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Preparation of Regional Waste Management Plans and Strategic Environmental Assessments for East and North-East regions

Regional Waste Management Plan
EAST REGION

Draft (Date 17/04/2014)
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Table of Contents

Annexes:

List of tables

List of figures

1. EXECUTIVE SUMMARY

Introduction

This document presents East Region's Regional Waste Management Plan for the project "*Preparation of regional waste management plans and strategic environmental assessments for east and north-east regions*" (EuropeAid/130400/D/SER/MK). The overall objective of this project is to achieve an integrated and financially self-sustainable waste management system in East and North-East Region of FYR Macedonia. The project purpose is to support the planning process for an integrated regional waste management system through preparation of Regional Waste Management Plans and Strategic Environmental Assessment (SEA) in East and North-East Region.

The Regional Waste Management Plan (RWMP) is an important instrument contributing to implementation and achievement of policies and targets set out in the field of waste management at national and EU level. The RWMP was drafted on the basis of: a) EU and national waste legislation and strategies, which may include objectives, set out in specific areas; and b) the analysis and evaluation of the current situation, which was the outcome of the elaborated Assessment Report.

EU Directives set the context for National waste legislation, policy and initiatives. The most relevant EC Directives, the National Waste Management Strategy 2008-2020 (NWMS) and the National Waste Management Plan 2009-2015 (NWMP) provide a directional framework and context for the Regional Waste Management Plan. New approaches and solutions across all sectors are required to set in train the radical change required in the management of waste. Regional waste management planning should be an integral part of the overall national planning system, both as a wider approach to sustainable development and in order to achieve the overall goals set out in the waste management plans.

The waste management hierarchy is at the centre of European waste management policy. A sustainable approach to waste management requires emphasis on options at the top of the hierarchy and less reliance on waste disposal to landfill without recovery[1].

Apart from the EU and national waste legislation and strategy, there are a number of significant parameters which influence the regional planning and were taken into account:

- Waste quantity and composition;
- Geographic origin of the waste; and
- Current situation regarding waste collection and treatment, including waste tariffs and affordability.

Brief description of the Region

Due to the permanent process of depopulation, a large number of displaced villages, villages with population size of 100 villages with exceptionally high index of aging. This condition leads to a concentration of about 66% of the population in urban areas[2].

[1] http://ec.europa.eu/environment/waste/plans/pdf/2012_guidance_note.pdf

[2] http://www.rdc.mk/eastregion/index.php/za-nas/za-regionot

As a result of the unfavorable age structure and the low fertility, the number of deaths exceeds the number of births.
The relatively poor condition of the road network in the East Region and the low coverage of the railway network are negative factors for the development of the region, particularly in terms of encouraging economic growth through investment.[3].

The Zletovica Basin Water Utilization Improvement Project is expected to contribute to further economic development in East Region, as a stable water supply is critical for industrial and manufacturing development[4].

The East region is a predominantly mountainous region and covers the far east of the Former Yugoslav Republic of Macedonia. Due to the specific geological characteristics of mountain ranges, the region has a developed lead and zinc mining industry. Another important industry is the textile industry and a large number of textile manufacturing plants are located in this region.

Mountainous, border and rural areas identified as areas with specific development needs are located in all 11 units of local government in the East Regio according to the Decision on determining the areas with specific development needs in the country in the period 2009-2013[5].

Existing waste management system and coverage

The waste management system is based mainly on waste collection and disposal. The waste collection, transportation and disposal service is provided by Public Communal Enterprises (PCEs). However, the insufficient liquidity of PCEs prevents investments in suitable infrastructure for waste segregation and treatment, therefore mainly mixed waste is collected and disposed of at municipal, non-EU compliant landfills.

According to the received questionnaires, the percentage of the population that receives a regular service ranges from 38% (Cesinovo-Obleshevo) to 100% (Stip& Pehcevo). Most of the population that does not receive any collection service lives in rural areas. This has lead to the proliferation of illegal dumpsites located on the outskirts of settlements. The waste collection frequency varies among municipalities.

In Štip settlement there are separate bins for PET and paper and according to the received questionnaire, 38,8 tons of paper (50% from institutions /commerce) - up to 08.01.2013 were collected and handed over to the Collective scheme "PAKOMAK". Pakomak is a nonprofit company, founded on 3/12/2010, whose main activity is management of packaging waste. Also, the Municipality of Berovo has established a Public-Private Partnership (PPP) with a local firm for collection of PET bottles in 4 settlements of the municipality. Furthermore, EKO-PAK HIT - Kocani cooperates with the municipalities of Kocani, Vinica, Zrnovci, Probishtip, Makedonska Kamenica and with various companies:[6]

[3] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[4] http://www.jica.go.jp/balkan/english/office/topics/topics130322.html
[5] Official Gazette of the Republic of Macedonia br.79/09 June 24, 2009
[6] http://www.ekopakhit.com.mk/partneri.html

Regarding the collection of industrial waste, the PCEs are contracted by the entities to perform services on a regular basis in accordance with the dynamics of the waste generation. The generated waste is usually collected in metal containers and without any prior separation.

Waste generation index and waste composition

A waste quantity analysis was performed during the elaboration of the Assessment Report. The collection of data about the total mass of generated waste was carried out by weighing the mass of fully-laden garbage trucks which collect waste in the territory of a municipality. The mass of fully-laden trucks was weighed using a weighbridge of a utility company or other business entities in the territory of the local self-government unit where the procedure is performed. The municipal waste mass was weighed during a period of seven days, successively (Monday to Sunday), including the weekend days. The obtained waste weightings and results for each municipality are presented analytically in the Assessment Report.

In order to calculate the waste production factor, the following were taken into account:

- The quantity of weighted (collected) waste in each municipality.
- The percentage of served population in each municipality (provided in the questionnaires submitted by each municipality
- The estimated population of 2012, which was used for the calculations (according to publication 2.4.13.13/757 of the Statistical Office of Republic of Macedonia)

The most populated Municipality of the region is Štip Municipality and covers 23.6% of the overall waste production in East Region and is closely followed by Kočani Municipality (20.7%). The pure rural municipalities i.e. Češinovo-Obleševo, Karbinci and Zrnovci have generally lower waste production than the urban areas resulting in small participation in regional waste production. The average daily waste production per habitant of the East Region is 0.254 t/habitant/yr, which very close to the estimated one from previous desk studies.

A waste composition analysis was performed together with waste quantity analysis. Share of garden waste is mainly around 17.0%, while some smaller amounts are recorded only for the case of the municipalities of Stip (10.6%) and Kocani (15.2 %). The largest proportion of garden waste has been recorded in the municipality of Berovo (28.7 %). Other biodegradable waste fraction has the highest overall share in the region (36.6%) and has a much greater variation, from only 18.04 %, in Pehcevo up to 44.5% in the municipality of Stip. Share of paper is mostly in the range of 4.0% to 5.0 % with the exception in case of the municipality Oblesevo-Cesinovo and Zrnovci, where share of this fraction is 7.2% and 1.91 % respectively.

Fraction of fine elements has 9.58% and represents great amount causing a negative result, considering that this fraction cannot be used in any waste treatment. Textile and diapers with share of 2.79% and 3.59% respectively also represent non-favorable fractions from treatment and reuse point of view.

Table 1-1: Average waste composition for East Region

FRACTIONS	TOTAL COMPOSITION/ EAST REGION
Garden waste	**17.13%**
Other biodegradable waste	**36.60%**
Paper	**5.94%**
Cardboard	**4.33%**
Glass	**3.07%**
Metals (ferrous)	**0.63%**
Aluminum (non-ferrous)	**0.19%**
Tetra Pak	**0.65%**
Plastic packaging waste	**1.04%**
Plastic bags	**9.15%**
PET bottles	**2.40%**
Other plastic	**0.85%**
Textile	**2.79%**
Leather	**0.29%**
Diapers	**3.59%**
Wood	**0.06%**
Construction and demolition material	**1.39%**
WEEE	**0.07%**
Hazardous materials	**0.25%**
Fine fraction (<20 mm)	**9.58%**
Total	**100.00%**

Waste generation forecast

The projection is an essential element in the planning process. Based on the municipal waste generation projection, the targets set at regional level are quantified, and implicitly the capacities of the waste management facilities to be installed are determined.

In order to calculate the waste generation forecast (2018-2042) for the Region, the following assumptions have been made:

- The population average rate of change for each Municipality during the period 2002-2012 was calculated. Using the calculated average rate of change, each municipality's population was estimated for the period 2013-2042.
- There were two approaches for the evolution of waste production factor. In the first approach, a total waste production factor was used and in the second approach, a separate waste production factor for each municipality of was used (calculated from collected waste and served population). Finally, the first approach was adopted. The waste production factor increases by 1% during the period 2013-2027 and by 0.5% during the period 2028-2042

