Report of The Great Municipality of Izmir, 1998-2004).

Table 7.4 The amount of municipal solid waste (MSW) transferred from Halkapınar, Gediz and Kısık Transfer Stations each year

	The MSW transferred from Halkapınar Transfer Station (ton/year)	The MSW transferred from Gediz Transfer Station (ton/year)	The MSW transferred from Kısık Transfer Station (ton/year)	Total amount of MSW transferred to Harmandalı Sanitary Landfill (ton/year)
1998	62.883	0	0	62.883
1999	47.480	0	0	47.480
2000	58.581	0	0	58.581
2001	144.371	0	0	144.371
2002	197.785	0	0	197.785
2003	100.451	53.000	18.000	171.451
2004	188.887	39.189	17.112	245.188

7.5 Disposal of Solid Wastes in Izmir

The municipal solid wastes of Izmir Metropolitan Area, industrial wastes, sludge and medical wastes collected from hospitals and health institutions are disposed in Harmandalı Sanitary Landfill as shown in Table 7.5 (The Annual Activity Report of The Great Municipality of Izmir, 1998-2004). This region having an area of 900.000 m^2, 25 km distant to the Centrum and 2,5 km to the east of Harmandalı district has been functioning since 08.04.1992 by The Great Municipality of Izmir (see Appendix B). The region has planned to meet the requirements of metropolitan area for a period of 15 years. There are four storage areas inside the landfill area and three of them have already filled with the municipal solid wastes and the last one is still functioning. The amount of solid wastes increases every year depending on the growth in population and new district municipalities were added to metropolitan area. So it becomes necessary to plan for the new storage areas inside the landfill region immediately.

The wastes from three transfer stations and also wastes from other municipalities are disposed in Harmandalı Sanitary Landfill. According to the first six months of the year 2005 the average amount of municipal solid wastes disposed in the landfill is 62.900 tons/month and 2.097 tons/day (Solid Waste Management Directory, The Great Municipality of Izmir, 2005). These numbers were 54.000 tons/month and

1.800 tons/day in 2004 (The Annual Activity Report of The Great Municipality of Izmir, 2004). The percentages of the amount of municipal solid wastes of district municipalities bringing their wastes to Harmandalı Sanitary Landfill in the first six months of the year 2005 are shown in Figure 7.2 (Solid Waste Management Directory, The Great Municipality of Izmir, 2005). Harmandalı Sanitary Landfill is functioning 365 days in a year and 24 hours a day.

Table 7.5 The composition of solid wastes landfilled in Harmandalı Sanitary Landfill each year.

	1998	1999	2000	2001	2002	2003	2004
Municipal Waste (ton/year)	575.239	654.756	644.801	689.867	674.430	642.124	681.437
Industrial Waste (ton/year)	26.734	24.315	25.156	20.561	20.951	22.297	26.316
Biological Sludge (ton/year)	4.251	3.362	1.795	1.313	1.872	4.405	3.008
Chemical Sludge (ton/year)	16.364	14.333	16.676	18.068	16.877	19.294	20.986
Annihilation Waste (ton/year)	6.543	6.254	11.328	8.852	6.767	3.956	3.986
Medical Waste (ton/year)	1.953	2.390	3.180	3.931	3.680	3.100	2.910
TOTAL (ton/year)	**631.084**	**705.410**	**702.936**	**742.592**	**724.577**	**695.176**	**738.643**

The landfill area for the municipal solid wastes has drainage channels which collect the leachate and transfer it to the lagoon prepared like a balancing pool. Then the leachate is transferred to the chemical treatment plant where wastewater is pre-treated inside the landfill area. Chemical treatment plant includes high-rate mixing, low-rate mixing and sedimentation facilities. After sedimentation treated water is transferred to Çiğli Municipal Wastewater Treatment Plant and the sludge is stabilized with lime, mechanically dewatered and transferred to drying beds. Then dry sludge having 25% solid content is landfilled in Harmandalı in the area for sludges.

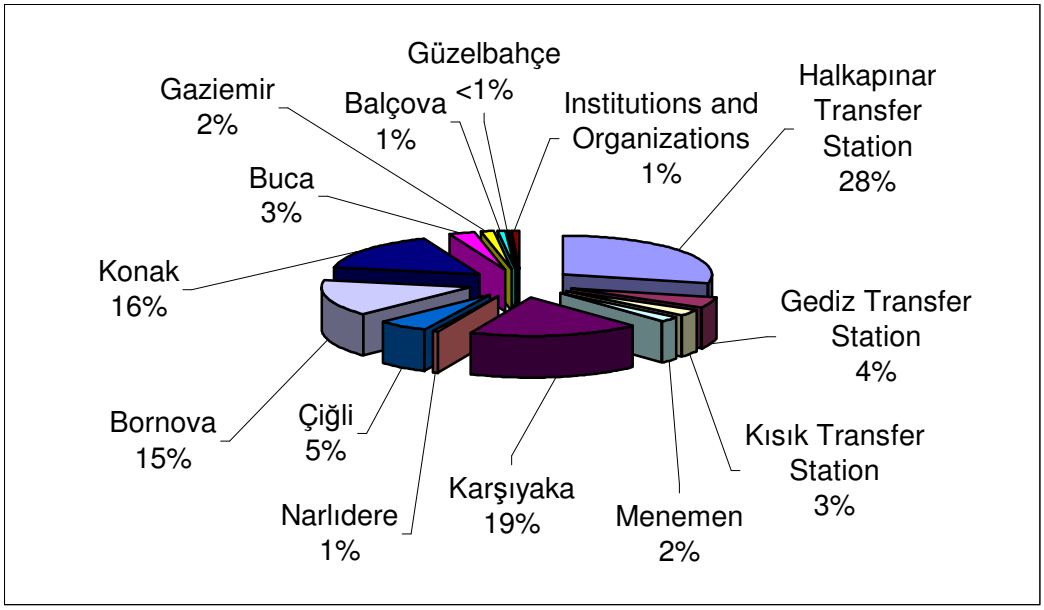

Figure 7.2 The percentages of the amount of municipal solid wastes of district municipalities bringing their wastes to Harmandalı Sanitary Landfill in the first six months of the year 2005.

There is also an area in Harmandalı Sanitary Landfill for biological and chemical sludges coming from industrial and municipal treatment plants in Izmir. They are supposed to have at least 25% solid content according to the Regulation on Solid Waste Control; otherwise it isn't allowed to dispose the sludge in a landfill area. The average amount of chemical sludge is about 60 tons/day and biological sludge is about 8 tons/day according to the first sixth months of 2005 in Harmandalı Sanitary Landfill (Solid Waste Management Directory, The Great Municipality of Izmir, 2005).

The industrial wastes and medical wastes are also disposed in Harmandalı Sanitary Landfill. They are separately taken to a special part of the landfill area. Medical wastes are buried in lime pits to prevent any connection with other wastes. The average amount of industrial wastes disposed in Harmandalı Sanitary Landfill is approximately 68 tons/day and this number is about 10 tons/day for medical wastes according to the first sixth months of 2005 (Solid Waste Management Directory, The Great Municipality of Izmir, 2005).

CHAPTER EIGHT
THE RECOVERY AND RECYCLING APPLICATIONS IN IZMIR METROPOLITAN AREA

There is a regular collection, transportation and disposal implementation in Izmir Metropolitan Area and on the other hand recovery and recycling applications are developed compared to other cities of Turkey.

8.1 Recycling of Organic Wastes in Izmir

The recycling application for organic wastes in Izmir is carried out in Uzundere Compost Factory. The operation of the factory used to be fulfilled by the staff of The Great Municipality of Izmir. But in July of 2003 the Great Municipality had a contract with a waste management company and the operation of the factory is given to the waste management company on the control of the Great Municipality.

The Uzundere Compost Factory has started functioning on 5 December 1988 and still on duty. The factory was constructed on 75.000 m^2 area and it has 1,5 km distance from the south east of Uzundere Village (see Appendix B). The factory functions two shifts in a day (8 a.m. – 4 p.m. and 4 p.m. – 12 p.m.) and 26 days (except Sundays) in a month.

Domestic waste is being processed with the windrow system in the Uzundere Compost Factory and compost is obtained from the organic waste to be used in agriculture. During the realization of this process, the recyclable wastes are being sorted out in this factory as well. Uncompostable materials and the residues are being stored in the area near the establishment.

The municipalities closer to the factory and having compostable municipal solid waste content bring their wastes to Uzundere Compost Factory as shown in Figure 8.1 (Solid Waste Management Directory, The Great Municipality of Izmir, 2005). The capacity of the factory is 500 tons/day but there occur some problems on the

process because of the old equipments and technology and so the capacity falls down to 420 tons/day.

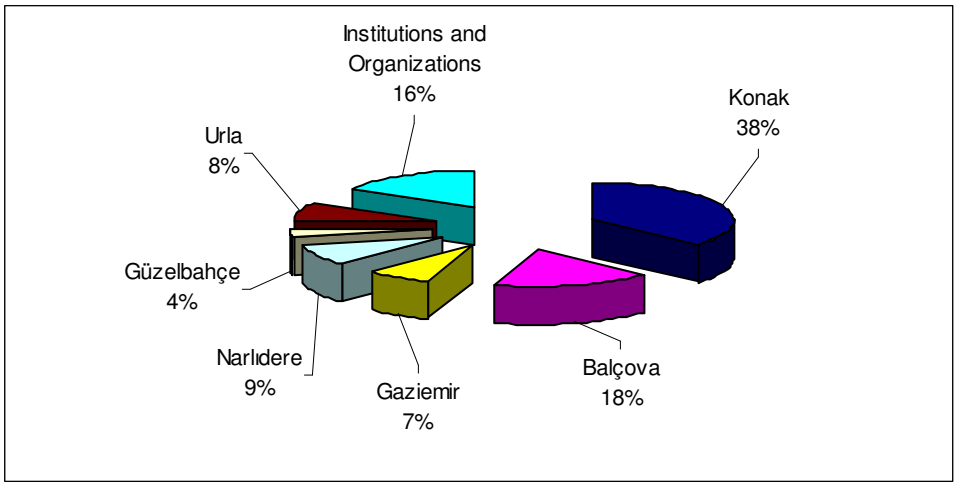

Figure 8.1 The district municipalities bringing their wastes to Uzundere Compost Factory

The wastes are first stored in a closed area and then feed to the first drum by a tired wheel scoop. The recyclable wastes are sorted by screening in the first drum and these wastes are separated depending on their types as plastic, metal, glass, paper and cardboard. Then the residues are disposed in the area close to the factory.

The organic wastes are fed to the fermentation area after screening in the first and second drum. The fermentation area has enough places for 12 piles and it takes between 8 and 10 days to form a pile almost 100 m length, 2 m width and 2.5 m height. Each pile spends 60 days in the fermentation area so as to finalize the digestion of organic wastes. After 60 days the stabilized compost is taken to the grinder and screener to form the final compost. The flow diagram of the process in Uzundere Compost Factory is given in Figure 8.2 (Solid Waste Management Directory, The Great Municipality of Izmir, 2005). The 17 % of the total municipal solid wastes taken to the facility is produced as final compost.