Figure 1-1: Population forecast

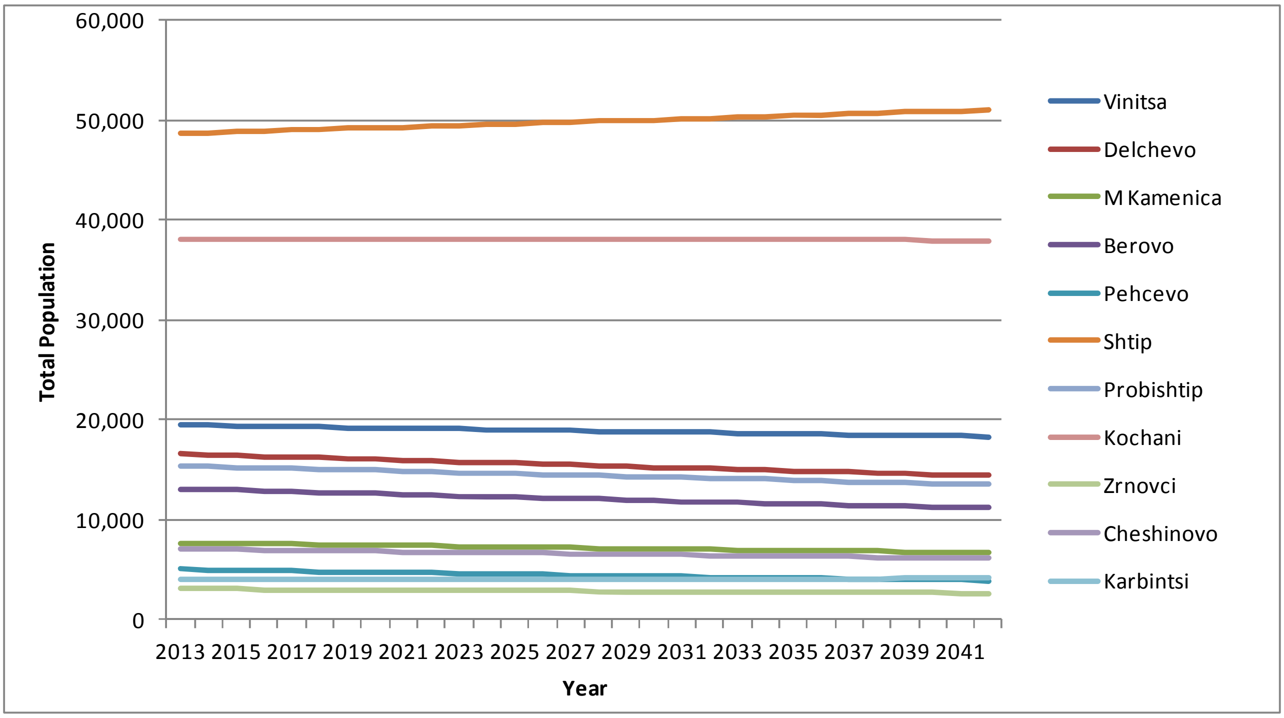


Figure 1-2: Regional population forecast

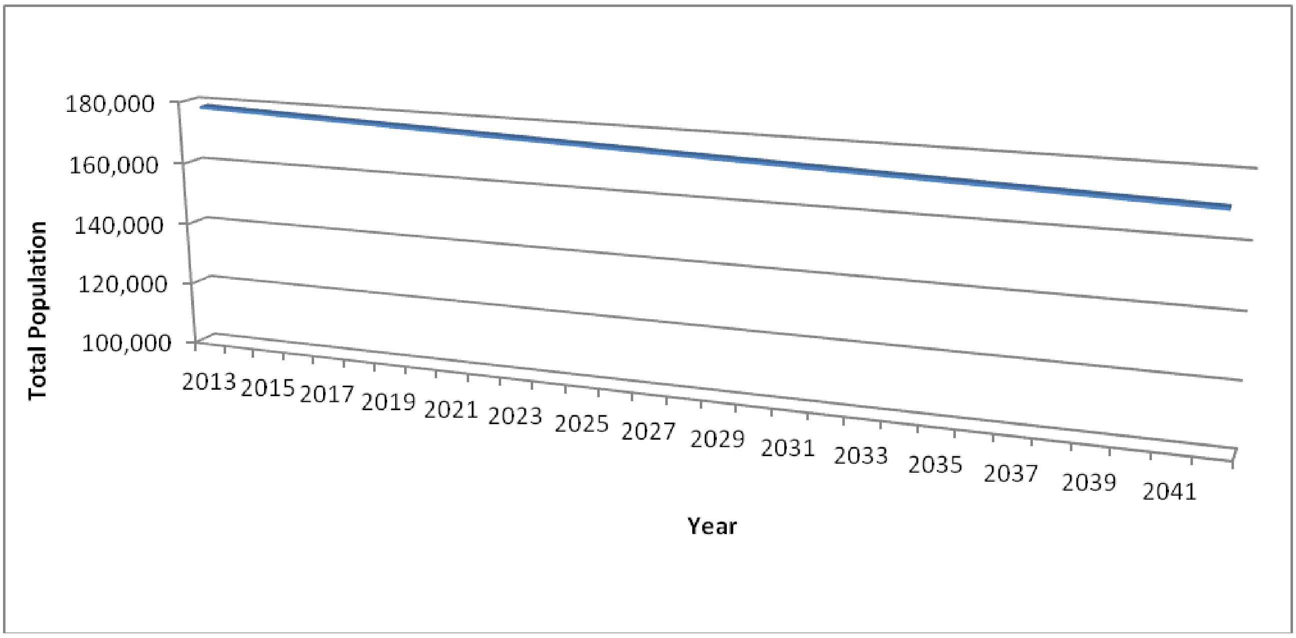
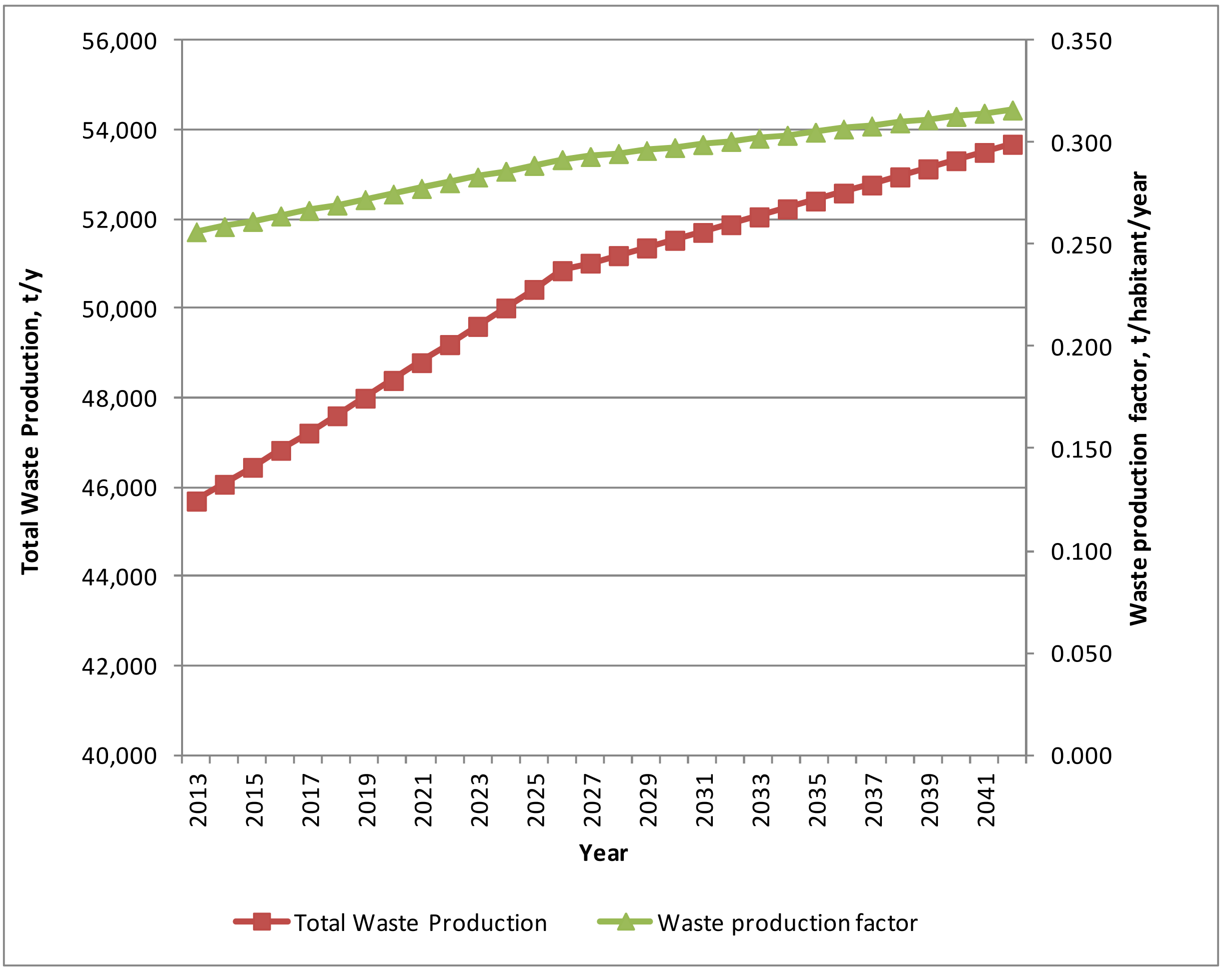


Figure 1-3: Waste generation forecast / evolution of waste production factor



Detailed presentation of the waste generation forecast and its composition is presented in Annex II-Waste generation forecast. A detailed calculation of forecasted waste quantities and the calculation of target achievement per waste management scenario is presented in Annex III-Calculation of targets.

Objectives of the regional waste management plan

The Regional Waste Management Plan is a key element of Regional Policy, providing a strategic framework which will allow the Region as a whole to rapidly progress to more sustainable ways to produce and consume goods, and then recycle or recover as much value as possible from that waste which is produced. It also has an important role to identify the current capacity of the Region to manage the waste and to set out the waste management infrastructure which will need to be developed to meet future needs.

The RWMP is in line with the provisions of Article 1 WFD (protection of environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use), Article 4 WFD (the waste management hierarchy), Article 13 WFD (protection of human health and environment), and Article 16 WFD (principles of self-sufficiency and proximity).

The Plan fulfills the mandatory elements of a waste management plan listed in Article 28(3) WFD and the additional elements which may be contained in the plan, listed in Article 28(4) WFD.

Guided by the European and National policy context, the Regional Waste Management Plan has the following vision and aims:

Vision & Aims of the Regional Waste Management Plan

Vision: To provide a regional planning framework for the sustainable waste management and recovery of resources by developing an integrated waste management system, with the following aims:

Aim A: Minimisation of negative impacts on the environment and human health caused by the generation and management of waste.

Aim B: Minimisation of negative social and economic impacts and maximisation of social and economic opportunities.

Aim C: Conformity with the legislative requirements, targets, principles and policies set by the European and National legal and regulatory framework.

To meet these aims, the following objectives have been set. The objectives will be reviewed during the Strategic Environmental Assessment (SEA) process.

Objectives of the RWMP

Environmental and Human Health Objectives (Aim A)

Protection and improvement of living conditions of the population
Protection and promotion of biological diversity and natural heritage
Protection and improvement of the water quality
Protection and improvement of the soil quality, quantity and function
Improvement of the quality of air and reduction of greenhouse gas emissions
Protection of material assetsProtection and promotion of cultural heritage
Preservation of landscape characteristics and protection of landscape everywhere and especially in the designated area
Sustainable use of land and other resources
Minimization of greenhouse gas emissions
Minimization of negative impacts on air quality and public health
Minimization of negative impacts on water quality and water resources
Land and cultural heritage conservation
Biodiversity protection

Socio-Economic Objectives (Aim B)

Provision of public awareness campaigns, enhancement of public involvement
Optimization of waste collection system and minimization of local transport impacts
Employment opportunities
Waste Management system in balance with economic resources of the society

Legal and Regulatory Framework Objectives (Aim C)

Conformity with EU and National waste legislation, policy and principles – achievement of waste management targets regarding waste generation, collection, recycling infrastructure, efficiency in relation to waste diversion from landfill targets, energy recovery, cost recovery, remediation of existing dumpsites and environmental awareness. The plan takes into consideration:

- The waste management hierarchy
- The Best Practical Environmental Option for each waste stream

- The principle of regional self-sufficiency
- The proximity principle

The Regional Waste Management Plan will be based on the Waste Management Hierarchy. The hierarchy highlights the need to move practices away from landfill disposal and to promote prevention, preparing for reuse, recycling and other recovery. Fundamental to achieving these policy objectives are recognition and acceptance by all target groups of society, as producers of waste, of their responsibility to support and adopt more sustainable waste management practices, both at home and at work. It is implicit therefore that the perception of waste as an unwanted but necessary by-product will need to change, with recognition of its potential as a resource.

The perspectives for regional waste management system are the following:

Environmental
The waste management system will be based on an integrated approach of self-regulation, regulation and control. Problem shifting across environmental media – air, soil, and water - must be avoided. Acceptance of user charges should be seen in connection with the application of the polluter pays principle.

Economic
The waste management system shall be developed in such a manner that it does not put an undue strain on the population. The waste system shall be worked out in such a manner that it is in balance with the economic resources of the society. The system should facilitate and assure waste collection, treatment, and disposal to attain desirable levels of hygiene and aesthetics, within the capacity of different economic actors to pay.

Institutional
Duties and responsibilities of the municipal and private institutions and companies involved in waste activities must be clearly defined and coordinated. Regional waste management planning is a pre-requisite for effective management and must be periodically evaluated and revised. Information collection and exchange between various institutions of waste management must be improved in order to facilitate the decision-making process.

Social
All stakeholders of the waste management system should accept the chosen strategy and all of its components in its institutional, legal and financial framework. This includes the willingness to adopt direct user charges and enhance waste regulations that have an impact on the stakeholders' attitudes.

Overview of proposed scenarios

With the Regional Waste Management Plan should be covered the minimum requirements set by the national waste management legislation for packaging and packaging waste. Also should be covered a set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills. The national targets for management of packaging and packaging waste and diversion of biodegradable municipal waste from landfills were presented in previous paragraph.

To fulfill the objectives of waste management, four main alternative waste management scenarios have been examined and presented afterwords via a flow diagram. All proposed waste management scenarios include some common elements like green points that will be a collection point for fractions such as electric and electronic waste (WEEE), hazardous municipal waste, construction and demolition waste and recyclables. Also all proposed scenarios include separate collection of green/garden waste and sorting at source of recyclables or packaging waste based on each examined scenario. Finally the proposed scenarios including a collection system with the use of either 1 bin, 2 bins and 3 bins. Obviously, based on the collection system, the proposed treatment facilities (including home composting), are also differentiated, accordingly by the way some sub-scenarios (a, b, c) are also developed, which are involving different technologies to treat waste that are collected with the same concept (1 bin, 2 bin or 3 bin system).

The table below presents a summary of the scenarios analyzed.

Table 1-2: Scenarios overview

	Scenario 1 (1 bin)		Scenario 2 (2 bins) Mixed + Biowaste	Scenario 3 (2 bins) Mixed + Recyclables			Scenario 4 (3 bins) Mixed + Recyclables + Biowaste
	1a (MBT)	**1b (Incineration)**	**2**	**3a (MRF+ Aerobic Composting)**	**3b (MRF + MBS + Aerobic Composting)**	**3c (MRF + Incineration)**	**4 (MBT)**
Waste Collection	One Bin collection system		Two Bin collection system (*Organic Waste Bin* and *Mixed Bin*)	Two Bin collection system (*Recyclable Waste Bin* and *Mixed Bin*)			Three Bin collection system
Green Points	√	√	√	√	√	√	√
Home Composting	√	-	-	√	√	-	-
Mixed Bin Treatment	Mechanical Biological Treatment (MBT) with Aerobic Composting	Incineration	Dirty MRF	Disposed to Landfill	MBS (Biostabilization)	Incineration	Disposed to Landfill
Recyclable waste bin treatment	-	-	-	MRF	MRF	MRF	MRF
Organic waste bin treatment	-	-	Aerobic Composting	-	-	-	Aerobic Composting
Green waste treatment	Aerobic Composting	Incineration	Aerobic Composting	Aerobic Composting	Aerobic Composting	Incineration	Aerobic Composting
Landfill	√	√	√	√	√	√	√

Investment costs

The investment cost of each scenario is given in the table below.

Table 1-3: Investment cost of each scenario

	Cost of Treatment, Collection Transportation (€)	Cost of Intangible components (€)	Cost of Acquisition of land (€)	Grand Total (€)
Scenario 1a/East Region	13.456.787	1.900.000	288.217	15.645.004
Scenario1b/East & North East Regions	92.938.462	1.900.000	287.127	95.125.589
Scenario 2/East Region	11.953.884	1.900.000	323.579	14.177.463
Scenario 3a/East Region	12.058.391	1.900.000	474.616	14.433.007
Scenario 3b/East Region	15.237.944	1.900.000	425.204	17.563.148
Scenario 3c/East & North East Regions	89.172.990	1.900.000	281.066	91.354.056
Scenario 4/East Region	11.691.697	1.900.000	376.419	13.968.116

	Cost of Treatment, Collection Transportation (MKD)	Cost of Intangible components (MKD)	Cost of Acquisition of land (MKD)	Grand Total (MKD)
Scenario 1a/East Region	828.032.442	116.912.130	17.734.751	962.679.323
Scenario1b/East & North East Regions	5.718.754.523	116.912.130	17.667.699	5.853.334.352
Scenario 2/East Region	735.554.772	116.912.130	19.910.681	872.377.582
Scenario 3a/East Region	741.985.357	116.912.130	29.204.379	888.101.867
Scenario 3b/East Region	937.631.838	116.912.130	26.163.934	1.080.707.902
Scenerio 3c/East & North East Regions	5.487.054.848	116.912.130	17.294.775	5.621.261.752
Scenerio 4/East Region	719.421.681	116.912.130	23.162.103	859.495.914

Operating costs

The operating cost of each scenario is given in the table below.

Table 1-4: Operating Cost of each Scenario (for the 1st year of operation)

Scenario	**Operating Cost (EUR/year)**	**Operating Cost (MKD/year)**
Scenario 1a/East Region	2.474.142	152.240.609
Scenario1b/East & North East Regions	10.501.344	646.176.074
Scenario 2/East Region	2.399.231	147.631.161
Scenario 3a/East Region	2.226.350	136.993.325
Scenario 3b/East Region	2.542.672	156.457.490
Scenario 3c/East & North East Regions	11.767.940	724.113.124
Scenario 4/East Region	2.339.432	143.951.583

Dynamic prime cost (DPC)

The DPC of each scenario is given in the table below.