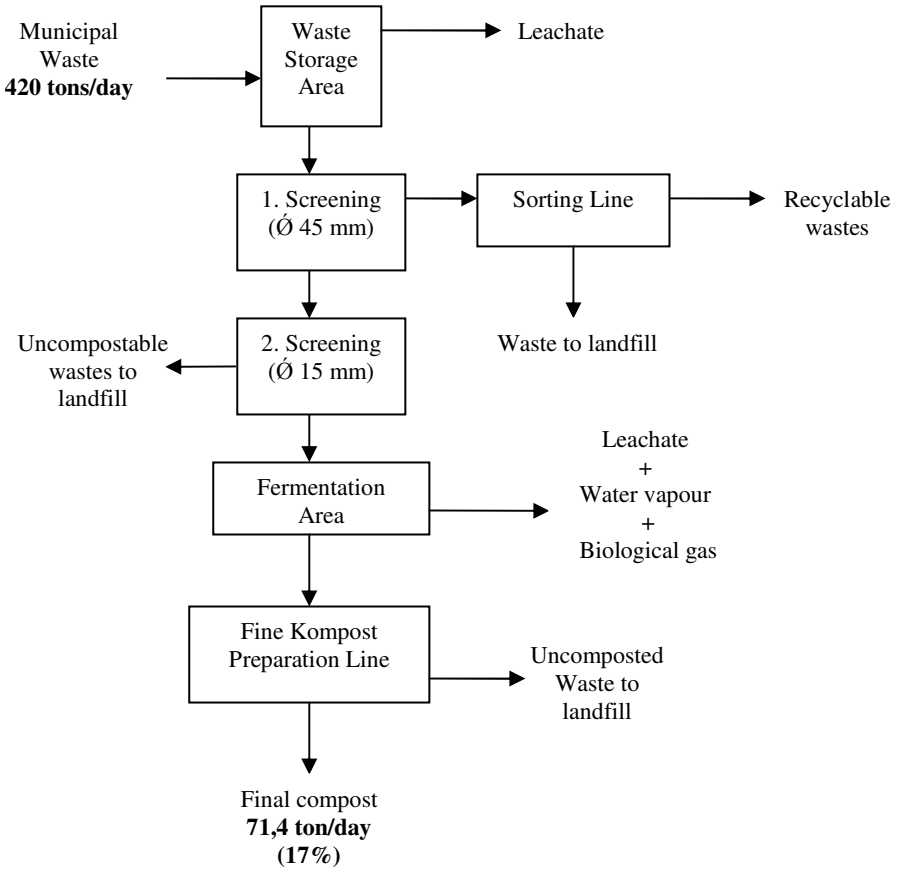

Figure 8.2 The flow diagram of Uzundere Compost Factory

In a compost factory, it is essential to use separately collected organic wastes to get good qualified compost. But in Izmir there isn't any application about separate collection of organic wastes at source, so the municipal wastes processed in Uzundere Compost Factory are mixed with non-organic wastes. In this way small plastic pieces and broken glasses can be seen in the final compost and that affects the quality, appearance and marketing of the compost.

There is another compost factory in Menemen inside the new borders of metropolitan area but not functioning because of the problems in establishment.

8.2 Recycling of Packaging Wastes in Izmir

8.2.1 Applications about Recycling of Packaging Materials in Izmir before the Regulation on Packaging and Packaging Waste Control

Izmir is one of the leader cities that started implementing recycling activities for packaging wastes. Before the Regulation on Packaging and Packaging Waste Control came into force, there were some voluntary applications of The Great Municipality of Izmir on glass, paper and cardboard. But after the Regulation, these voluntary applications turned to an obligation for municipalities, industries and consumers.

8.2.2 Applications about Recycling of Packaging Materials in Izmir after the Regulation on Packaging and Packaging Waste Control

8.2.2.1 Separate Collection at Source Project in Izmir

In accordance with the Regulation, the main principles are separate collection of packaging materials at source and recycling these uncontaminated materials. In this point of view, some pilot cities are chosen to fulfill the obligations stated in the Regulation. The properties expected from the pilot cities are their having a sanitary landfill and a regular collection scheme for solid wastes. Izmir Metropolitan Area is appropriate for the required properties, so it was chosen as a pilot city by ÇEVKO Foundation which is the authorized institution to apply the separate collection at source project. The other reason to apply the separate collection at source project in Izmir is insufficient place for the storage of solid wastes in Harmandalı Sanitary Landfill and as it is mentioned in Chapter 7, The Great Municipality started to look for the new storage areas. This separate collection at source project will also be very effective on reducing disposal facilities' dimensions, minimizing net disposal costs and transfer costs of municipalities. Also there were adequate studies and data for the solid wastes of Izmir carried out between municipalities and university.

8.2.2.2 The Preparation Studies for the Separate Collection at Source Project

The recovery applications in Izmir have started with a contract between The Great Municipality of Izmir and a waste management company in July 2003. With this contract, high costs in the operation of Uzundere Compost Factory are finalized and The Great Municipality saves a high amount of money every year. Besides, the recyclable content in the total municipal solid waste will be separated and amount of solid waste going to landfill will be reduced. In accordance with the contract, the company is responsible for the construction of a Sorting Facility in Harmandalı Sanitary Landfill and operation of both Uzundere Compost Factory and Sorting Facility. The contract also includes that the applications about separate collection of recyclable materials at source will be fulfilled by the waste management company (The Annual Activity Report of The Great Municipality of Izmir, 2003).

The Sorting Facility was constructed and got ready for the operation in April 2004. The location of the Sorting Facility in Harmandalı Sanitary Landfill is given in Appendix C. The facility was constructed on 5000 m^2 area inside Harmandalı Sanitary Landfill Area and has three sorting lines at the length of 30 meters for each one. The aim of the factory is to separate the recyclable materials sorted at source and prepare them for the recycling facilities by baling, crushing, pressing and chipping. The pictures of The Sorting Facility in Harmandalı Sanitary Landfill are shown in Figure 8.3 and 8.4.

Figure 8.3 The Sorting Facility in Harmandalı Sanitary Landfill

Figure 8.4 The Sorting Facility in Harmandalı Sanitary Landfill

Before the applications for separate collection of recyclable wastes at source, some preparation studies were carried out. The biggest district municipalities are chosen as pilot region to launch the application. On the other hand the first application was planned to be done in economically developed neighbourhoods

having tidy streets and buildings and having a systematic solid waste collection scheme. According to those preparations some neighbourhoods of Konak, Karşıyaka and Bornova Districts are chosen as pilot region for the first application.

8.2.2.3 First Stage of the Separate Collection at Source Project

The application was started with signing a protocol between The Great Municipality of Izmir, The District Municipalities of Konak, Karşıyaka and Bornova, the authorized institution ÇEVKO Foundation and the waste management company in June 2004. The duties of each side about the application were clarified in the articles of the protocol. After the protocol, the number of the houses and the population in the pilot region was determined as shown in Table 8.1 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005). The first pilot region included a small amount of house because it was a model application to show the triumph of the project and find out the interest of the people to this project. According to the number of the houses, the collection scheme became definite for each day.

Table 8.1 The number of houses and population of the pilot region in Konak, Karşıyaka and Bornova

The pilot district	The number of houses	Population
Konak District	2.363	6.344 people
Bornova District	223	892 people
Karşıyaka District	8.380	25.140 people
TOTAL	**10.966**	**32.376** people

After all the data for the application were prepared, especially the doorkeepers of the apartments and people live there were informed about the project by the teams of the district municipalities. Besides, posters about the project were tacked in the entrance of each apartment (see Appendix D) and brochures were delivered (see Appendix E). Special plastic bags for recyclable materials were also delivered and people were told to collect the packaging materials into these bags by separating them from organic wastes as shown in Figure 8.5. Also the letters written by The

Mayor of The Great Municipality of Izmir were delivered to the people to improve the interest on the project (see Appendix F). On the other hand some meetings were prepared in the pilot regions to give more detailed information to the people and emphasize the importance of the project. The local and national presses were provided to participate in the meetings so that everyone could have a chance to get information about the new project.

Figure 8.5 Special plastic bags for recyclable materials used in separate collection project

The two specially prepared trucks (Figure 8.6) for recyclable wastes were started the first collection in November 2004 in the pilot area having 10.966 houses. Beside the houses in the project area, the recyclable wastes were collected separately from the institutions and organizations as well. The collection was carried out by the staff of the waste management company as shown in Figure 8.7. The collected recyclable wastes were transported to the Sorting Facility in Harmandalı Sanitary Landfill to get sorted as their material types.

On the other hand the students in elementary and high schools inside the pilot area were educated by the cooperation of The Great Municipality, district municipalities and ÇEVKO Foundation.

Figure 8.6 The specially prepared truck for recyclable materials used in separate collection of wastes at source projects

Figure 8.7 The collection of the recyclable wastes separated at source

The separate collection project was applied in the same pilot area without any expansion till the end of the February 2005. The data from the collection and the efficiency of the project were examined for four months and the data showed that average recyclable waste collected from a house was 0,6 kg/week at the end of February 2005. The amount of recyclable materials collected in the first four months

is given in Table 8.2 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Table 8.2 The amount of recyclable materials collected in the first four months

	Materials collected from houses (kg/month)	Materials collected from institutions and organizations (kg/month)	TOTAL (kg/month)
November	6700	7800	14.500
December	16620	11560	28.180
January	31770	4640	36.410
February	54180	9900	64.080
TOTAL	**109270**	**33900**	**143.170**

8.2.2.4 Second Stage of the Separate Collection at Source Project

Finally the peoples' participation to the project was proved and it was decided to add new pilot areas. The new pilot areas were determined as an expansion of the existing application areas, so the other economically developed neighbourhoods of Konak, Karşıyaka and Bornova Districts were chosen as new pilot region to apply the separate collection project. The total number of the houses and the total population were given in Table 8.3 after the expansion on the existing pilot area (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Table 8.3 The total number of the houses and the total population after the expansion on the existing pilot area

The Pilot Area	The total number of houses	Total population
Konak District	22.794	91.176 person
Bornova District	24.996	99.984 person
Karşıyaka District	15.886	63.544 person
TOTAL	**63.676**	**254.704 person**

At the end of February 2005, a team of 16 students from Environmental Engineering Department of Dokuz Eylul University was formed by ÇEVKO Foundation to inform the people live in the new pilot area about the project. As it was carried out in the first application area, the doorkeepers of the apartments and people live there were informed about the project by the team as shown in Figure 8.8. Besides, posters about the project were tacked in the entrance of each apartment and brochures were delivered (Figure 8.9). Special plastic bags for recyclable materials were also delivered and people were told to collect the packaging materials into these bags by separating them from organic wastes. Also the letters written by The President of The Great Municipality of Izmir were delivered to the people to improve the interest on the project.

Figure 8.8 The doorkeepers of the apartments and people live there were informed about the project by the team of students from environmental engineering.