Table 1-5: DPC of each Scenario

Scenario	DPC (€/t)	DPC (MKD/t)
Scenario 1a/East Region	75	4.596
Scenario1b/East & North East Regions	115	7.088
Scenario 2/East Region	70	4.304
Scenario 3a/East Region	61	3.726
Scenario 3b/East Region	72	4.448
Scenario 3c/East & North East Regions	116	7.116
Scenario 4/East Region	62	3.797

Affordability

The affordability of each scenario is given in the table below.

Table 1-6: Affordability of each Scenario

	Waste tariff as a % of lowest decile HH income	Waste tariff as a % of average HH income
Scenario 1a/East Region	2,20%	0,47%
Scenario1b/East & North East Regions	5,84%	1,24%
Scenario 2/East Region	2,13%	0,45%
Scenario 3a/East Region	1,41%	0,30%
Scenario 3b/East Region	1,66%	0,35%
Scenario 3c/East & North East Regions	5,66%	1,20%
Scenario 4/East Region	1,53%	0,32%

Recommended scenario for regional waste management

In order to support decisions regarding future solutions for the Waste Management Plan in East Region, reliable strategies and concepts are needed. For this purpose, a SWOT analysis of waste management options has been elaborated and four waste management scenarios (including sub-scenarios) have been defined. The scenarios are based on national objectives and targets and recent national waste management legislation. The minimum requirements set by the national waste management legislation for packaging and packaging waste should be covered. Also, the set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills should be achieved (par. 3.4.1).

Furthermore, the scenarios take into account regional waste production and composition, as well as existing waste system infrastructure. For each scenario, the following material flows were quantified:

(1) wastes that would be sent to collection systems, such as green waste, biodegradable waste, electric and electronic waste (WEEE), hazardous material, Construction and Demolition waste, recyclable waste (paper/cardboard, glass, plastic, Fe, Al);

(2) wastes that would be sent to different processes, such as those of mechanical-biological treatment, mechanical-recycling facility, mechanical-biological stabilization, incineration;

(3) residues to be diverted to landfills;

(4) materials recoverable by recycling processes (mechanical separation)
(5) energy obtainable by waste-to-energy plants.

Also for each scenario, carbon dioxide emissions (CO_2) from waste management activities are quantified.

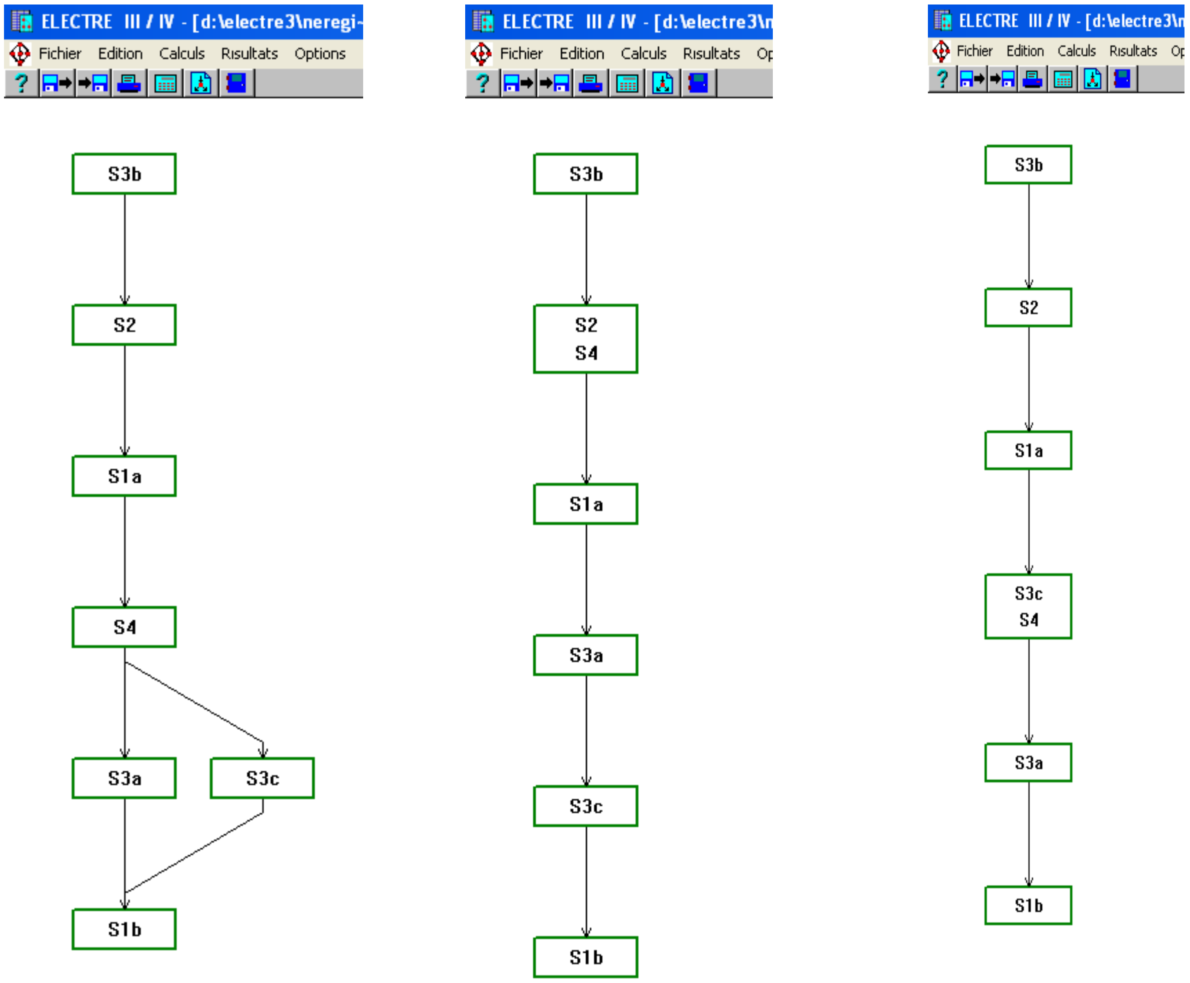
To fulfill the objectives of waste management as defined above, four alternative waste management scenarios have been examined and presented via a flow diagram. All proposed waste management scenarios include green points that will collect fractions such as electric and electronic waste (WEEE), hazardous municipal waste, construction and demolition waste and recyclables. Also all proposed scenarios include separate collection of green/garden waste and sorting at source of recyclables or packaging waste based on each examined scenario. All proposed scenarios include a collection system with the use of either 1 bin, 2 bins and 3 bins. In some scenarios home-composting is also taking into consideration. The scenarios are described in detail in par. 3.6.2.3.

Moreover, the investment cost of each scenario was calculated and the operating costs and revenues of each scenario were projected. Afterwards, the Dynamic Prime Cost of each scenario was calculated. The Dynamic Prime Cost, or commonly also known as Net Present Value, is an index of cost-effectiveness and it is widely used in environmental projects as a best proxy of a long run average cost (for the present case it would be equivalent to the gate fee, €/ t of waste). This index has a similar structure like the Cost-Benefit Ratio, i.e. it is a ratio between discounted costs and discounted benefits. It takes into account: operation and maintenance costs, a lifetime of an investment and profile of an ecological effect. Furthermore, the affordability of each scenario was calculated (par. 3.6.2.4 and 3.6.2.5).

A Multi – Criteria Analysis (MCA) was undertaken using the model ELECTRE III, in order to simultaneously analyse the characteristics of the various alternative scenarios through the evaluation and rating of all the different criteria, for the extraction of the optimal solution (par. 3.6.2.6).

Below is presented the comparative assessment of the alternative scenarios, for each of the three calibrations, as occurred after the application of the method ELECTRE III, as well as the final ranking of the scenarios.

Figure 1-4: Results of ELECTRE III model



<u>A Scenario Evaluation:</u> **Equal value of all the groups of criteria**

<u>Evaluation Scenario B:</u> Focus on the technological-economic criteria

<u>Evaluation Scenario C:</u> **Focus-legislative environmental criteria**

Considering all the elements which have been presented in various chapters of the plan namely:

- Requirements of the European and National Legislation regarding waste management and the achievement of targets for prevention and reduction of waste production and recycling in all scenarios
- The characteristics of the treatment and disposal methods
- The detailed presentation and design of projects and alternative management scenarios
- The financial details of alternative management scenarios
- Benchmarking and rating of alternative scenarios,

The recommended Waste Management System for East Region is Scenario S3b (two bin collection system, MRF and MBS plant), including:

Scenario 3b	
Collection	✓ Two Bin Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓ MRF
Treatment of Residual Waste Bin	✓ MBS
Treatment of Green Waste	✓ Windrow composting (open composting)
Treatment at the Source	✓ Home Composting
Products	✓ Compost ✓ Recyclables
Landfill	✓ Residues from MRF Facility and Biostabilization of Residual Waste Bin

The proposed scenario is perfectly applicable, workable and complete in terms of technological options and proposals. The processes included, result in a rational and environmentally sound waste management and the production of high-quality products (recyclables, compost, etc.). These features give it an advantage and promote it as first choice. Regarding the scenario's economic characteristics, the investment cost could be considered high due to the completeness of the proposed technological options, but it is advantageous in terms of operating costs. The grand total cost of the recommended scenario is 1,080,707,902 MKD or 17,563,148€.

Tariff plan

The simplest way to implement PPP is to introduce a full cost recovery waste tariff, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system. However, according to the "Guidance on the methodology for carrying out Cost-Benefit Analysis" Working Document No. 4, when the affordability of tariffs is considered, stakeholder may artificially cap the level of charges to avoid a disproportionate financing burden for the users, thus ensuring that the service or good is affordable also for the most disadvantaged groups. The minimum requirement is that tariffs should at least cover operating and maintenance costs as well as a significant part of the assets' depreciation. An adequate tariff structure should attempt to maximise the project's revenues before public subsidies, while taking affordability into account.

Taking into account the aforementioned for the present project, the tariffs to the users of the project are proposed to be as follows:

i. The tariffs for commercial activities are considered from the first year of operation to be equal to the Dynamic Unit Cost 72€/t (4.448 MKD/t).
ii. The tariffs for households are taken so as to cover the net operating costs of the project 29€/t (1.779MKD/t)

The proposed tariffs for households are given in Annex V – Financial Analysis.

According to the statistical data, the average annual income per household in the country for 2012 is 328.444 MKD. As data for income in the region is not provided, an average annual income per household for the East Region is estimated, considering GDP per capita in East region. GDP per capita for the East Region is 93% of the average country GDP. Based on this assumption, the average annual income per household for East Region is calculated at 305.460MKD (4.964,07 €) and the lowest decile income is calculated at 64.666,62MKD/y (1.050,93€/y).

The value of affordability as % of the average annual income for the 1st year is equal to 0,35% and as % of the lowest decile income is for the 1st year is equal to 1.66%.

It can be argued that calculation of affordability ratio shall be based on average household income, rather than to the average household income of the lowest decile. Indeed, the former gives more representative results for waste management investments. For part of the population (pensioners, farmers, etc) that live on the poverty limits, even the current waste tariffs that practically cover collection service only, are not bearable. For these people, will pose an additional burden. It has to be seriously considered that the municipalities grant exemptions or subsidies to the more vulnerable group of citizens, at the expense of having a modernized waste management that covers the sanitation standards of EU, yet being affordable to the majority of population.

Action Plan

Having set the regional targets and objectives as well as the measures via which these targets will be achieved in the previous paragraphs, an action plan for the proposed interventions is prepared. This plan focuses on the priority measures and the respective main infrastructure investments, but it also gives an indication of all future activities (reinvestment or other activities) that will need to be implemented.

The set of measures for implementation of the plan are:

1. Priority measures for a period of up to three years
2. Short-term measures for a period of up to five years
3. Medium-term measures for a period of six to ten years
4. Long-term measures for a period longer than ten years.

The content of short-term measures addresses the most pressing weaknesses in the existing waste management system, and the need to build a foundation for the future waste management system in the region.

The Action Plan includes sufficient data on whose grounds the level of required investment and reinvestment during different periods, together with estimates of the necessary operating costs can be determined.

The Action Plan may be divided into the following periods:

1. Priority measures for a period of up to three years (2015-2017)

- **1st period 2015 – 2016:** The maturation of the priority projects will take place and the raising of public awareness will commence. Also, a Regional Waste Prevention Program will be elaborated.

- **2nd period 2017 – 2018:** Supply of the main collection equipment i.e. collection vehicles and bins. Initiation of construction of priority infrastructures (landfill for residues cell A, Material recovery Facility, Green Points, Transfer Station, MBS plant), continuation of raising of public awareness campaigns.

2. Short-term measures for a period of up to five years (-2019)

Completion of construction of priority infrastructures (landfill for residues cell A, Material recovery Facility, Green Points, Transfer Station, MBS plant). Review of the Regional Waste Management Plan, implementation of any required additional investments, which may be pending or determined in the revised RWMP, closure and rehabilitation of the non conforming very high-risk landfills and dumpsites. Remediation of existing high-risk landfills and illegal dumpsites in need of medium-term remediation measures according to the remediation plan (i.e. landfills at Lipkovo and Kratovo).

3. Medium-term measures for a period of six to ten years (2020-2024)

Remediation of existing medium-risk landfills and illegal dumpsites in need of long-term remediation measures according to the remediation plan (i.e. landfills at Vinica and Berovo).

4. Long-term measures for a period longer than ten years (-2042).

Substitution of old waste collection, transportation and treatment equipment, review of RWMP, implementation of any required additional investments (according to revised RWMP).

The Action Plan clearly defines the actions, duration and responsibility for implementation, along with the costs of the measures to be implemented. It includes clear and measurable steps for each of task and measure set, presented in tabular form. The following table summarises the necessary actions, which should be taken.