Figure 8.9 The posters about the project were tacked in the entrance of each apartment

In the beginning of March, it was started to collect the recyclable materials from three pilot areas consisting of 63.676 houses after the new pilot regions were added to the project. The number of the trucks rose up to seven from two after the expansion in the application areas and a systematic collection was applied by the waste management company. The collection scheme implemented in the pilot regions of Konak, Karşıyaka and Bornova is given in Table 8.4 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005). According to the collection scheme, six of the trucks were used in houses and one of the trucks was used in institutions and organizations.

Table 8.4 The collection scheme implemented in the pilot regions

The Pilot Area	The collection system	The collection scheme	The collection frequency	The number of the trucks
Konak District	Collection with plastic bag	Seven days in a week	Two times in a week	2
Bornova District	Collection with plastic bag	Six days in a week	Two times in a week	2
Karşıyaka District	Collection with plastic bag	Six days in a week	Two times in a week	2
Institutions and organizations	Collection with plastic bag	Six days in a week	Once a week	1

On the other hand, the educations of the students in elementary and high schools were continued in the new pilot area by the cooperation of The Great Municipality, district municipalities and ÇEVKO Foundation. The containers for recyclable wastes were given to the schools inside the pilot area so the students' participation to the project was provided.

8.2.2.5 Third Stage of the Separate Collection at Source Project

In April 2005, a new protocol was signed between The Great Municipality of Izmir, The District Municipalities of Balçova and Narlıdere, the authorized institution ÇEVKO Foundation and the waste management company, so two more districts were joined to the project. The economically developed neighbourhoods of the districts were selected and the numbers of the houses were determined. The population of the selected pilot areas and the number of the houses in these application regions were given in Table 8.5 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Table 8.5 The number of the houses and the population of the pilot region in Balçova and Narlıdere

The Pilot Area	The number of the houses	Population
Balçova District	18.356	73.424 person
Narlıdere District	4.327	17.308 person
TOTAL	**22.683**	**90.732 person**

As it was carried out in other application areas, the doorkeepers of the apartments and people live in the selected pilot area were informed about the project by the team of the waste management company. After the expansion, new trucks were inserted in the project and the number of the trucks rose up to 11, so a systematic collection scheme for recyclable materials from houses, institutions and organizations were fulfilled by the waste management company. In accordance with the developments in the project, the total number of the houses in 5 application areas rose up to 86.359 from 63.676 houses and the collection of the recyclable materials were started in Balçova and Narlıdere in the beginning of June 2005. The collection scheme of Balçova and Narlıdere is given in Table 8.6 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Table 8.6 The collection scheme of Balçova and Narlıdere

The Pilot Area	The collection system	The collection scheme	The collection frequency	The number of the trucks
Balçova District	Collection with plastic bag	Six days in a week	Two times in a week	2
Narlıdere District	Collection with plastic bag	Four days in a week	Two times in a week	1
Institutions and organizations	Collection with plastic bag	Six days in a week	Once a week	1

Instead of the expansion on the number of the houses, some hypermarkets, shopping centres and hotels were participated in the separate collection at source project of the Great Municipality as it is stated in the Regulation (Article 28-29).

In June 2005, the waste management company has its temporary working permit which is a certificate showing the duration of activity of the facilities with pre-license under the supervision of the Ministry of Environment and Forestry so as to certify that the facilities in question are operated in accordance with this Regulation.

8.2.2.6 Fourth Stage of the Separate Collection at Source Project

In July 2005, on the principle of spreading the separate collection at source project all over Izmir Metropolitan Area, a new protocol was signed between The Great Municipality of Izmir, The District Municipalities of Gaziemir, Çiğli, Buca, Aliağa, Özdere, Eski Foça, Yeni Foça, Ürkmez, Gümüldür, Seferihisar and Urla, ÇEVKO Foundation and the waste management company. So after this protocol, 7 new district municipalities and 4 new town municipalities were participated in the project.

The pilot areas for the new municipalities and the number of the houses in these areas were determined. Because of the summer season, the hotels and holiday resorts of some district and town municipalities were decided as pilot area. After the number of these hotels and holiday resorts were determined, the team of the waste management company began to inform the people live in the houses and the staff of the hotels and holiday resorts. The number of the houses and the population of the new pilot area in the Districts of Gaziemir, Çiğli and Buca are given in Table 8.7 and the number of the hotels and holiday resorts and the bed capacities of these hotels and holiday resorts are given in Table 8.8 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Table 8.7 The number of the houses and the population of the new pilot region in the Districts of Gaziemir, Çiğli and Buca

The Pilot Area	The number of the houses	The population
Çiğli District	25.223	100.892 person
Buca District	7.430	29.720 person
Gaziemir District	7.000	28.000 person
TOTAL	**39.653**	**158.612 person**

Table 8.8 The number of the hotels and holiday resorts and the bed capacities of these hotels and holiday resorts chosen as pilot area

The Pilot Area	The Number of the Hotels and Holiday Resorts	The Bed Capacities
Aliağa District	3	612 bed
Özdere District	34	5826 bed
Seferihisar District	17	1349 bed
Urla District	4	984 bed
Ürkmez District	20	1500 bed
Eski Foça District	32	2491 bed
Yeni Foça District	6	1114 bed
Gümüldür District	31	3600 bed
TOTAL	**147**	**17.476 bed**

The studies about informing people on the project in new pilot areas are still going on and the collection of recyclable materials in these areas will start after the preparation period.

Beside all those applications, The Packaging Waste Management Plan of Izmir Metropolitan Area was prepared by The Great Municipality of Izmir with the help of ÇEVKO Foundation as it is stated in the Regulation (Article 8). In this plan the duties and responsibilities of all the sides were clarified and according to the plan these sides were responsible to participate in the separate collection project of The Great Municipality of Izmir Metropolitan Area.

8.2.2.7 The Results of the Separate Collection at Source Project after Nine Months

The total amount of recyclable materials separately collected at source for nine months starting from November is given in Table 8.9 and Figure 8.10 is also given to show the increase in the total amount and the triumph of the project (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005). It is clearly seen

from Figure 8.10 that the total amount of recyclable materials collected separately at source increases every month depending on the increase on the interest of the public to the project.

Table 8.9 The total amount of recyclable materials separately collected at source for nine months

	Materials collected from houses (Kg)	Materials collected from institutions and organizations (Kg)	TOTAL (kg)
November	6.700	7.800	14.500
December	16.620	11.560	28.180
January	31.770	4.640	36.410
February	54.180	9.900	64.080
March	123.150	16.400	139.550
April	153.880	12.620	166.500
May	232.580	15.880	248.460
June	277.580	21.760	299.340
July	283.080	80.880	363.960
TOTAL	**1.179.540**	**181.440**	**1.360.980**

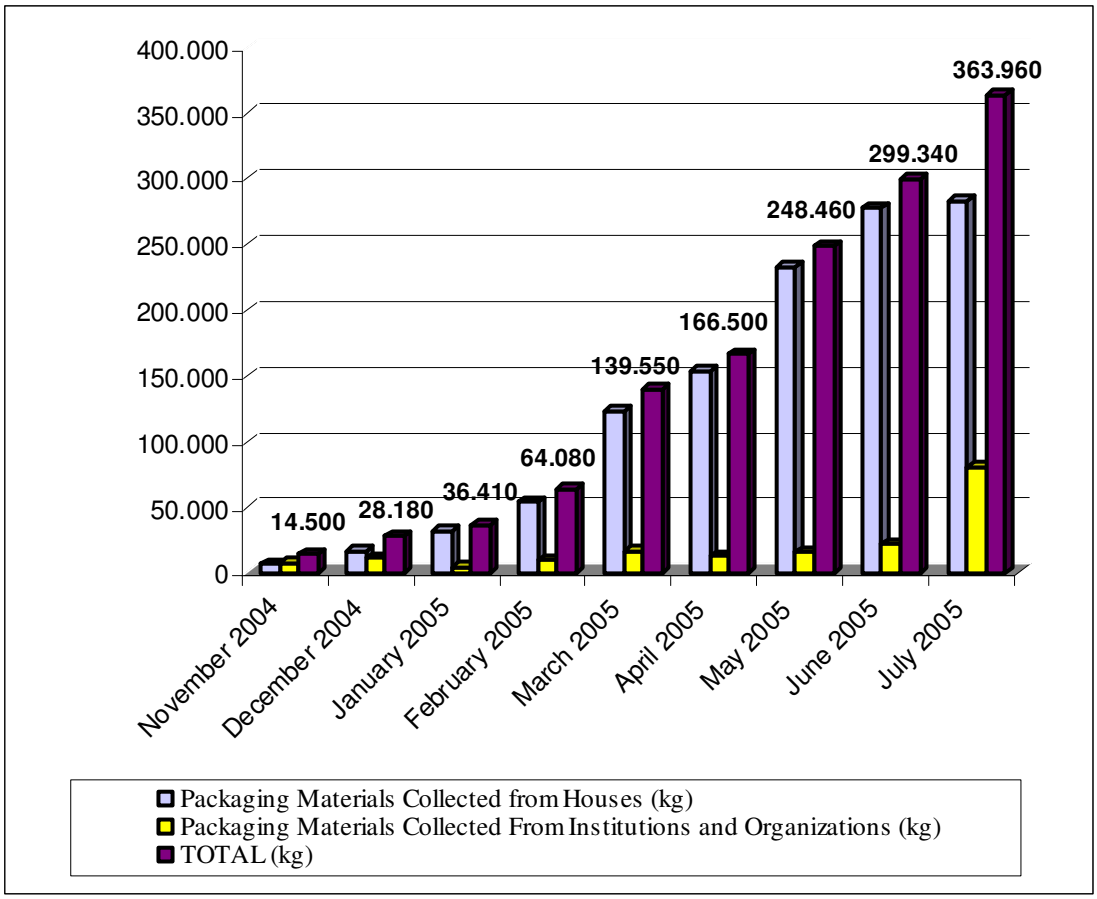

Figure 8.10 The total amount of recyclable materials separately collected at source for nine months

Also the data about the amount of recyclable materials in each district were collected and examined (Figure 8.11). This data show that Konak, Bornova and Karşıyaka have almost the same amount of materials, but if we look at the population of pilot areas in these three districts, we can say that Karşıyaka is the most successful area on this project. Balçova is also one of the most successful districts because it reached to almost the same amount of material as Konak, Karşıyaka and Bornova only in six weeks.

The decrease shown in the Figure 8.11 between the weeks of 33 and 40 is because of the summer season. In summer, the schools are closed and it is so hot in Izmir so people go to their summer houses for holiday and this affects not only the amount of recyclable materials but also the amount of municipal solid wastes in Izmir Metropolitan Area.