Table 1-7: Action plan for the period 2015 – 2042 – East Region

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
1.	**Priority measures for a period of up to three years (2015-2017)**				
1.1	Maturation of the priority projects (Feasibility Studies, CBA, EIA, environmental permits, application for funding, approval, tendering and contracting)	2015-2016	MoEPP, Inter-municipal Board for Waste Management	1,300,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.2	Supply of collection equipment - recyclables, mixed waste, green waste, home composting	2016-2017	Inter-municipal Board for Waste Management	2,078,920	Cost will be reconsidered during the feasibility study and cost benefit analysis.
1.3	Technical assistance & supervision during implementation	2017-2018	Inter-municipal Board for Waste Management	1,500,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.4	Construction of integrated waste management infrastructure (Material Recycling Facility for recyclables, biostabilization plant for residuals, landfill cell A for residues, transfer station, green points)	2017-2018	Inter-municipal Board for Waste Management, with the municipalities	13,584,228 (Land acquisition – 425,204)	Cost will be reconsidered during the feasibility study and cost benefit analysis.

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
2.	**Short-term measures for a period of up to five years (-2019)**				
1.3	Technical assistance & supervision during implementation	2017-2018	Inter-municipal Board for Waste Management	1,500,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.4	Construction of integrated waste management infrastructure (Material Recycling Facility for recyclables, biostabilization plant for residuals, landfill cell A for residues, transfer station, green points)	2017-2018	Inter-municipal Board for Waste Management, with the municipalities	13,584,228 (Land acquisition – 425,204)	Cost will be reconsidered during the feasibility study and cost benefit analysis.
2.1	Raising of public awareness campaigns on waste management and common campaigns on waste prevention and waste management	2015-2019	MoEPP and Inter-municipal Board for Waste Management	170,000	Promoting an information, awareness-raising and motivation system for the public and all relevant stakeholders. The cost depends on the strategy and means of the public awareness campaign.
2.2	Implementation of bundle of waste prevention measures, including sector specific awareness campaigns that are not included in 2.1	2015 - 2019	MoEPP and Inter-municipal Board for Waste Management		The cost depends on the strategy applied at municipal or regional level and the means of the awareness campaign
2.3	Promotion of establishment of repair / reuse centres and public awareness activities to promote repair/remanufacture	2018-2019	MoEPP and Inter-municipal Board for Waste Management		The cost depends on various elements, i.e. the ownership of the repair/reuse centers (public/private) or the strategy applied at municipal or regional level and the means of the awareness campaign
2.4	Review of the Regional Waste Management Plan	Every two years	MoEPP and Inter-municipal Board for Waste Management	N/A	
2.5	Remediation of existing very high-risk landfills and dumpsites	2017-2018	MoEPPInter-municipal Board for Waste Management	2,810,560	Depends on approval of application or funding. The closure of the landfill is closely connected to the starting of operation of the transfer station and central landfill. Cost will be reconsidered during the feasibility study and cost benefit analysis.
2.6	Remediation of existing high-risk landfills and dumpsites	2018-2019	MoEPP and Inter-municipal Board for Waste Management	270,760	Cost will be reconsidered during the detailed design study.
2.7	Remediation of existing medium-risk landfills and dumpsites	2018-2019	MoEPP and Inter-municipal Board for Waste	162,240	Cost will be reconsidered during the detailed design study.

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
			Management		
3.	**Medium-term measures for a period of six to ten years (2020-2024)**				
3.1	Review of the Regional Waste Management Plan	Every two years	MoEPP and Inter-municipal Board for Waste Management	N/A	Implementation of any add\itionally required measures according to the review of the RWMP
3.2	Construction of landfill cell B in for residues	2024	MoEPP and Inter-municipal Board for Waste Management	TBA	Cost will be reconsidered during the feasibility study and cost benefit analysis.
4.	**Long-term measures for a period longer than ten years (-2042)**				
4.1	Reinvestment - substitution of collection equipment and transfer station	2027	Inter-municipal Board for Waste Management	2,126,352 (collection equipment), 400,000 (transfer station)	Cost will be reconsidered during the detailed design study.
4.2	Reinvestment - substitution of treatment equipment (plant and machinery)	2031	Inter-municipal Board for Waste Management	4,143,828	Cost will be reconsidered during the detailed design study.
4.3	Reinvestment - substitution of collection equipment and transfer station	2036	Inter-municipal Board for Waste Management	2,126,352 (collection equipment), 400,000 (transfer station)	Cost will be reconsidered during the detailed design study.
4.4	Construction of landfill cell C for residues	2032	MoEPP and Inter-municipal Board for Waste Management	TBA	Cost will be reconsidered during the feasibility study and cost benefit analysis.

Procurement plan

The appropriate set of steps in indicative procurement sequence for a waste management scheme, which sets out the milestones within the procurement process, is presented below:

⇨ **SPECIFICATIONS**

Requirements must be specified, avoiding brand names and other references, which would have the effect of favouring or eliminating particular providers, products or services. The Regulations now make it clear that authorities may use performance specifications rather than technical specifications. They also provide clarification on the scope to reflect environmental issues in specifications.

⇨ **SELECTION**

Rejection or selection of candidates based on:

- Evidence that they are not unsuitable on certain grounds, e.g. of bankruptcy, criminal conviction or failure to pay taxes. Certain offences now require, in normal circumstances, a mandatory exclusion;
- Economic and financial standing e.g. that they are judged to be financially sound on the basis of their annual accounts;
- Technical capacity, e.g. that they will be adequately equipped to do the job and that their track record is satisfactory.

⇨ **AWARD**

The award of contracts is either on the basis of 'lowest price' or various criteria for determining which offer is 'the most economically advantageous' to the purchaser. This is in keeping with the Government's Procurement Policy that all public procurement must be based on Value for Money (defined as the optimum combination of whole-life cost and quality to meet the user's requirement).

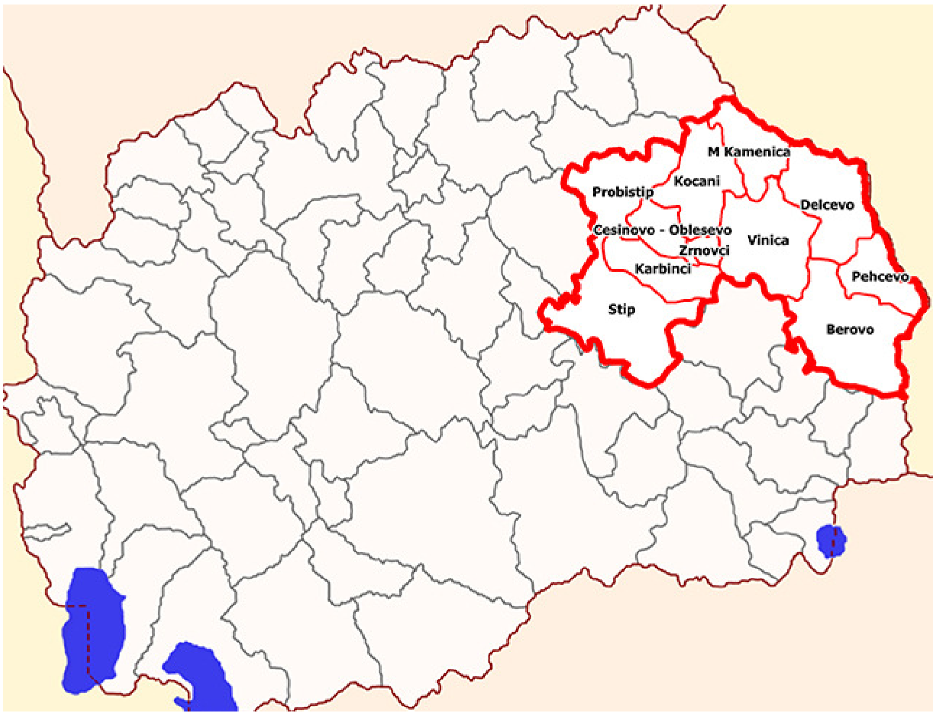
2. DESCRIPTION OF WASTE MANAGEMENT REGION

2.1 GEOGRAPHICAL LOCATION

The East Region is located in the eastern part of the country and it borders Bulgaria. Internally, it borders the Vardar, Skopje, Northeastern, and Southeastern regions. East Region is divided into eleven municipalities:

1. Berovo
2. Češinovo-Obleševo
3. Delčevo
4. Karbinci
5. Kočani
6. Makedonska Kamenica
7. Pehčevo
8. Probištip
9. Štip
10. Vinica
11. Zrnovci

Figure 2-1: Municipalities of East region



The East region is a predominantly mountainous region and covers the far east of the Former Yugoslav Republic of Macedonia. It spreads along the Bregalnica River, over the basins of Shtip, Maleshevo and Pijanec and the field of Kochani.

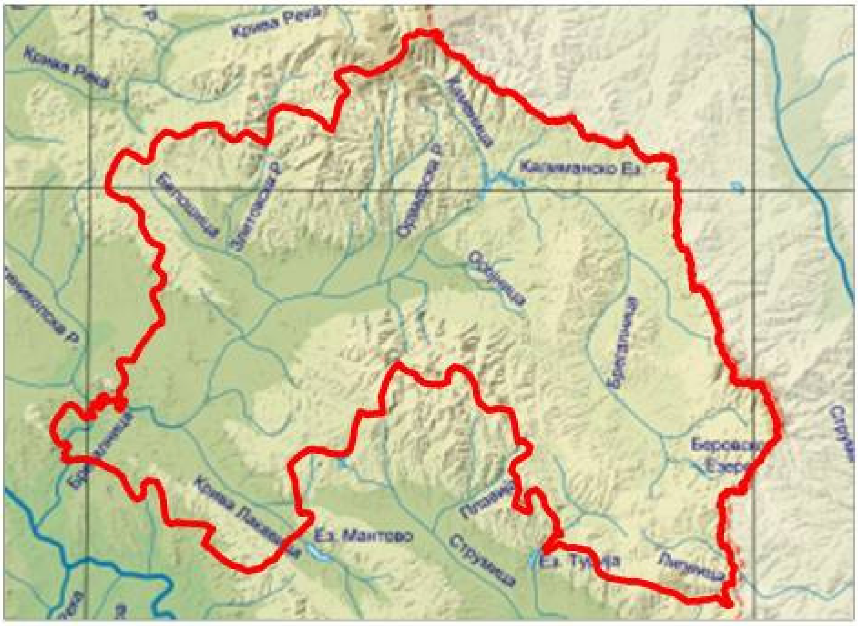
The current population of the Eastern Statistical Region is 181,858 citizens or 9.0% of the total population of the country, according to the last population census in 2002. The population density is 51/km^2 (129/sq mi). The East region has an area of ~4,177 km^2 with an urban population of 119,863 and a rural population of 83,296.

2.2 TOPOGRAPHY

The wider region, as well as the area in our focus, belongs to two major geotectonic units, the Serbian-Macedonian massif and the Vardar zone. The Crna Skala-Vinica section is mostly on hilly and mountainous terrain, then passes through mild and flat areas, mildly hilly and hilly terrains.

Figure 2-2: Relief of East region (elevation profile)

Figure 2-3: Relief of East region



The terrain comprises of high hills and deep dales and dry gorges with protruding elevations with steep faces towards streams and dry gorges. The Vinica-Stip section stretches mainly through Kocansko Pole and in certain parts through hilly terrain, then passes through the Kocani leveled depression from the height of 325 to 416 metres above sea level. The majority of the course is flat-hilly terrain with occasional valleys and ravines.

The Otovica-Kadrifakovo section is mainly on flat terrain – the Ovce Pole depression, which features mild slopes and no significant breaks in the terrain. Part of the Kadrifakovo-Otovica section passes through the Ovce Pole plain with slight elevations in the parts with Eocene sediments and Pliocene sediments.

The projected route avoids the surrounding elevations (hillocks). The terrain near Stip is slightly rolling.

2.3 CLIMATE

For the former Yugoslavian Republic of Macedonia the most important climate factors are the geographical position, the relief, the distance of the nearby seas and the atmospheric currents.

The former Yugoslav Republic of Macedonia is in the temperate climate zone and is closer to the Equator than the North Pole. That is why it receives sufficient heat for growth of the flora and fauna throughout most of the year. Due to its position, in the former Yugoslav Republic of Macedonia there are four distinct seasons. The summer is from 22 June to 23 September and the winter from 22 December to 21 March.

The vicinity of the Aegean Sea of only 60 km and the Adriatic Sea of 80 km greatly influences the climate in the former Yugoslav Republic of Macedonia. It is especially noticeable in the valleys of the rivers Vardar and Strumica and to a lesser extent Crn Drim, where warm and wet air masses penetrate. Apart from the seas the climate in the country is also influenced by the Atlantic Ocean, from where wet air masses penetrate especially in spring and autumn.

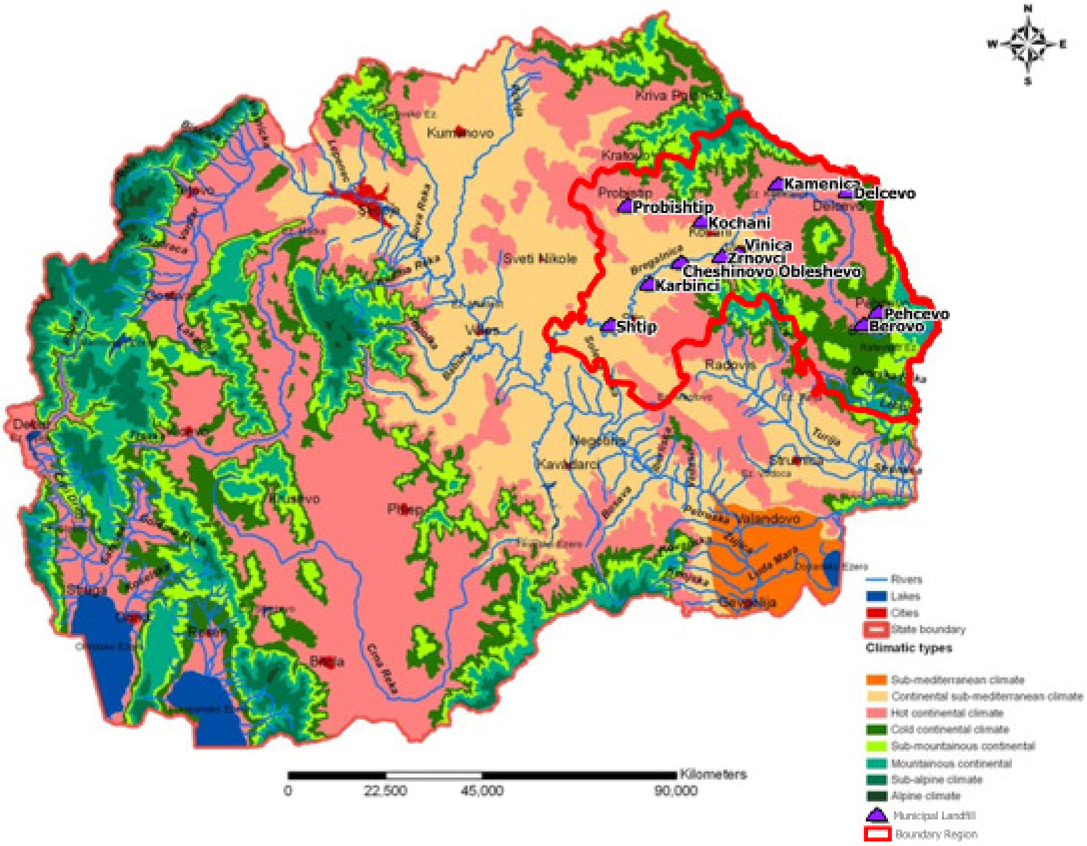
The relief with its elevation and position significantly affects the climate in the country. The high mountains in the western and southern parts of the former Yugoslav Republic of Macedonia prevent the warm and wet sea fronts to penetrate deeply into the interior. Their penetration is possible only through the valleys of the rivers Vardar, Strumica and Crn Drim. On the other hand, the moderately high mountains and the wide valleys in the north part allow for cold air masses to penetrate from the north. That is why in the winter even in the southern-most parts of the country the temperatures can be very low. In addition to the mountains, the valleys also have a significant influence. Some valleys are surrounded by mountains on all sides so in the winter their lowest areas can get very cold. Other valleys are filled with lakes which do not allow the surrounding air to get too warm in the summer or too cold in the winter.

Temperate-continental climate with some minor Mediterranean influences is found in the Vardar valley, from Demir Kapija in the south to Skopje and Kumanovo in the north, then along the Bregalnica River to Kocani in the east and Crna Reka to Mariovo in the west. Here winter ice is a frequent occurrence. The temperature can drop even below 20°C, while in the summer it can reach up to 45°C. Judging by the average rainfall of only 400-500 mm/y, this area is one of the poorest in Europe, thus having the appearance of a steppe and semi-desert. It is interesting to note that in the Vardar valley there are strong winds, especially in Ovce Pole and near Demir Kapija, and because of this wind-powered plants are planned for construction.

The Delcevo valley has a typical **temperate-continental climate,** with cold winters and very hot summers. Here there is slightly more rainfall (around 600 mm), however it is still insufficient and adversely spread throughout the year. The higher valleys (Kriva Palanka, Berovo) have **continental climate,** with cold winters (up to -32°C) and cool summers (up to 35°C) and not very strong winds.

The high mountain areas have a harsh **Alpine climate,** cold winters and summers, with average annual temperatures of around 0°C and rainfall of around 1000-1200 mm, during the winter in the form of snow. The snow typically stays from November to May and at the highest shaded sides until August.

Figure 2-4: Climate in East region



2.4 GEOLOGY

The region has the following geological features:

Two-mica banded gneisses – GMB: The gneisses are the most widespread varieties of Precambrian creations and cover the greatest surface compared to the other members of this complex. Because of that they can be considered as the basic rocks of the highly metamorphic complex of the given area, while the other metamorphic rocks of Precambrian age are only minor facial transitions. Together with the leptinoliths and the mica-schists they create a gradual transition or appear in them as lenses and bands. The younger creations from Riphean Cambrian are in the form of thrusts or nappe.

Mica-schists – Sm: these rocks cover an important area in the region. They lie above the two-mica banded gneisses. They are characterized with retrograde metamorphism, while rarely they are ridged. In the entire area the mica-schists have a strongly pronounced schistosity with brownish yellow colour.

East of the Orizarska river they appear as a lithological homogenous mass, with grey-silver colour, big mica with schistose structure and granolepidoblastic structure.

Lepticollites and mica-schists-SmG: these rocks are mostly found in the area of the villages of Istibanje, Preseka and Vinica and along the road to Stip.

Quartz-chlorite-sericitic schists –Sco: in the Crna Skala-Vinica section these rocks comprise the central part of the terrain, in the direction NW-SE. In the Kadnica region the quartz-chlorite-sericitic schists facially alternate with epidote-chlorite-amphibolic schists.

In the Crna Skala-Vinica section feldspathised chlorite-muscovite schists – Scom: they can be found in a narrow area in the direction of N-S, as rocks with light blue colour and sheet-like appearance which are quite similar to gneiss. In the western area, more precisely towards the orthogneisses the layer is quite sharp, while with the quartz-chlorite-sericitic schists it is gradual and alternates laterally. Microscopically these rocks are quite schisted and small-granulated.

Paleozoic (Pz)

Orthogneisses-G*:* They were found east of inundated granite porphyry near the village of Kamenica and stretch south to the Laki River. They are very firm, compact yellow rocks. They are medium-granulated, have a schistic texture and fresh appearance. Their structure is granoblastic to porfyroblastic, in places cataclastic.

Phyllites and quartz-sericitic schists-FS: These schists were found as bands on the biotitic coarse-granulated granites in the direction of N-S. They are dark grey in colour with a phyllitic appearance. The dark grey are split into thin sheets and mica, while in the contact area with the granite they are quite firm and quartz-like.

Granodiorites, Aplites - δγ, ϕ: granodioritic rocks are frequently found in this area in the form of great masses. They mainly look like volcanogenic creations from the Riphean-Cambrian. Smaller masses of these rocks can be found near the village of Blatec and in the lower reaches of Sirava river, where they breach through the two-mica banded gneisses. They are compact, hard and locally crushed rocks with somewhat smaller granules and the structure of coarse-foliated biotitic granites. They range from blue-yellow to blue-green in colour. They are leucocratic to mesocratic. Their structure is allotriomorphic to hypidiomorphic granular.

Quartz diorites – δ: These rocks cover a small area compared to the other granitoids and appear in the area of Delcevo. Macroscopically they are light grey to dark grey, compact, medium granular rocks and they do not differ from the granodiorites.

Aplithoide granites – γ: These rocks are found in two types, as massif and in filaments. It they are in the form of filaments their thickness is from 5 cm to 2 m. These rocks are the most acidic differentiation of a granitoid massif. They have small granules with light grey to yellowish-pink colour, hard, but mechanically quite crushed rocks. Frequently in the cracks there are crusts of Fe and Mn oxides.

Medium granular leucocratic granites – γ: these granites appear in the area of the village of Bigla, where gradual transition from large granular biotitic granites can be clearly noticed. They have clear medium granular to small granular structure and rapid reduction of the biotite. They are fresh and massive with light yellow and white colour, in some places with minor schists. Their structure is allotriomorphic to hypidiomorphic granular.

Triassic – T1, T2

The Triassic sediments in the research area were defined as lower and middle Triassic period. These sediments are present as red quartz sandstone and conglomerates, as well as dark grey limestone that are layered and mylonitized. The lower Triassic sediments are found SE from Delcevo towards the state border with the Republic of Bulgaria. They are built of red quartz sandstone and conglomerates. These creations are tectonically spread over the green rocks or granites, as well as over the paleogenic creations and quartz-latite breaches. In certain cases they appear as a bed of medium Triassic limestone. The conglomerates are made of boulders of quartz, granites and grandiorites as well as pieces of volcanic rocks. The sandstone is comprised of fine grains of quartz, while the sandy shale consists of quartz and mica with a matrix of loamy cement.

Paleogene

The Paleogenic creations are represented with the upper Eocene in the Delcevo-Pehcevo trench and the area around Vinica, Kocani and Stip. According to their litholytic features and the superposition of the layers, the following litholytic members are noticed: conglomerates, sandstone, shale, marl and gravel.

Congolomerates – E3: they are the basal part of the upper Eocene. This facies was discovered in the area between the villages of Gabrovo and Zvegor. It is built of conglomerates and breccia which alternate with thinner layers of sandstone, shale and marl. Their thickness is around 100 m. The lithological composition of the conglomerates is heterogenic. They are composed of boulders of Triassic limestone, with less granite, gabbro, green schists and diabases.

Flysch facies – SE3: in this lithological series there were various lithological members represented by yellow sandstone with rare intercalation of aleurolite shale and alternate micro-conglomerates with poorly pronounced gradation. They are most frequently found NE of Delcevo, towards Golak mountain. The sandstone is the most frequent lithological member. There are varieties of big to medium granular, thick between 30 and 150 cm. The lithological vertical changes are very frequent, with rhythmic changes of yellowish medium grain to small grain aleurolite shale. Occasionally there are yellow banked sandstone and parts of macro-conglomerates. In the finely granulated sediments, which are usually loamier, there is some poorly pronounced horizontal lamination with alternate dark and light laminas, thick between 2 and 5 mm. The conglomerates as well as the micro-conglomerates appear in some places in its middle and final part.

They are composed of different fragments, mostly quartzite and boulders of rounded sandstones, fragments of grandioritic rocks, schists, etc. which are unequally distributed. The cement is sandy-loamy. The aleurolites are dark-leafed.

Eocenic flysch sediments (4E3): they are separated as flysch rocky masses from the Paleogene, prevalent north and north-east of Stip. They are a series of sandy shale, marl and sandstones, which alternate vertically.

The sandy shale and marl are dominant and they appear layered in the form of plates of “m” size. There are thinner ones, when they appear between two layers of sandstone. They are most often grey to green-grey.

The sandstone is small to medium granulated with a carbonate cement matrix. They are usually in the form of plates, rarely banked. The flysch sediments in the Stip area are around 1,500 m thick.

The quartz latite as important volcanic breaches are present in the Delcevo area, while in the other areas they are just an occurrence. It is clearly determined that they breach the Riphean-Cambrian volcanogenic sedimentary and paleogenic creations, while the Triassic sediments are layered over them, and the Pliocene is transgressive in the form of big breaches, with a sharp conical shape. Their colour is light grey, blue-grey, grey-green and very rarely light pink. They are composed of the following minerals: sanidine, plagioclase, quartz, amphibole and biotite. The structure of these rocks is holocrystalline porphyry. The basic mass is always crystalized and with the same components as the phenocrysts.

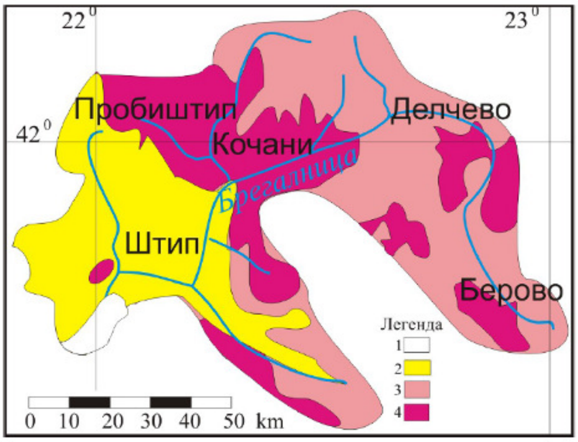
Facies of clays and sands – P: these sediments cover the largest surface. This development is found in the area of the villages of Gabrovo, Zvegor, Stamer, then in the Pehcevo-Berovo valley and the Kocani-Vinica trench. In the series there are blue-green, slightly sandy clays, then multicoloured kaolinized clays with intercalation of bitumen and clays, carbonic clay, marly clays and sands. All these lithological members alternate both horizontally and vertically. The dark grey clays contain prints from flora.

Gravels and sands – Pl: this lithological composition is typical for the upper reaches of the Pliocene deposits, which are made of large granule gravel, locally cemented in conglomerates with sand and sandy clay. They are most frequently found in the Delcevo area and beyond, locally in the entire region. These sediments are the final horizon of the Pliocenic lake sediments in the Delcevo-Pehcevo trench and the Kocani-Vinica trench.

Quaternary (Q)

It is represented with proluvial (pr), diluvial (d) and alluvial sediments, developed along the route. The biggest part of the route passes through the Quarternary sediments – mainly Proluvial sediments that are composed of silt-sandy clay, loamy sand and gravel with poorly processed and unprocessed pieces from the original rocky masses, strengthened with clay soil and sandy soil. Their thickness varies from several metres to 30 m, composed of semi-processed pieces from the surrounding hills mixed with sand and large percentage of loamy substance. The diluvial sediments (d) are irregularly positioned in the areas with mild slopes and in a small area along the route. Along the major rivers (Sveti Nikola River, Bela Voda) and the minor rivers there are alluvial sediments (al) on the contemporary river terraces (various sands and gravel with silty clay).

Figure 2-5: Geological Map of the Bregalnica river basin



Source: Analysis and modeling of hydrological processes in the Bregalnica river basin, 2007

(1.Quarternary; 2. Tertiary; 3. Proterozoic; 4. Magmatic rocks)

2.5 HYDROGEOLOGICAL FEATURES

From a hydrogeological aspect, the Crna Skala-Vinica section consists of terrains with different water permeability. According to the geological structure of the terrain, there is a type of aquifer with a free level formed in areas with intergranular porosity, i.e. in the quarternary and the Pliocene. In the Eocene sediments the materials are hydrogeological complexes in which there are separate layers for hydrogeological collection and insulation. The diffuse aquifers are formed in the granites and the gneisses. They are poor water permeable and the formed aquifers are not abundant, usually 0.1 to 1.0 /sec.