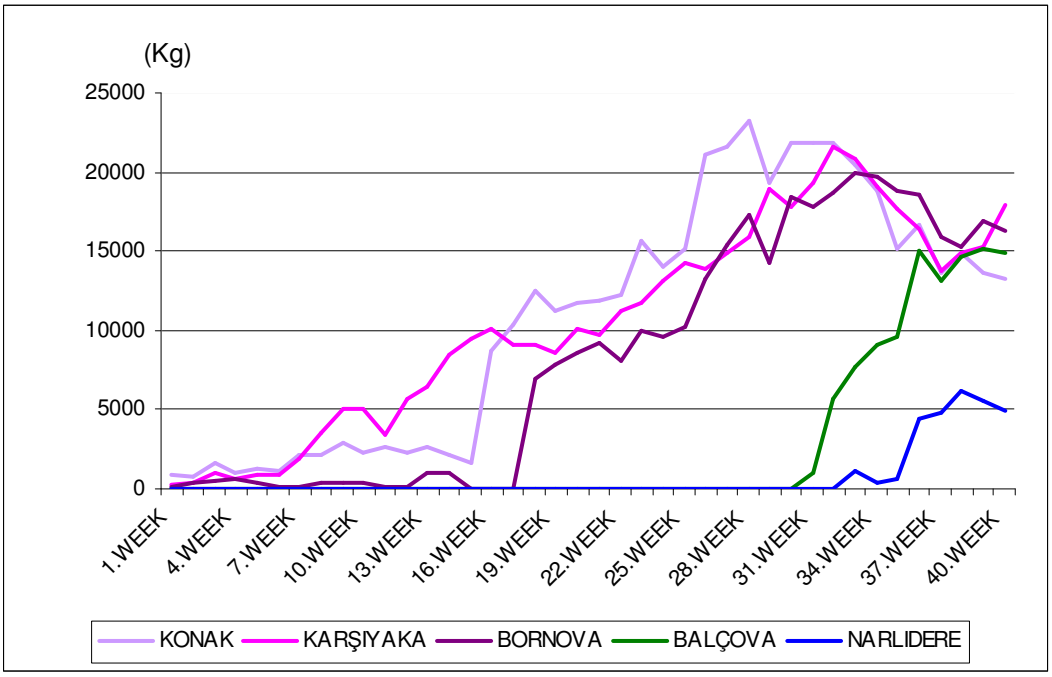

Figure 8.11 The amount of recyclable materials collected from different districts during 40 weeks

The composition of the recyclable materials separately collected from houses, institutions, organizations, hotels and shopping centres is given in Figure 8.12 (Solid Waste Management Directory, The Great Municipality of Izmir, 2005). The figure shows that paper, cardboard and newspaper form half of the total recyclable material content. The residues include non-recyclable materials like contaminated paper, used tissues, toilet papers and organic wastes. The ratio of residues defines the high ratio of uneducated people that still don't know much about the project. This composition of recyclable wastes is another clue to show the importance of the publics' education and participation to the project.

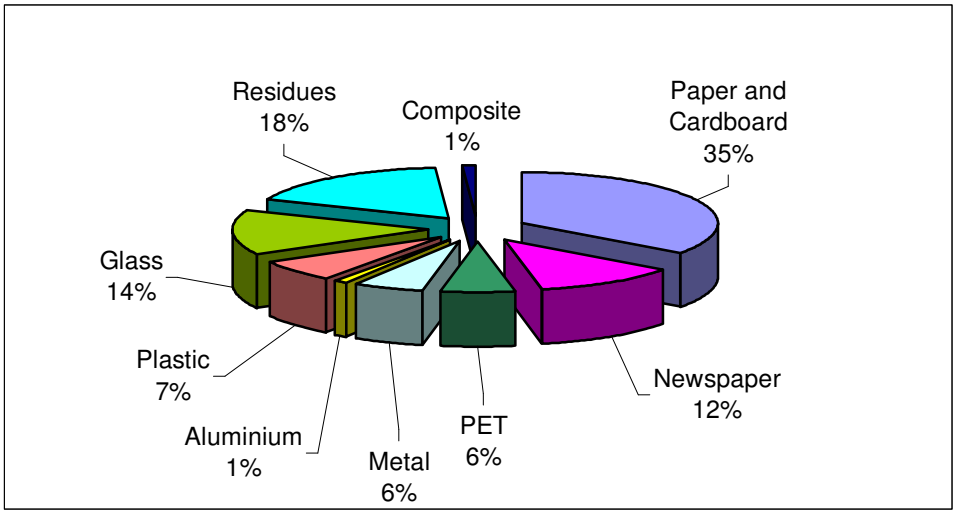

Figure 8.12 The composition of recyclable materials separately collected at source

During the project all the trucks coming to the sorting facility were weighed in the steelyard and the steelyard receipts were registered by The Great Municipality of Izmir. So all the data were under control and steelyard receipts were checked to guarantee the recycling of the packaging materials transferred to the relevant recycling facilities. Plus, the steelyard receipts show the transfer number of trucks which affects the cost and efficiency of the project. Figure 8.13 shows the transfer numbers of the trucks in the first nine months of the project (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005). The transfer number of trucks in November 2004 was 28 and this number rose up to 431 in July 2005. This increase shows the efficiency of the project and the rise in the participation of the people to the project. The Figure 8.13 also clarifies that total transfer number of the trucks in nine months is 1613 and this shows that 1613 trucks of packaging materials were recycled and haven't transferred to Harmandalı Sanitary Landfill to be landfilled.

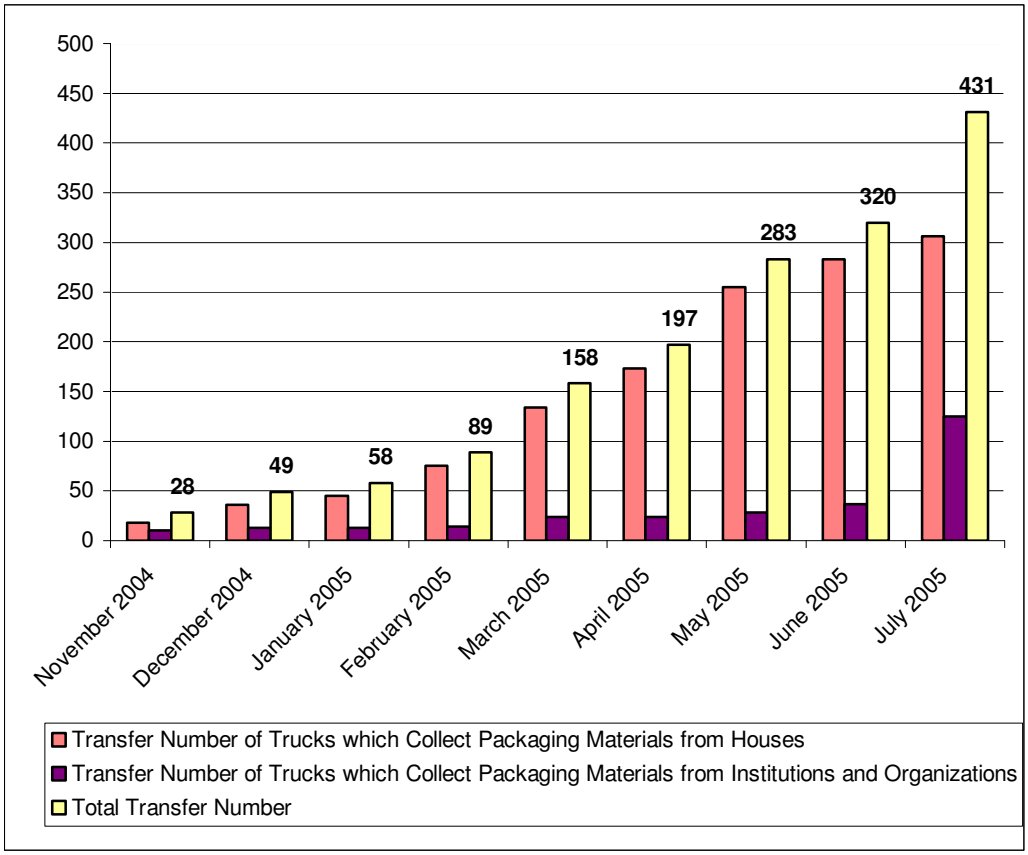

Figure 8.13 The transfer numbers of the trucks in the first nine months of the separate collection at source project

The waste management company has the responsibility to collect the recyclable materials at source, to finance the required trucks and staff for the project according to the contract between The Great Municipality of Izmir and the waste management company. Besides they are able to utilize the recyclable materials by sorting them into their material types in a Sorting Facility and selling them to the relevant recycling facilities.

As mentioned in this study before, the waste management company has constructed a Sorting Facility in Harmandalı Sanitary Landfill in April 2004. But this facility had some problems and difficulties on the operation, so it was decided that a new sorting facility, which is smaller than the old one, should have been constructed closer to the pilot areas. Finally a smaller sorting facility was constructed inside the borders of Uzundere Compost Factory in June 2005. The location of the facility can be seen in Appendix C. It has one sorting line, the building was constructed on 1500

m^2 closed area and also it has almost 4000 m^2 open storage area for the sorted materials before they are transported to the recycling facilities. It has a capacity of 15 ton/day on one shift. The pictures about the new sorting facility are given in Figure 8.14, Figure 8.15, Figure 8.16 and Figure 8.17 (The Packaging Waste Management Plan of The Great Municipality of Izmir, 2005).

Figure 8.14 The picture of the Sorting Facility in Uzundere Compost Factory, the entrance of the facility

Figure 8.15 The picture of the Sorting Facility in Uzundere Compost Factory, the storage area for commingled recyclable materials before they are sorted

Figure 8.16 The picture of the Sorting Facility in Uzundere Compost Factory, the manual sorting line of the facility

Figure 8.17 The picture of the Sorting Facility in Uzundere Compost Factory, the open storage area for the sorted recyclable materials in the facility

8.2.2.8 Future Plans for the Improvement of the Separate Collection at Source Project

After the Regulation on Packaging and Packaging Waste Control, the applications about separate collection of recyclable materials at source have increased in Izmir as mentioned in this study on the previous chapter. The publics' interest to the separate collection project applied in Izmir Metropolitan Area increases every day and depending on that increase the project has reached to almost 10% of the total metropolitan area in nine months. New pilot areas will be participated in the project for the following years and this project will be applied all over Izmir Metropolitan Area less than five years according to the Packaging Waste Management Plan of The Great Municipality of Izmir.

According to the Packaging Waste Management Plan of the Great Municipality of Izmir, the expansion of the project is planned to be done within five years. Table 8.10 shows the stages of the expansion in the project depending on the number of the houses, hotels and holiday resorts in Izmir Metropolitan Area.