In depths these rocky masses are more compact, on the surface there are some crevices and in that part they have the function of hydrogeological collectors, while in the depth they are hydrogeological insulators. As conditional waterless terrains in the research area, are the tightly linked semi-petrified rocky masses represented by the Eocene sediments. As part of the distinctive types of aquifers, from the aspect of the regime of groundwater (replenishment, movement of groundwater, depletion and level of groundwater), we can conclude that from the geological structure of the terrain, the main factor for the formation of aquifers are the permanent and the occasional rivers and streams as well as the atmospheric precipitation (rain, snow), which are the main source of replenishment for the aquifers.

The rocky masses along the route of the Vinica – Stip section by their hydrogeological function are characterized as typical h. g. collectors, relative h. g. insulators and hydrogeological insulators.

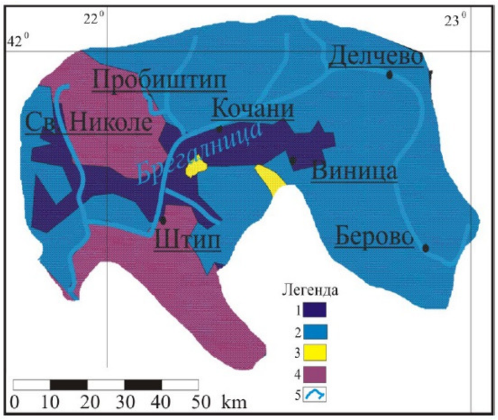
The main hydrological feature in this terrain, along the entire length of Kocansko Pole, is the Bregalnica river with its left tributaries: Pekljanska, Osojnica, Zrnovska, Kozjacka and its right tributaries: Orizarska, Kocanska and Zletovska rivers.

In dry periods of the year it is possible for their watercourses to reduce the flowing water while some dry up occasionally. The other ravines were waterless during the plotting. This shows that along the course of the Bregalnica river and its tributaries there are the typical geological preconditions for an aquifer zone to be formed.

According to the structural type of porosity of the rocks in the Bregalnica river basin, there are four types of aquifers :

- Compact type of aquifers;
- Fissure type of aquifers;
- Karst type of aquifers;
- Terrains with poor well yield and waterless terrains.

Figure 2-6: Hydrogeological map of the Bregalnica river basin



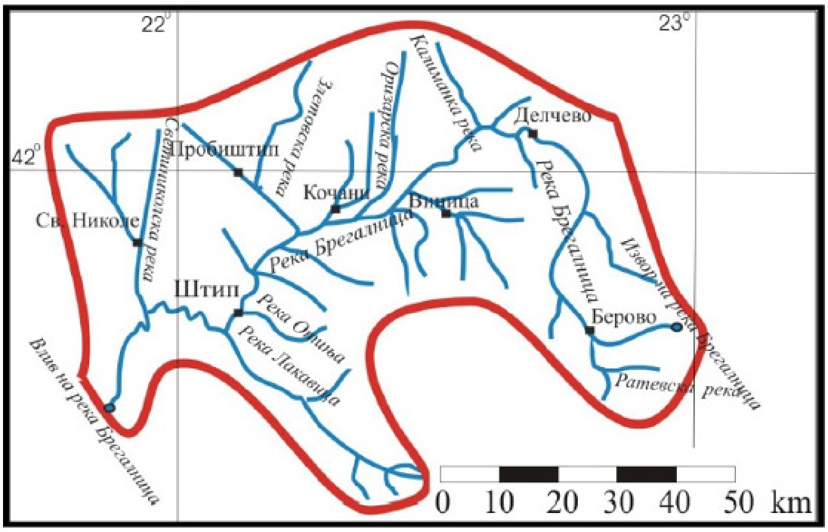
Source: Analysis and modeling of hydrological processes in the Bregalnica river basin, 2007

(1 – Compact type of aquifers (Q = 1-10 l/s); 2 – Fissure type of aquifers (Q = 1-10 l/s); 3 – Karst type of aquifers (Q = 1-10 l/s); 4 – Terrains with poor well yield and waterless terrains (Q = 0.1-1 l/s))

2.6 HYDROLOGY

In the hydrographic network of the Bregalnica river basin the eastern part is distinctive with rivers that have permanent and torrential flow. The following are some of the major rivers: Zelevica, Ratevska, Osojnica, Smiljanska, Blatecka, Gradeska, Grabrovska and Suha. Of these, Bregalnica and Ratevska rivers are the richest in water and that is why they are used as accumulation systems for electric power (the Kalimanci and the Ratevska dams).

Figure 2-7: Hydrographic network of the Bregalnica river basin



Source: Analysis and modelling of the hydrological processes in the Bregalnica river basin, 2007

With its length **Bregalnica** is the biggest tributary of Vardar. It rises below the Cengino Kale peak in the Malesevo Mountains at an elevation of 1,720 m, and it flows into Vardar between the villages of Nogaevci and Uljanci, at an elevation of 137 m. The average water flow at the confluence is 28 m^3/s (maximum water flow 640 m^3/s, while when the water flow is minimal the riverbed is dry). Its total length is 225 km, confluence area of 4.307 km ^{2} and a relative average slope of 7%. After flowing down the Malesevo Mountains, where Bregalnica has a very developed catchment area, it flows through the Berovo valley where it is quite wide and slow, and accumulates significant fluvial material. At the village of Budinarci the valley is 500-600 m wide, while from the village of Razlovci it enters the gorge part of the 19.1 km long Razlovci gorge. In the gorge there are certain erosive extensions, such as the one near the v. Mitrasinci. After the Razlovci gorge Bregalnica flows through Delcevsko Pole, where it deposits a significant amount of gravel and sand, due to which in certain sections the course of the river is split into several branches. The upper reaches of Bregalnica are in Pijanec and Males. Here it flows from south to north in a meridian direction. From the confluence of Ocipalska river to the v. Istibanja, in other words up to the entrance of the Kocani valley and further on to the confluence into Vardar, Bregalnica flows from east to west in a parallel direction. Through the Isitbanja gorge Bregalnica flows for 39 km. The Kalimanci lake was made there, used for the irrigation of around 28,000 ha farmland in Kocansko and Ovce Pole.

Bregalnica enters the Kocani Valley at the village of Istibanja and flows almost through the middle of it, and leaves it at the village of Krupiste, where to the west a short river gorge is made. At the bottom of the valley Bregalnica is a plain-type river with an average slope of only 1.8%. Flooded by the deposits and the downpours the riverbed is shallow and unstable, because of which the river frequently overflows.

From the Stip river gorge to the confluence in Vardar Bregalnica flows through young Paleogene and Neogene sediments and the riverbed is meandering. This is the Slan Dol area.

In its course Bregalnica has 23 tributaries that are longer than 10 km. On the right hand-side there are 10 tributaries with a total length of 241 km, while on the left hand-side 13 tributaries with a total length of 260 km. The valleys of all tributaries, unlike the Bregalnica valley which is polygenetic, are monogenetic. They developed as tributaries of individual lake basins and with the flowing out of the lake their waters become tributaries of Bregalnica. In the mountain areas their valleys are deep and in the shape of the letter V. Cutting into the former lake basins their valleys were extended, while the valley slopes decreased. Today they usually have symmetrical valley slopes.

Some of the right side tributaries of Bregalnica

Orizarska River or Masalnica – springs below Carev Vrv in Osogovo at an elevation of 1.510 m and flows into Bregalnica above the village of Mojanci at an elevation of 320 m. It is 30 km long and is made up of Bela and Crna river which merge near the village of Recani. It covers a confluence area of 198 m² and has a relative slope of 39.5%.

Kocanska River – It springs on the south side of Lopensko Bilo on Osogovo at an elevation of 1630 m and flows into Bregalnica above the village of Ciflik at 295 m above sea level. It has a developed catchment area and its main tributary is Mala river; at their confluence the Gratce accumulation was made. It is 34 km long, has a confluence area of 198 m² and a relative slope of 39.3%.

Zletovska River – it springs on the north side of Lopensko Bilo on Osogovo at an elevation of 1620 m and flows into Bregalnica below the village of Ularci at 293 m above sea level. It is 50 km long and has several tributaries of which the longest is the river of Belasica. It covers a confluence area of 460 km² and has a relative slope of 26.5%0. Zletvoska River has 35 major and minor tributaries, of which Venecka river is the biggest. Zletovska River is between the mouth of its left side tributaries: *Emiricka River* and *Esterec.* This locality is important because of the deeply cut river valley with a gorge-like and in some place canyon-like appearance.

Some of the left side tributaries of Bregalnica

Osojnica- It springs from Strumicki Rid on Plackovica at an elevation of 1,260 m and flows into Bregalnica below the village of Jakimovo at 345 m above sea level. It is 32 km long, covers a confluence area of 327 km² and has a relative slope of 28.6%0. It has a developed catchment area which is comprised of several rivers such as Kalugerica, Laki and Barbosnica, and later on it has several tributaries such as Susica, Dragobraska and Blatesnica. The waters of the Osojnica river and its tributaries are used for irrigation of the tobacco and rice fields in the Vinica region. The running waters of Osojnica, Gradecka and Vinicka rivers irrigate 210 ha of fertile land. A total of 1,140 ha are irrigated.

Gradeska River – it springs in the north slopes of the Kozbran peak in Bacalija on Plackovica at an elevation of 1,420 m and at first flows west under the name of Ulomija and then turns north under the name of Zrnovska River and flows into Bregalnica immediately by the Kocani-Zrnovci road at 325 m above sea level. It is 23 km long, covers a confluence area of 70 km² and has a relative slope of 47.6%0. Until the village of Zrnovci it is a mountain river with a gorge-like valley, and further on through the plains it is a plain river. It flows right next to the Kocani-Zrnovci road, at 325 m above sea level. The river is used for irrigation of 250 hectares under maize, leeks and other crops.

Kozjak - It springs below the Jajla peak on Plackovica at an elevation of 960 m and flows into Bregalnica at the village of Karbinci at 280 m above sea level. It is 22 km long, has a confluence area of 60 km² and a relative slope of 30%0.

Suva River – It springs in the area of Jurukluk on Plackovica at an elevation of 820 m and flows into Bregalnica near the village of Dolni Balvan at 276 m above sea level. It covers a confluence area of 70 km² and has a relative slope of 23.6%0.

Radanjska River is a short (19.8 km) left tributary of Bregalnica and its confluence area stretches SE-NW on 62.8 km². The Radanjska River watercourse is known under that name downriver from the village of Radanje. Upriver to the village of Golem Gaver it is called Suvi Potok, while at the springs it is called Kuri Dere.

The rivers Kozjacka (annual water flow of 0.28 m³/sec), Argulicks (annual water flow of 0.102 m³/sec) and Radanjska (annual water flow of 0.10 m³/sec) have a small average water flow and only partially meet the needs of the regions where they pass through. The river courses are not regulated during their entire length and during torrential rains the rivers overflow.

Table 2-1: Confluence area, length, average slope and river afforestation

River	Confluence area in km²	Length in km	Average slope	Afforestation in %
Kocanska River	198.0	34.0	39.3%0	45
Orizarska River	137.0	30.0	39.5%0	50
Voltinje	28.5	7.5		5
Vrbicka River	21.0	12.0		0
Zletovska River	460.0	50.0		25
Zrnovska River	70.0	23.0	47.6%0	60
Morodvisna River	7.0	6.0		90
Vidoviska River	5.0	6.0		85
Bregalnica	4307.0	225.0	7.0%0	-

Significant water measuring gauges on the Bregalnica river are Oci Pale and Stip.

Table 2-2: Average water flow at water measuring gauges

River	Gauge	Confluence km²	Typical average water flow m³/sec							
			Qcp	Qcp 75%	Qcp 98%	Qsr VEG	Qcez	Spec. Flow ql/km²	Qmin	Qmin 90%
Bregalnica	Oci Pale	845.6	5.02	3.62	2.0	4.0	1.68	5.9	0.07	0.11
Bregalnica	Stip	2490.0	12.21	8.32	3.48	10.2	5.31	4.1	0.36	0.45

Caption:
Qcp – average annual water flow
Qcp75% - average water flow in 75% dry year
Qcp98% - average water flow in 98%
QsrVEG – average water flow in veget. season IV-IX
Qcez – average water flow in critical season VII-X.
Qmin- absolute minimum water flow
Qmin90% - minimum water flow with 10% occurrence

Table 2-3: Review of minimum, monthly average and maximum water flow for the 1961-2005 period on the Bregalnica river with a confluence area of 2940.0 km², hydrological station – Stip, 257.93 m.

ordinal number	calendar year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Qmin m³/s
Qmin 1961-2005		0.730	1.150	1.510	0.480	0.032	0.376	0.080	0.032	0.032	0.339	0.400	0.510	0.032
Qcp 1961-2005		12.826	18.797	18.913	18.615	13.346	8.814	4.799	4.056	5.196	5.641	7.948	11.181	11.271
Qmax 1961-2005		226.0	337.0	305.0	344.0	330.0	155.0	138.00	69.5	88.8	168.0	260.00	203.00	344.0

Table 2-4: Review of minimum, monthly average and maximum water flow for the 1961-2005 period on the Osojnica river with a confluence area of 73.30 km², hydrological station – Laki, 650 m.

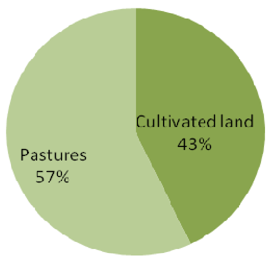
ordinal	calendar													Qmax
number	year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	m^3/s
Qmin 1961-2005		0.096	0.072	0.072	0.143	0.143	0.096	0.056	0.072	0.064	0.064	0.010	0.088	0.010
Qcp 1961-2005		1.128	1.458	1.408	1.515	1.129	0.734	0.419	0.279	0.241	0.395	0.606	0.980	0.876
Qmax 1961-2005		13.6	39.5	18.1	9.1	9.6	24.2	7.3	3.8	3.2	7.0	9.7	67.00	67.0

2.7 LAND USE

The natural, geographical, climate and hydrological characteristics give the potential for production of rice, especially in the Kochani Field, which is well renowned for its rice. The basins of Pijanec and Maleshevo are favorable for growing fruits and vegetables. The most abundant is wheat, followed by potatoes, maize, alfalfa and tomatoes. Due to the specific geological characteristics of mountain ranges, the region has a developed lead and zinc mining industry. Another important industry is the textile industry and a large number of textile manufacturing plants are located in this region. The mountainous terrains in the region have great potential for development of winter and alternative tourism even though they are still in the early stages of development[1].

The agricultural land includes areas used for agricultural production: arable land and pastures. There is considerable stability, without major differences from year to year. Pastures are areas used for grazing. They comprise the majority of the agricultural land, including the pastures on hills and mountains and lowlands.

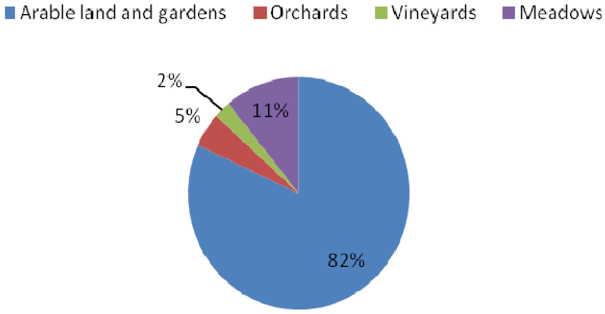
Figure 2-8: Structure of agricultural area in % - East Region, 2012



(Source: State Statistical Office (2013) "Regions of the Republic of Macedonia, 2013)

[1] State Statistical Office (2013) "Regions of the Republic of Macedonia, 2013" (http://www.stat.gov.mk/PrikaziPublikacija_1_en.aspx?rbr=411)

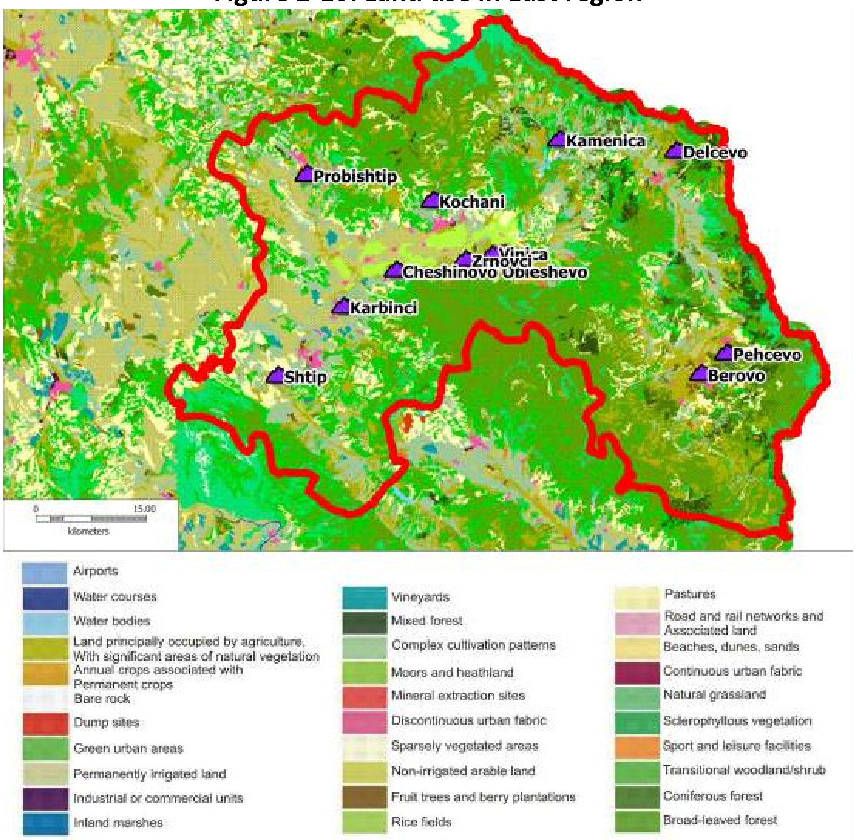
Figure 2-9: Cultivated land by categories in % - East Region, 2012



(Source: State Statistical Office (2013) "Regions of the Republic of Macedonia, 2013)

The land use in the "East" region according to CORINE Land Cover for the 2000-2006 period is shown in the following figure.

Figure 2-10: Land use in East region

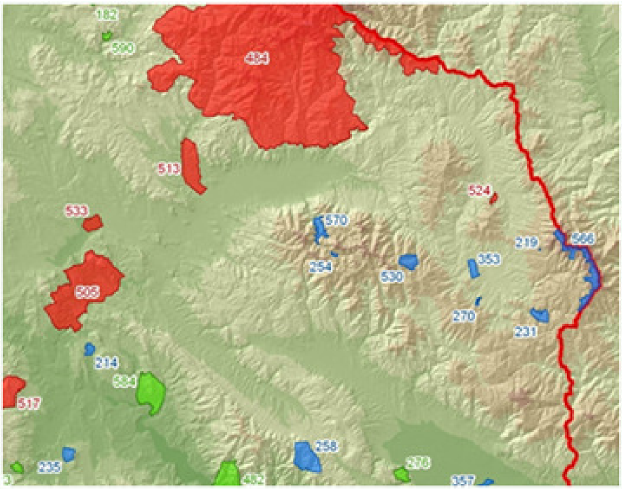


(Source: Ministry of Environment and Physical Planning)

2.8 PROTECTED AREAS

There are no protected areas is East region of the country. However, there are 11 areas important for nature protection and these were proposed for protection in the national system of protected areas. The proposed protected areas Osogovo, Lower Bregalnica, and river Lomija are shared between the East region and other NUTS regions.

Figure 2-11: National system of protected areas in the East region



(Green - protected areas; Blue - proposed areas for protection according to the Spatial Plan of RM; Red - Newly proposed areas for protection (Brajanoska et al. 2011[2])

484 - Osogovo Mountains (Protected Landscape); 513 Lower Zletovica/Dolna Zletovica (Protected Landscape); 505 - Lower Bregalnica/Dolna Bregalnica (Monument of Nature); 570 - Zrnovska Reka (Nature Park); 254 - Reka Lomija (Nature Park); 530 - Kartal (Nature Park); 270 - Temniot Andak (Nature Park); 231 - Berovsko Ezero (Protected landscape); 353 - Machevo (Monument of Nature); 219 - Judovi Livadi (Nature Park); 524 - Kukuljeto (Monument of Nature); 566 - Maleshevski Planini (Nature Park).

Table 2-5: National system of protected areas in the East region

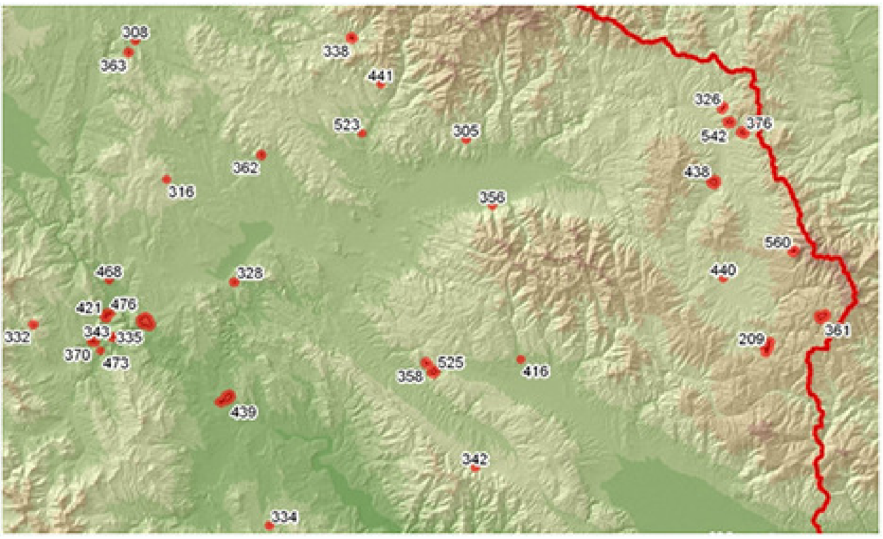
Code	Macedonian Name	English Name	Protected area category	Surface (ha)
231	Беровско Езеро	Lake Berovo	PL	428.17
570	Зрновска Река	River Zrnovska Reka	PN	484.84
219	Јудови Ливади	Judovi Livadi	PN	5.67
530	Картал	Kartal	PN	592.79
566	Малешевски Планини	Maleshevski Planini	PN	1753.16
353	Мачево	Machevo	NM	360.47
270	Темниот Андак	Temniot Andak	PN	47.69
524	Кукуљето	Kukuljeto	NM	97.92
254	Река Ломија	River Lomija	PN	41.84
505	Долна Брегалница	Lower Bregalnica	NM	8817.24
513	Долна Злетовица	Lower Zletovica	PL	2139.47
484	Осоговски Планини	Osogovo Mountains	PL	77226.15

According to the definition in the Law on Nature Protection, natural rarities (as a new form of protection beyond the categories of protected areas) include parts of living nature (rare, threatened and endemic plant and animal species and their parts and communities) and inanimate nature (relief forms, geological profiles, paleontological and speleological objects, provided that their area is smaller than 100 ha) which as objects to nature, thanks to their scientific, aesthetic, health and other importance, cultural, training and education and tourist and recretational functions, enjoy special protection by the state. Natural rarities designation is carried out by way of decision by the Minister managing the body of the public administration responsible for the

[2] "Development of representative protected areas network" (Project Activity Ref. RFP 79/2009). Project 00058373 - PIMS 3728: "Strengthening of ecological, institutional and financial sustainability of the system of protected areas in the Republic of Macedonia". UNDP, Ministry of Environment and Physical Planning, Macedonian Ecological Society.

affairs in the area of nature protection, and thus the time required for the completion of the procedure for their designation is much shorter and therefore the application of specific protection measures in these areas may start much sooner. In the country, there are 91 areas in total that have been identified and proposed for designation as natural rarities. Fourteen (14) of them are of relevance for the East region.

Figure 2-12: Proposed natural rarities in the East region



(441 - Black Mulberry (Crna Dudinka); 523 - Volcanic bombs (Vulkanski Bombi); 305 - Pubescent Oak (Bel Dab, s. Beli); 326 - Zvegor; 542- Stamer; 376 Cave Konjska Dupka; 438 - Trabotivishte; 560 Wetland Elensko Blato; 440 - Black Poplar (Crna topola); 361 - Murite; 209 - Daboski Andak; 356 - Morodvis; 358 - Mochanrik; 525 - Pilav Tepe).

Internationally important areas for protection

There are five Important Bird Areas in the East region: Osogovo Mountains, River Zletovska valley, Ovche Pole, Topolka-Babuna-Bregalnica and Mantovo-Lakavica.

Figure 2-13: Important bird areas in the East region

Table 2-6: Important bird areas in the East region

ID	Name	Criteria	Year designation	Area (ha) GIS
35	**Mantovo & Lakavica**	IBA B2	2010	5729,81
34	**Osogovo Mountains**	IBA B2	2010	7048,58
32	**Ovche Pole**	IBA A1; IBA A3; IBA B2	2010	41365,91
19	**River Zletovica valley**	IBA A1	2010	12480,68
24	**Topolka-Babuna-Bregalnica**	IBA A1; IBA A3; IBA B2	2010	27962,41

There are five Important Plant Areas in the East region, well: Osogovo, Ovche Pole-Bogoslovec, Judovi Livadi, Krivolak-Serta and Plachkovica.

Figure 2-14: Important plant areas in the East region

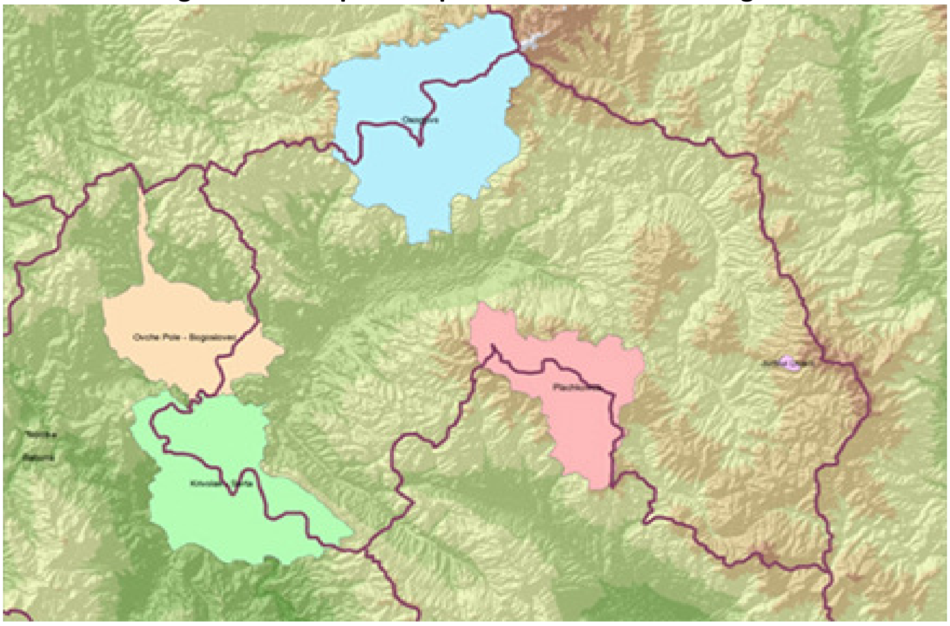


Table 2-7: Important plant areas in the East region

No.	ID	Name	Criteria	Year designation	Area (ha) GIS
1	**50**	**IPA Krivolak (Orlovo Brdo-Solen Dol-Serta)**	IPA (Aii); IPA (Aiii); IPA (Aiv); IPA (Ci); IPA (Cii)	2004	39366,96
2	**517**	**IPA Osogovo Mountains**	IPA (Aii); IPA (Aiv); IPA (Cii)	2004	50542,86
3	**55**	**IPA Ovche Pole-Bogoslovec**	IPA (Aii); IPA (Aiii); IPA (Aiv); IPA (Ci); IPA (Cii)	2004	25457,86
4	**72**	**IPA Pehchevo-Judovi Livadi**	IPA (Cii)	2004	388,42
5	**56**	**IPA Plachkovica**	IPA (Aii); IPA (Ci); IPA (Cii)	2004	26542,72

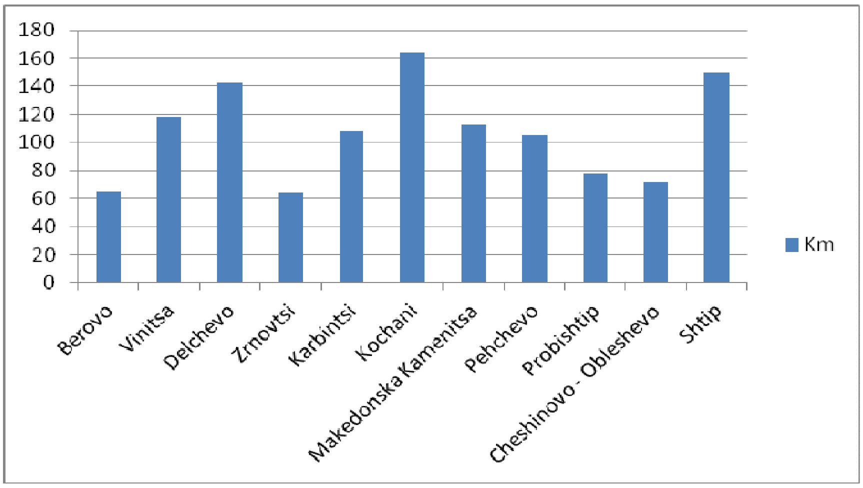
2.9 TRANSPORTATION INFRASTRUCTURE

As a landlocked country, FYR Macedonia is particularly dependent on a well-developed road and rail network for its economic and social development. Key elements of this network are also part of the Trans-European transport network[3]. East Region is not part of this network.