Table 8.10 The expansion of the separate collection at source project within five years

Municipality	Total Number of Houses	The Number of Hotels and Holiday Resorts	The First Six Months of 2005	The Last Six Months of 2005	2006	2007	2008	2009	Total Number of Houses
Konak	305.000	-	22.794	25.006	50.000	70.000	67.200	70.000	305.000
Karşıyaka	194.326	-	15.886	20.440	40.000	48.000	40.000	30.000	194.326
Bornova	159.714	-	24.996	10.718	30.000	30.000	44.000	20.000	159.714
Balçova	22.695	-	18.356	4.339	-	-		-	22.695
Narlıdere	15.000	-	4.327	4.500	6.173	-		-	15.000
Çiğli	45.900	-	-	25.223	20.677	-	-	-	45.900
Buca	13.210	-	-	7.430	5.780	-		-	13.210
Gaziemir	24.963	-	-	7.000	10.963	7.000	-	-	24.963
Aliağa	12.200	3	-	3 hotels	-	7.200	5.000	-	12.200+ 3 hotels
Özdere	14.840	34	-	34 hotels	-	8.050	6.790	-	14.840+ 3 hotels
Seferihisar	11.000	17	-	17 hotels	-	-	11.000	-	11.000+ 17hotels
Urla	17.987	4	-	4 hotels	-	-	17.987	-	17.987+ 4 hotels
Ürkmez	3.000	20	-	20 hotels	-	-	3.000	-	3.000 + 20hotels
Eski Foça	6.010	32	-	32 hotels	-	-	6.010	-	6.010 + 32hotels
Yeni Foça	7.000	6	-	6 hotels	-	-	7.000	-	7.000 + 6 hotels
Gümüldür	5.400	31	-	31 hotels	-	-	5.400	-	5.400 + 31hotels
TOTAL	858.245	147	86.359	104.656 + 147 hotels	163.593	170.250	213.387	120.000	858.245 + 147 hotels

The plastic bags delivered to the houses by ÇEVKO Foundation have 80X110 cm dimensions and it was estimated that 5 houses need one plastic bag for a week. According to the estimations, the approximate requirement for the plastic bags was calculated for each municipality (Table 8.11).

Table 8.11 The approximate number of the plastic bags that will be used in the project

Municipalities	Total number of the houses	The approximate requirement for the plastic bags (unit/week)	The approximate requirement for the plastic bags (unit/year)
Konak	305.000	61.000	3.172.000
Karşıyaka	194.326	38.866	2.021.000
Bornova	159.714	31.943	1.661.000
Gaziemir	24.963	4.993	260.000
Balçova	22.695	4.539	236.000
Çiğli	45.900	9.180	477.000
Buca	13.210	2.642	137.000
Narlıdere	15.000	3.000	156.000
Aliağa	12.200	2.440	127.000
Foça	6.010	1.202	63.000
Gümüldür	5.400	1.080	56.000
Özdere	14.840	2.968	154.000
Seferihisar	11.000	2.200	114.000
Urla	17.987	3.598	187.000
Ürkmez	3.000	600	31.200
Yeni Foça	7.000	1.400	72.800
Total	**858.245**	**171.651**	**8.925.000**

Depending on the expansion plan for the separate collection at source project, new trucks and staff will be needed in each year and Table 8.13 shows the need for the trucks and staff for each municipality within the expansion. The numbers of the trucks and staff were calculated by taking the amount of packaging materials as 25 % of total municipal solid wastes and the collection efficiency was estimated as 50% of the total packaging materials (Table 8.12). The increase in the population was neglected on the calculations for the future plan of the project because the project period was taken as five years.

Table 8.12 The amount of packaging wastes for each municipality after five years

Municipalities	The daily amount of municipal solid wastes (ton/day)	Total amount of packaging wastes (ton/day)	The amount of packaging wastes that can be collected (50% efficiency-ton/day)
Konak	850	212,5	106,25
Karşıyaka	480	120	60
Bornova	400	100	50
Gaziemir	90	22,5	11,25
Balçova	70	17,5	8,75
Çiğli	200	50	25
Buca	100	25	12,5
Narlıdere *	35	8,75	4,4
Aliağa	39,9	9,975	4,9
Foça *	75	18,75	9,4
Gümüldür *	75	18,75	9,4
Özdere *	8	2	1
Seferihisar *	42	10,5	5,25
Urla *	100	25	12,5
Ürkmez *	40	10	5
Yeni Foça *	25	6,25	3,1
Total (ton/day)	**2629,9**	**657,475**	**328,7**

(*) In these municipalities the difference between the amount of municipal solid wastes in summer and winter is very high and the amount of municipal solid wastes in summer was taken in the calculation of the packaging wastes.

Table 8.13 The requirement for the truck and staff for each municipality within the expansion of the separate collection at source project in five years

Municipalities	The amount of packaging wastes (ton/day)	The amount of packaging wastes that can be collected (50% efficiency-ton/day)	The required truck number	The required staff number
Konak	212,5	106,25	27	81
Karşıyaka	120	60	15	45
Bornova	100	50	13	39
Gaziemir	22,5	11,25	3	9
Balçova	17,5	8,75	3	9
Çiğli	50	25	6	18
Buca	25	12,5	3	9
Narlıdere	8,75	4,4	1	3
Aliağa	9,975	4,9	1	3
Foça	18,75	9,4	2	6
Gümüldür	18,75	9,4	2	6
Özdere	2	1	1	3
Seferihisar	10,5	5,25	1	3
Urla	25	12,5	3	9
Ürkmez	10	5	1	3
Yeni Foça	6,25	3,1	1	3
Total	**657,4**	**328,7**	**83**	**249**

The requirement for the truck and the staff which will work in the collection of the packaging wastes were calculated as the given example below (The Packaging Waste Management Plan of the Great Municipality of Izmir, 2005);

For Konak Municipality

The daily amount of packaging wastes collected at source in Konak is 106,25 tons/day. A truck can collect approximately two tons of packaging wastes in one

time and a truck can transfer the packaging wastes to the sorting facility two times in a day. So a truck can collect four tons of packaging wastes in a day.

106,25/4 = 26,56 trucks => **27 trucks** is needed to collect the amount of packaging wastes after five years

One driver and two collection staffs are needed for one truck during the collection of packaging wastes, so three staffs are required for one truck.

27 trucks X 3 staffs = **81 staffs** will be needed for the collection of packaging wastes of Konak Municipality in five years.

The requirement for the sorting facility:

After all the calculations above, the total amount of packaging wastes that will be collected in five years was determined as 328,7 tons/day in Izmir Metropolitan Area. So there will become a requirement for the sorting facility to separate the daily packaging materials collected at source. The capacity of a sorting line in one shift is approximately 15 tons/day. If the sorting line is operated two shifts in a day, 30 tons of packaging wastes can be separated into their material types in a sorting line in one day.

So the sorting line requirement for Izmir Metropolitan Area in five years is;
328,7 tons / 30 tons = 10,9 = **11 sorting lines**

One foreman and eight sorting staffs are needed for a sorting line in one shift and it is determined that each sorting line will be operated two shifts in a day. So Table 8.14 shows the number of the sorting lines, the capacities of the sorting lines and the number of the staffs that will work in the sorting facilities. Table 8.14 also shows the location of the sorting facilities and the municipalities that will be able to use those facilities. The locations of the sorting facilities were determined according to density of the population and settlement in Izmir Metropolitan Area, the properties of the

places and transfer distances. The approximate locations of the new sorting facilities planned to be constructed after five years are shown in Appendix C.

Table 8.14 The location of the sorting facilities, the required number of sorting lines, the capacities of sorting lines and the number of the staff for the separate collection at source project in Izmir Metropolitan Area after five years

The location of the sorting facilities	The municipalities that will be able to use the sorting facility	The number of the sorting lines	The capacity of the sorting lines (ton/day)	The number of staffs in the sorting facilities
Uzundere	Konak, Balçova	2	60	36
Harmandalı	Karşıyaka, Çiğli	2	60	36
Halkapınar	Konak, Bornova, Buca	2	60	36
Kemalpaşa	Bornova, Konak, Kemalpaşa, Bayındır	2	60	36
Aliağa	Aliağa, Foça, Yeni Foça, Çiğli	1	30	18
Urla	Urla, Narlıdere, Güzelbahçe	1	30	18
Gaziemir	Konak, Buca, Gaziemir, Gümüldür	1	30	18
Total		**11**	**330**	**198**

According to the Packaging Waste Management Plan of the Great Municipality of Izmir, the cumulative increase in the number of the houses that will be participated in the separate collection at source project in five years is given in Figure 8.18. Also the cumulative increase of the amount of packaging wastes that will be collected daily in each year during the separate collection at source project of Izmir Metropolitan Area is given in Figure 8.19. On the other hand the cumulative increase on the number of the trucks and sorting lines are given in Figure 8.20 and 8.21 respectively.

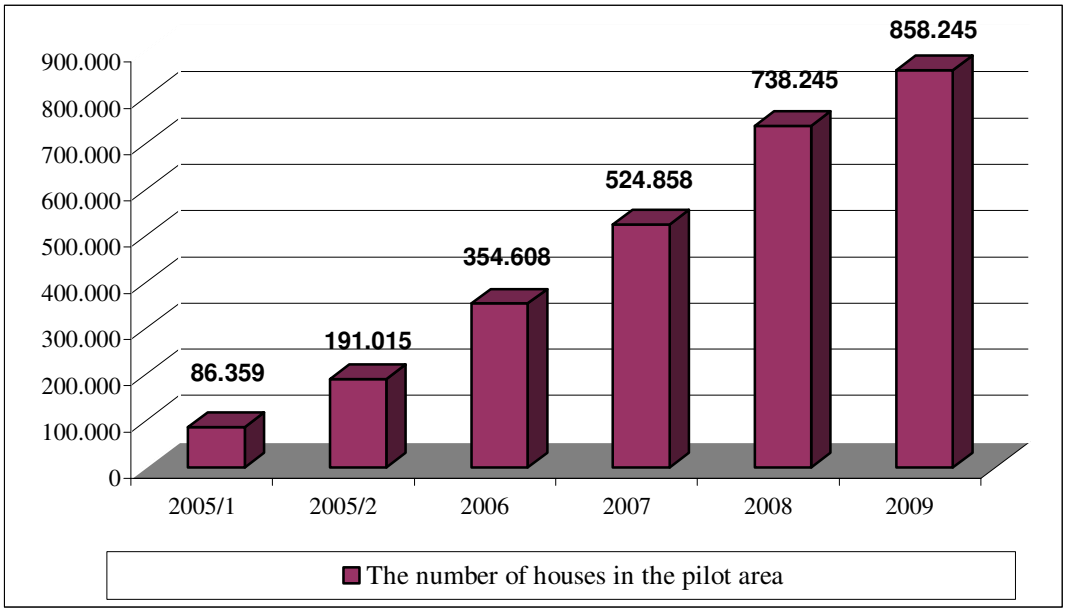

Figure 8.18 The cumulative increase in the number of the houses that will be participated in the separate collection at source project in five years

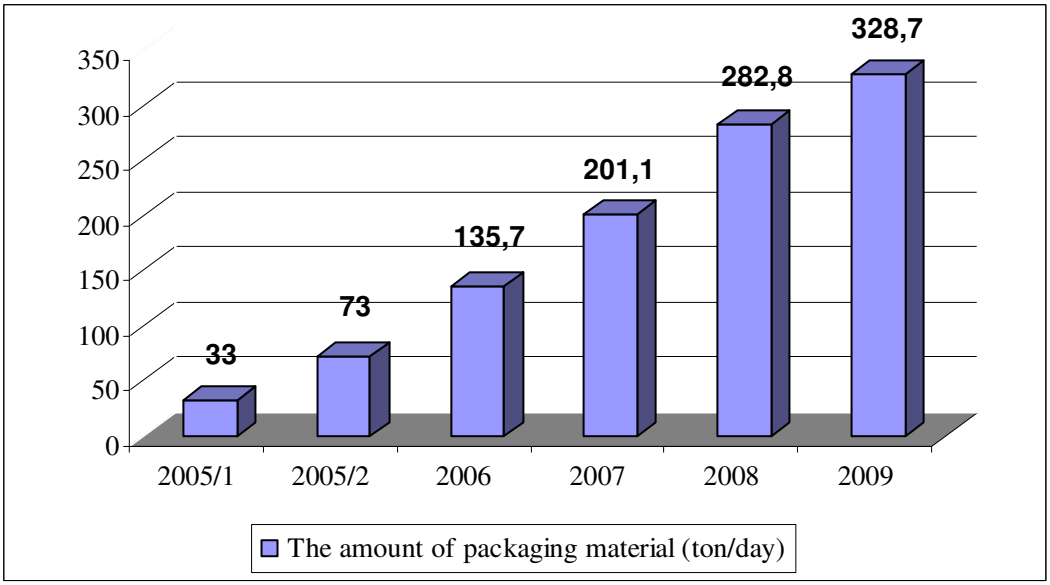

Figure 8.19 The cumulative increase of the amount of packaging wastes that will be collected daily in each year during the separate collection at source project of Izmir Metropolitan Area

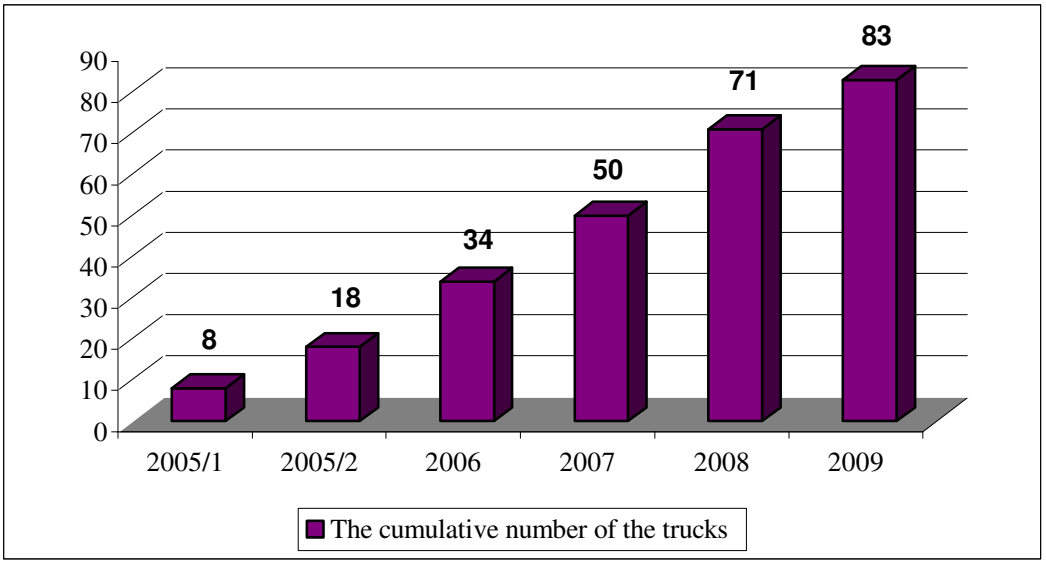

Figure 8.20 The cumulative increase on the number of the trucks in each year during the separate collection at source project of Izmir Metropolitan Area

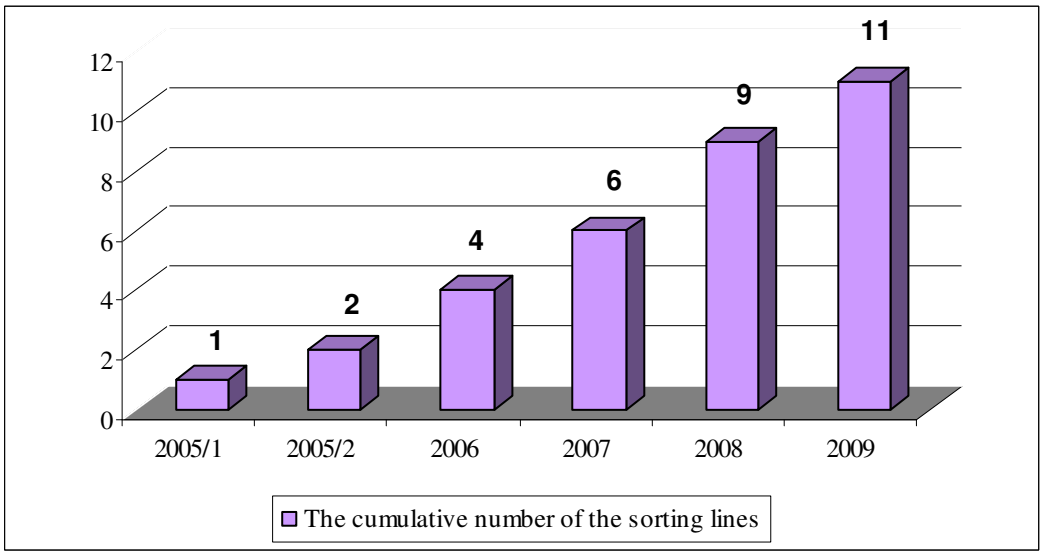

Figure 8.21 The cumulative increase on the number of the sorting lines in each year during the separate collection at source project of Izmir Metropolitan Area

The scavengers collecting the recyclable materials from the containers in the streets and even in the landfill areas form a very bad image, uncontrolled and unhealthy conditions. During the project these scavengers had an inhibitor affect and some preventive measures had to be taken for these people. Because of these scavengers the collection system is chosen as bag collection so it becomes hard for them to steal the bags inside the apartments. After all the measures are taken to

prevent these people, it is decided to change the system to container system and put some containers specially prepared for recyclable materials to the streets as shown in Figure 8.22. So this container system will decrease the cost of the project, the waste of time on the collection and will be more useful than bag system. In this system people separate their recyclable materials into their material types as metal, glass, plastic, paper and cardboard at home and put into these containers. This system also won't be so efficient yet because of the uneducated public who don't have enough information about the importance of the project.

Depending on the expansion on the project areas, the amount of recyclable materials increase every day and new sorting facilities are needed in different parts of Izmir to minimize the transport costs and the time for transportation.

Figure 8.22 The picture of the container specially prepared for recyclable materials

The efficiency of the project depends on the participation of the public so TV programs and advertisements can be done to educate and give more information to the people about the importance of the project. This project is thought to be a voluntary application but after the Regulation, it became an obligation for the people but most of them still don't know about their responsibilities. Billboards, posters and brochures are the most effective requisites on the education of people, some meeting

can be arranged and also door to door information should be done periodically in the same areas.

On the other hand the education will be more effective if it is applied to the students in elementary and high schools. So it is needed to arrange some entertaining activities, competitions and educations for the students and give information about the aim of the project and what will happen if they participate in the project.

CHAPTER NINE
CONCLUSION AND REMARKS

Solid waste is a serious problem in Turkey the same as other countries. Parallel to fast urbanization and the increase in the population, there have been irregular urbanization and infrastructure problems especially in big cities. According to all those factors, environmental problems have appeared in Turkey and have been on the agenda for 20 years. But there have been studies and investments usually to solve the problems on wastewater and water sources. In recent years, solid wastes have become an important problem especially in big cities of Turkey after the increasing costs of collection, transportation and disposal of solid wastes and the insufficient landfill areas. Plus, inadequate disposal methods implemented in Turkey for solid wastes have become one of the most important subjects on the harmonization studies for the membership of Turkey to European Union.

In the beginning of 90s, Turkey has started to carry out the detailed studies about environment and finally The Regulation on Solid Waste Control came into force. This regulation has consisted of all the types of solid wastes together, but each separate type of solid wastes haven't been considered detailed and separately in this regulation. In addition, there hadn't been enough studies about solid wastes in 90s because The Ministry of Environment had just been established and the legislations hadn't been improved yet.

The studies on the disposal of solid wastes were started to be applied comprehensively in big cities of Turkey like Istanbul, Izmir and Bursa. In conclusion to those applications, the requirements have appeared for making comprehensive investments and preparing more specific legislations for each type of solid wastes.

It was designated that recyclable wastes were very important especially in big cities and the places having high consumption rates. Depending on that, in the middle of 90s, there have been some studies about the recyclable wastes in the municipalities like Bursa, Kuşadası, Marmaris and Beşiktaş. ÇEVKO Foundation

which is a non-governmental organization also assisted in those studies of the municipalities and those pilot applications about recyclable wastes made people have more knowledge about the importance of the project.

On the other hand, there have been very serious investments about the recycling industry for the last ten years and used packaging materials were needed for the raw material requirement of those industries. Those packaging materials were collected from the streets and landfill areas in primitive, unhealthy and untidy conditions by the scavengers and were used in the recycling industry as raw material. Several investigations showed that one million ton from three millions tons of total packaging wastes was collected from the streets and landfill areas in a year in Turkey (ÇEVKO).

In 2004, some specific and more detailed regulations about solid wastes came into force in accordance with the relevant EU directives. While those developments have been occurring in Turkey, there were already a lot of studies especially in European countries about legislations and applications for solid wastes. Turkey started to carry out new applications about solid wastes with the help of the developments taken from the European countries.

The Regulation on Packaging and Packaging Waste Control which was prepared in 2004 by The Ministry of Environment and Forestry is one of the new regulations prepared for the harmonization studies of Turkey to be a member of European Union. This regulation defined the responsibilities of industries, municipalities and consumers to form and implement basic recovery and recycling systems for packaging wastes. The targets for ten years period till the end of 2014 were determined in this regulation and it came into force in the beginning of 2005. According to this regulation, separate collection at source was taken as a fundamental principle and the obligation to finance the establishment and application of the separate collection at source systems was given to the industries. Also it was determined that municipalities were responsible to coordinate the separate collection at source systems and besides, the authorized institution was defined.

Depending on both the regulations' coming into force and the developments in Turkey, ÇEVKO Foundation which is the authorized institution has begun to implement serious and widespread applications for the separate collection at source studies. Izmir was one of the cities chosen by ÇEVKO Foundation. The aims of the separate collection at source project which was started in Izmir are;

- To fulfill the obligations stated in The Regulation on Packaging and Packaging Waste Control.
- To extend the life of Harmandalı Sanitary Landfill Area and reduce the dimensions of disposal facilities.
- To minimize the costs for the collection, transportation and disposal of the solid wastes.
- To contribute the economy of our country by using uncontaminated recyclable materials separated at source in the recycling industries.
- To preserve natural resources, in terms of raw materials and energy.
- To improve and increase the environmental knowledge of people.

The studies applied in Izmir about the separate collection of packaging wastes at source were spread in a short time and as a result of the project it was seen that the recyclable wastes could be collected easily if the people were informed sufficiently about the project. Plus, the separate collection at source system could be successful without causing high costs and responsibilities to the municipalities. While the separate collection at source system was increasing, people noticed about the benefits of the project and so the participation increased day by day.

One of the most important factors on the development and achievement of the separate collection at source system is presentation and public knowledge. The success of a recycling programme will be achieved only if the reasons for participating are understood and accepted by the public. The public and local officials must be regularly reminded of the environmental, economic and social reasons for implementing the recycling system, and to do so, a continuous publicity

and promotion plan should be developed. School education is another important factor for the success of the system. Especially kids in elementary and high school should be educated about the project to teach the benefits of implementing a recycling system.

As a result, it is seen that the progress should be applied stage by stage starting from the most suitable area of the city for the success of the project. On the other hand, it is necessary to make investments continually for the development of the project but it is not easy to make all those investments at a time, so the project should be spread over a long time period. It is also necessary to have a slow increase in the development otherwise it would be a hardship to control the application of the project. As it is seen in Izmir project, it is important to try separate collection at source applications first of all in pilot regions and if the project is successful on pilot level, it should be developed all over the city.

To make all those studies regularly and also to determine the requirements of the project in a long time period, it is needed to prepare a rationalistic and detailed waste management plan. In this study, the preparation, application, developments, required investments and future plans of the separate collection at source project were revealed according to the Packaging Waste Management Plan of Izmir prepared by The Great Municipality of Izmir and ÇEVKO Foundation.

When the results of this study is evaluated;

- It is seen that the number of the houses inside the pilot area rose up to 130.000 from 10.000 in the first nine months of the project, the studies are still going on all over Izmir with 11 trucks which collect the recyclable wastes from houses, institutions, organizations, schools, hotels and hypermarkets and it is collected approximately 15 tons of packaging wastes daily.

- Besides, the rise in the transfer number of the trucks from 28 to 431 after nine months shows the conservation on the disposal area at the same proportion.

- According to the Packaging Waste Management Plan of Izmir, it is planned that approximately 330 tons of packaging wastes will be collected daily from 860.000 houses with 83 trucks in five years, if the project is developed all over Izmir. So the benefits of the project for Izmir city will increase and the costs for the disposal of the solid wastes will decrease in a big rate.

- It is seen in the project of Izmir that when the separate collection at source system is developed all over the city, the separation of recyclable wastes from the containers in the streets and landfill areas will decrease, people will no longer work in unhealthy conditions and all the collected packaging wastes will be registered under control.

- On the other hand, because of the separation of recyclable wastes at source before they are put into garbage, these packaging wastes aren't contaminated, the clean packaging materials can be recycled almost 100% and more qualified products is obtained from them. It is determined that while the paper and cardboard, which are separated from the containers and landfill areas, have a loss of 40 – 50 % when they are taken to a recycling industry, the paper and cardboard separately collected in Izmir project have a maximum loss of 10 %.

The project of Izmir, which is implemented appropriately depending on the obligations stated in the regulation, is the first and the most developed application in Turkey after the changes in legal orders. The results and experiences obtained from this project will be an example for the same applications in the other cities.

The applications about separate collection at source are not a system that can be achieved by the municipalities alone, so the responsibilities should be shared by each side. As it is stated in The Regulation on Packaging and Packaging Waste Control, especially industry should fulfill its responsibilities. The authorized institution is an effective model to provide the industries' participation to the system. Besides, consumers should carry out their responsibilities and participate in the system, too.

The results of this project show that for the achievement of the system, the municipalities should coordinate and supervise the project and waste management companies should carry out the collection, recovery and recycling of the packaging wastes. In this way, the developments of the separate collection at source systems can be provided faster and more effective all over Turkey.

Separate collection at source is not a solution alone by itself. As it is determined in this study, separate collection at source system forms just a part of the Integrated Solid Waste Management. If the solid waste problem of a city are planned to be solved, it is very important to collect a detailed data about those wastes. It is necessary to collect data, to develop, apply and evaluate different disposal methods for each waste type. In brief, it is essential to apply different and the most convenient collection and disposal methods for packaging wastes, hazardous wastes, organic wastes, medical wastes, waste electrical and electronic equipments, construction and demolition wastes and batteries and accumulator wastes separately.

Consequently, the solid wastes will no longer be a problem if all those solutions mentioned in this study are applied.

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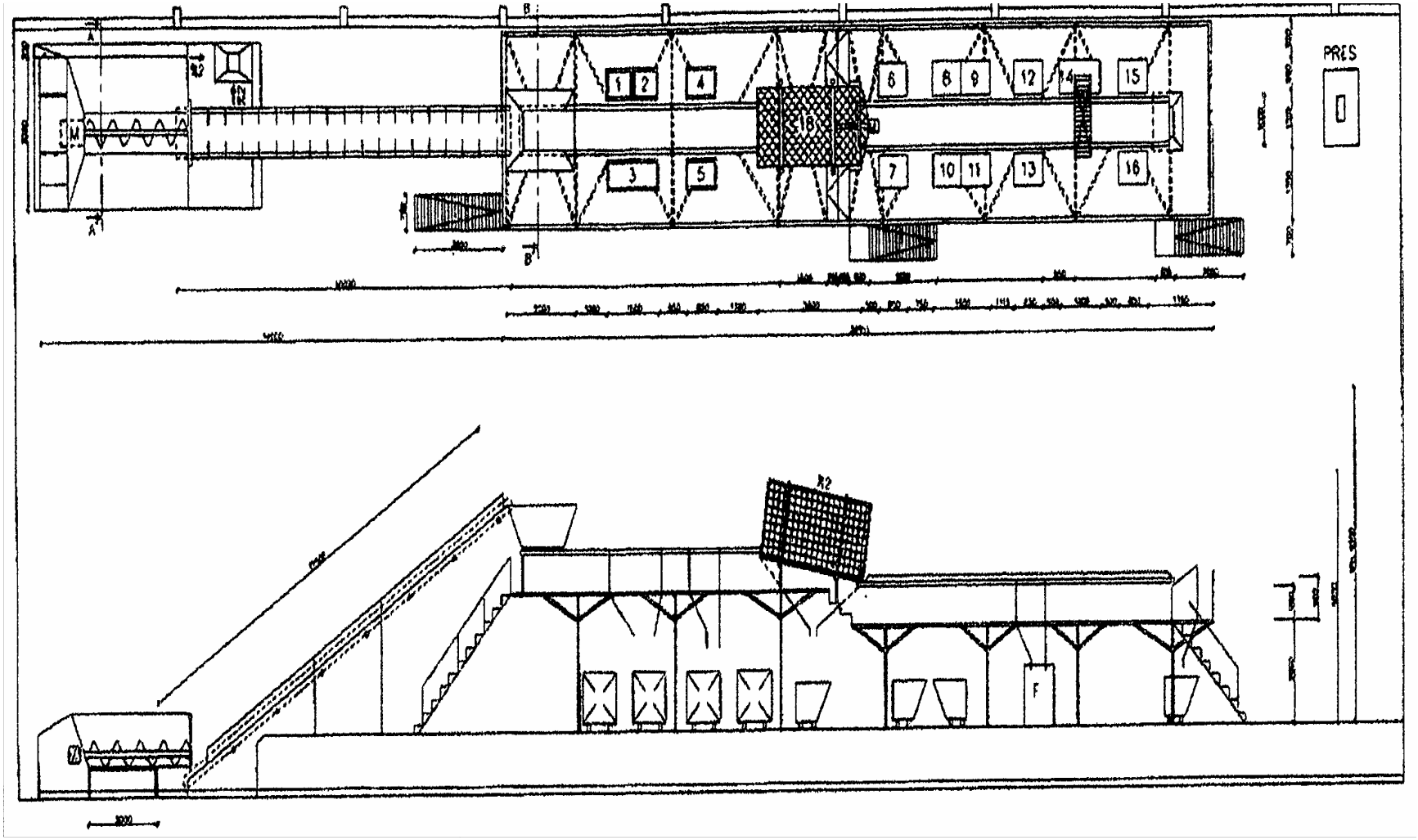
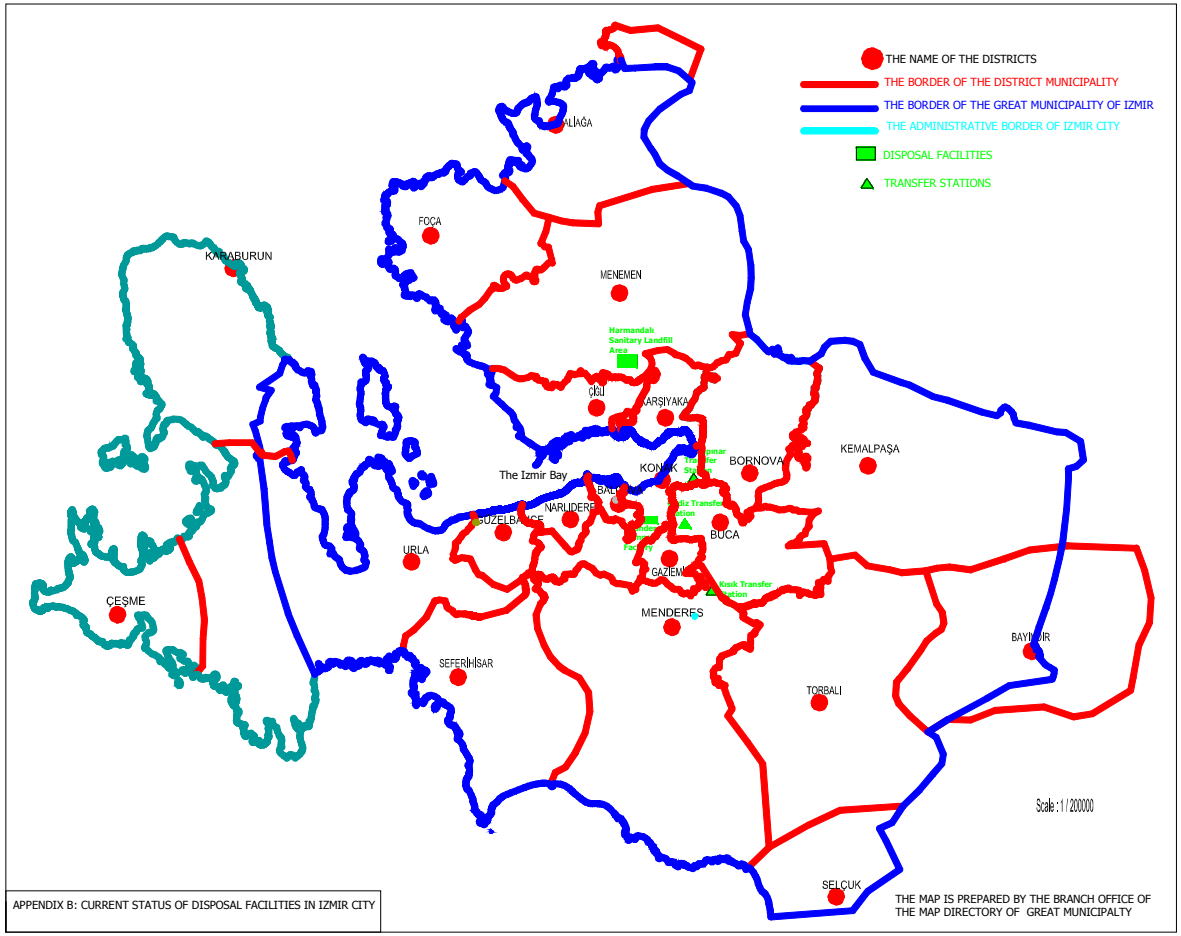
APPENDICES

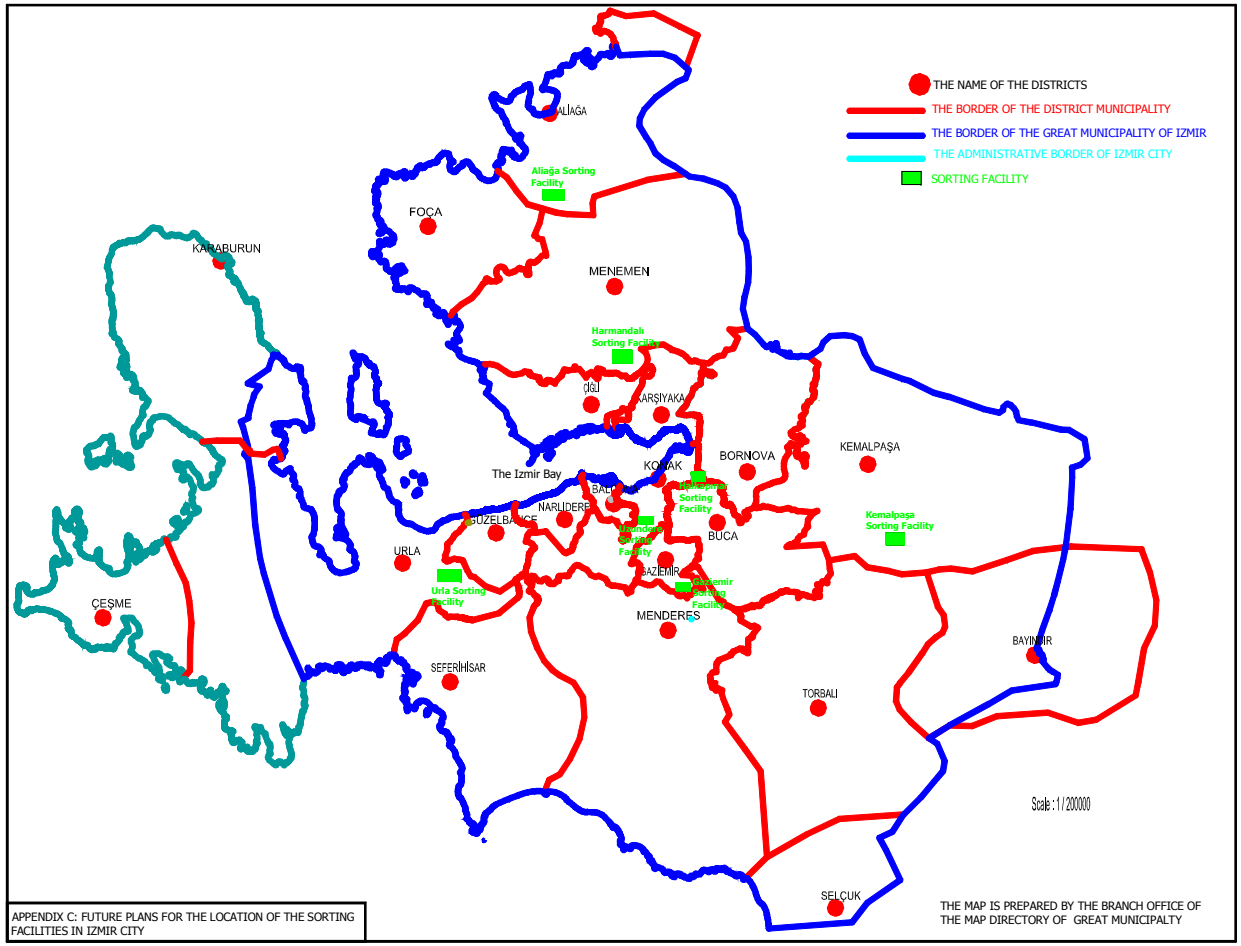
- Appendix A: The picture of a manual sorting facility
- Appendix B: Current status of disposal facilities in Izmir City
- Appendix C: Future plans for the location of the sorting facilities in Izmir City
- Appendix D: The poster used in the information studies of the separate collection of packaging wastes at source project
- Appendix E: The brochure used in the information studies of the separate collection of packaging wastes at source project
- Appendix F: The letter written by The Mayor of The Great Municipality of Izmir for the information studies of the separate collection of packaging wastes at source project



Appendix A: The picture of a manual sorting facility



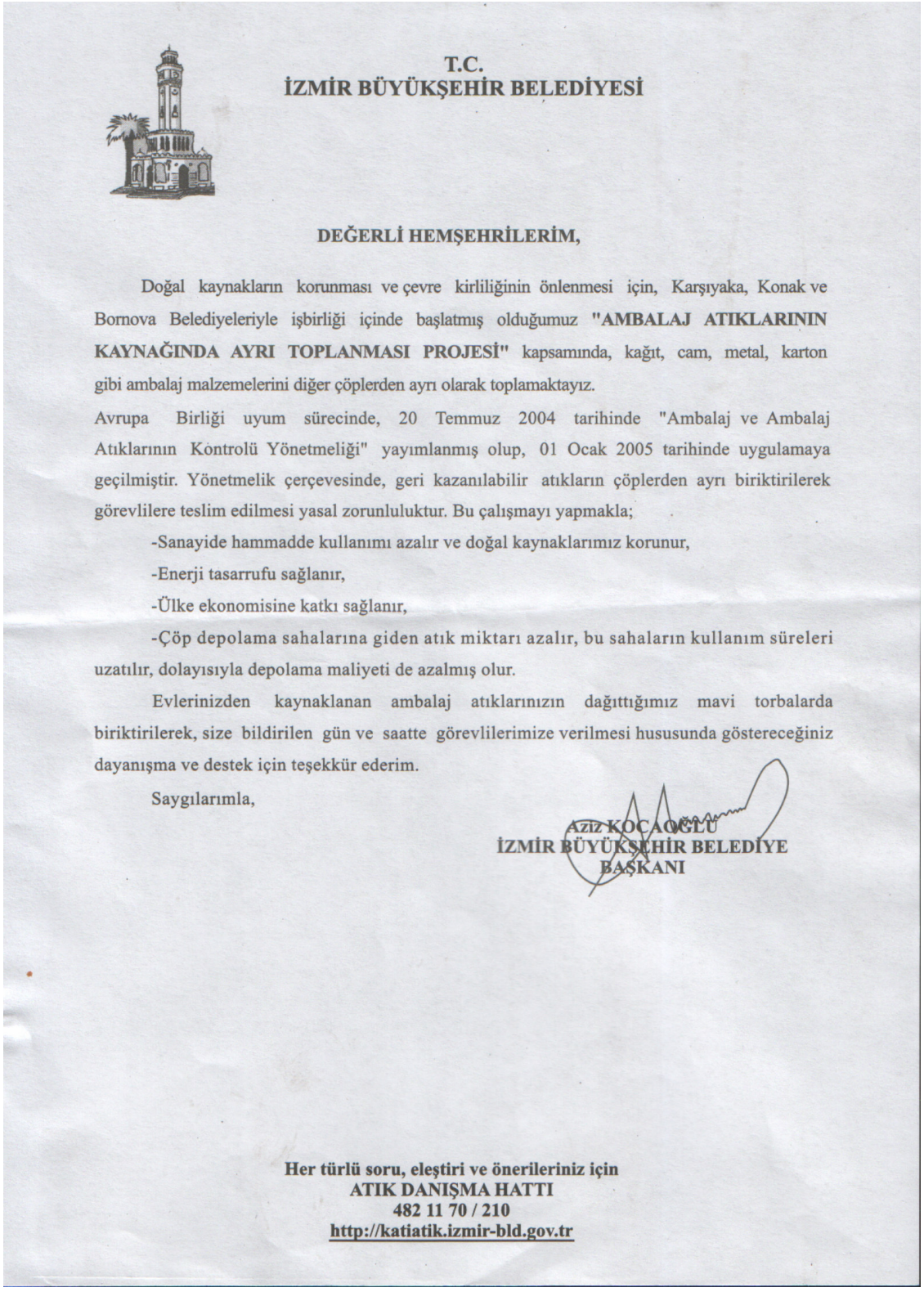
Appendix B: Current Status of Disposal Facilities in Izmir City



Appendix C: Future Plans for the Location of the Sorting Facilities in Izmir City

Appendix D: The poster used in the information studies of the separate collection of packaging wastes at source project

Appendix E: The brochure used in the information studies of the separate collection of packaging wastes at source



T.C.
İZMİR BÜYÜKŞEHİR BELEDİYESİ

DEĞERLİ HEMŞEHRİLERİM,

Doğal kaynakların korunması ve çevre kirliliğinin önlenmesi için, Karşıyaka, Konak ve Bornova Belediyeleriyle işbirliği içinde başlatmış olduğumuz **"AMBALAJ ATIKLARININ KAYNAĞINDA AYRI TOPLANMASI PROJESİ"** kapsamında, kağıt, cam, metal, karton gibi ambalaj malzemelerini diğer çöplerden ayrı olarak toplamaktayız.

Avrupa Birliği uyum sürecinde, 20 Temmuz 2004 tarihinde "Ambalaj ve Ambalaj Atıklarının Kontrolü Yönetmeliği" yayımlanmış olup, 01 Ocak 2005 tarihinde uygulamaya geçilmiştir. Yönetmelik çerçevesinde, geri kazanılabilir atıkların çöplerden ayrı biriktirilerek görevlilere teslim edilmesi yasal zorunluluktur. Bu çalışmayı yapmakla;

-Sanayide hammadde kullanımı azalır ve doğal kaynaklarımız korunur,

-Enerji tasarrufu sağlanır,

-Ülke ekonomisine katkı sağlanır,

-Çöp depolama sahalarına giden atık miktarı azalır, bu sahaların kullanım süreleri uzatılır, dolayısıyla depolama maliyeti de azalmış olur.

Evlerinizden kaynaklanan ambalaj atıklarınızın dağıttığımız mavi torbalarda biriktirilerek, size bildirilen gün ve saatte görevlilerimize verilmesi hususunda göstereceğiniz dayanışma ve destek için teşekkür ederim.

Saygılarımla,

Aziz KOCAOĞLU
İZMİR BÜYÜKŞEHİR BELEDİYE
BAŞKANI

Her türlü soru, eleştiri ve önerileriniz için
ATIK DANIŞMA HATTI
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Appendix F: The letter written by The Mayor of The Great Municipality of Izmir for the information studies of the separate collection of packaging wastes at source project