The road network in the region is developed on average, and the state of the bus roads and some regional roads is regarded as bad.[4]. Specifically, the current state of the bus roads (M-5: Veles - Stip - Kocani - Macedonska Kamenica - Delchevo) and some regional roads (R-523: Delchevo - Pehchevo - Berovo, R- 527: Kocani - Vinica - Berovo and R-603: Radovish – Berovo) is poor[5]. The following diagram shows the local road network by municipality.

[3] http://www.worldbank.org/en/country/macedonia/overview
[4] http://www.rdc.mk/eastregion/index.php/za-nas/za-regionot
[5] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

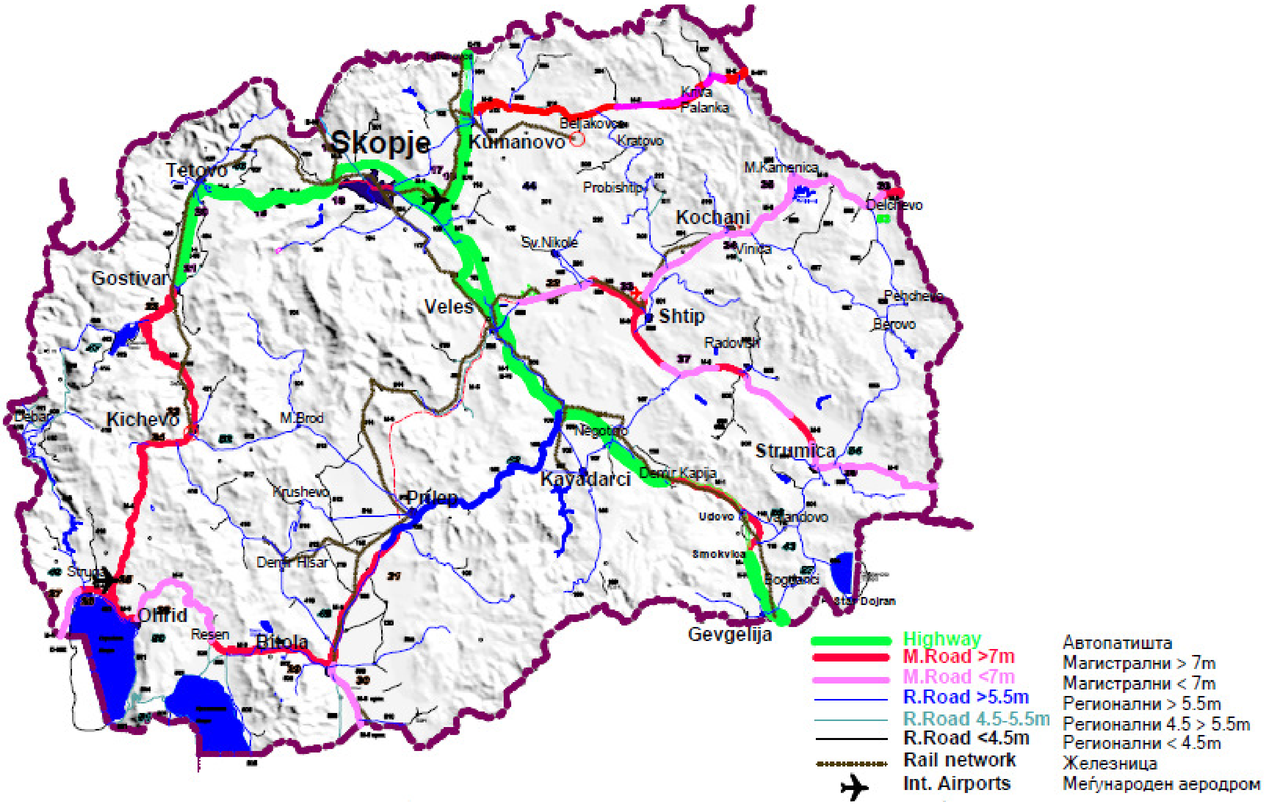
Figure 2-15: Local road network by municipality, km (2012)



(Source: State Statistical Office)

The following figure shows the road network in relation with other modes of transport.

Figure 2-16: Road network in relation with other modes of transport

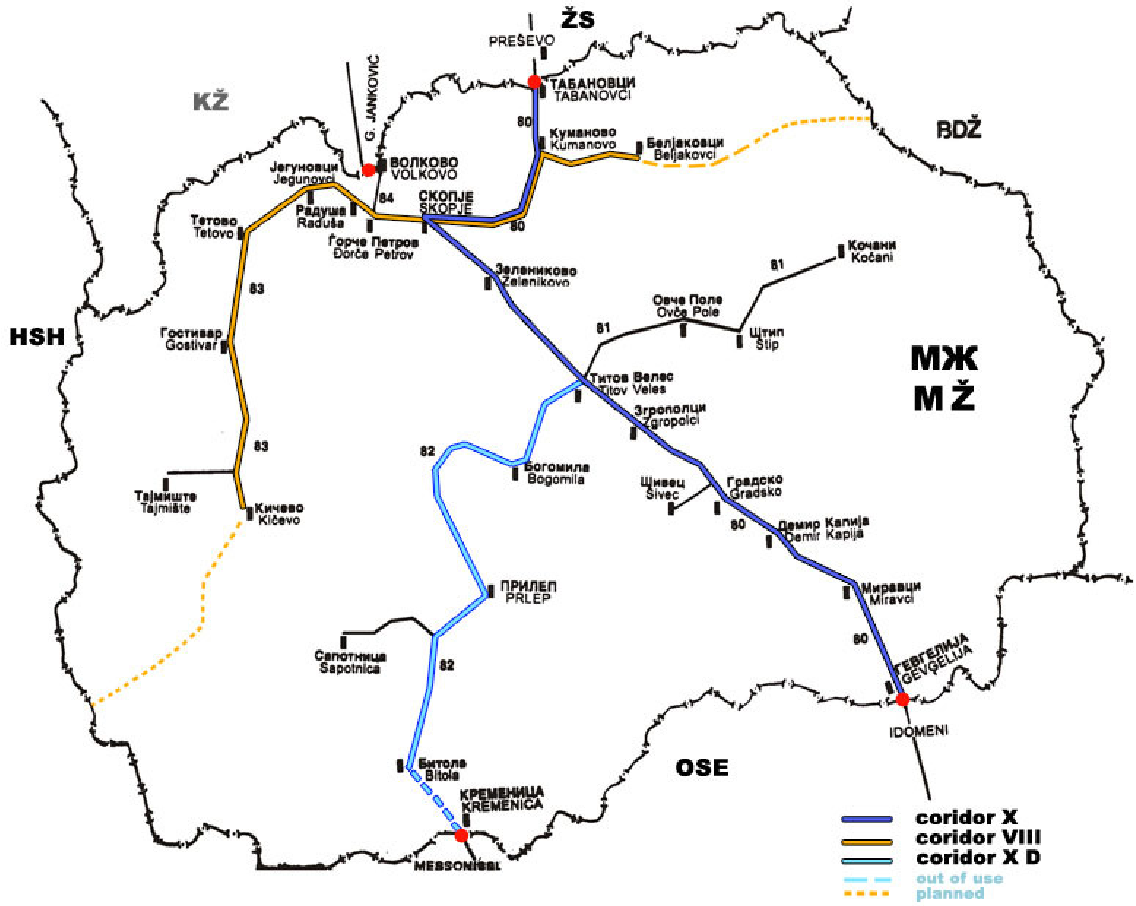


(Source: http://www.mtc.gov.mk/new_site/images/storija_doc/104/fig%20m%2001.pdf)

The development of the railway network in the East region can be assessed as low. Part of the railway line Veles-Kocani runs across the Eastern Region (70 km), which ends as a blind track. The railway network doesn't serve adequate municipalities in the region. Only Stip and Kocani are linked with the rail lines [6].

[6] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

Figure 2-17: Railway infrastructure in FYR Macedonia



(Source: http://mz-rail.atwebpages.com/infra/infra-en.html)

2.10 WATER SUPPLY NETWORK

Supplying the population with drinking water is an important priority for every country. Hence, the Census of Population, Households and Dwellings, as a statistical survey which covers the whole population, is also used to collect data on the manner in which the households are supplied with drinking water, as well as on the existence of appropriate water supply installations in dwellings. However, the only available data are from the Census of 2002.

Table 2-8: Apartments and their equipment in the planning regions (2002)

Region	Total number of apartments		Growth in%	Share (%) of dwellings built after 1990	Share (%) of households whose apartments have facilities for:			Share (%) of households whose apartments are equipped with:		
					Water supply, sewerage, electricity and central heating	Water, sewer and electricity	Only current	Kitchen, bathroom and toilet	Bathroom and toilet	Only the kitchen
Year	1994	2002	2002/1994	2002	2002	2002	2002	2002	2002	2002
R.. Macedonia	580,342	697,529	20.2	17.0	14.6	81.0	4.2	73.5	0.5	15.2
East	68,389	80.390	17.5	14.9	3.7	90.7	5.3	63.2	0.5	25.2

(Source: Predlog strategija za regionalniot razvoj na RM 2009-2019)

The length of the water supply network is located predominantly in the urban centers of municipalities. According to the 2002 census, 94.4% of the households in East Region were supplied with drinking water. The population coverage in urban areas ranged from 90% to 100% (Stip, Vinica). In rural areas it ranged from 10% to 80%. In more populated areas of the region, there is the problem of lack of water. This problem is a result of several factors such times as: high average per capita consumption, then over the loss of water supply systems for more than 50% of their age (mostly older than 15 years), insufficient volume of reservoirs, treatment plants and other facilities. The problem of providing sufficient quantities of drinking water in this region can be solved with better utilization of reservoir lakes that are located in this region, as well as the reconstruction and rehabilitation of existing water supply systems and reservoirs, which will reduce losses of water. Construction of new, upgrade and reconstruction of existing installations and facilities for water supplying and waste water collection and treatment is ongoing process. The Zletovica multi-purpose water management -supply system is expected to solve the water supply problem for municipalities Probishtip, Stip and Karbinci[7]. On January 2013, a completion ceremony was held near a multipurpose dam constructed by the Zletovica Basin Water Utilization Improvement Project. In addition to the dam, the project constructed water intake and conveyance facilities to supply drinking, agricultural and industrial water to the eastern part of Macedonia, which suffers from chronic water shortages[8].

2.11 INSTALLATIONS AND FACILITIES FOR WASTE HANDLING

The waste management system is based mainly on waste collection and disposal. The waste collection, transportation and disposal service is provided by Public Communal Enterprises (PCEs) (please see ch. 3.3.1-3.3.2). Waste disposal is provided by the PCEs at eleven (11) municipal landfill sites. The sites are operated on a controlled basis, but they are not compliant with EU requirements. Furthermore, according to the field investigations, there are seventy one (71) uncontrolled dumpsites, especially in rural areas not covered by the waste collection system (please see ch. 3.3.6).

The following companies have licenses for storage and transport of waste in East Region.

- DPTTU FALANGA RECIKLAZA DOOEL Municipality Vinica
- MIJO VALI Mihail DOOEL Municipality Vinica
- DPTU “MIMAL“DOOEL, eksport-import, Kocani
- DPTU SIDRA DOOEL izvoz-uvoz Delcevo
- DOSSTUP FAMILIJA TODEV DOOEL Probishtip
- DPTU DEMITRANS uvoz-izvoz DOOEL Vinica
- DZPTU "AGROFILA" DOOEL, Municipality Shtip
- DSPPOPTT "ISTOK-SUROVINA" DOO uvoz-izvoz Vinica
- ZDVIL Factory for manufacturing industrial oils MINOL DOOEL Shtip
- DPPU "PETREP" uvoz-izvoz DOO SHTIP
- DPTU DEMITRANS uvoz-izvoz DOOEL Municipality Vinica

[7] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[8] http://www.jica.go.jp/balkan/english/office/topics/topics130322.html

- TDVILZDPTU "RECIKLAŽA" eksport-import DOOEL v. Ocipala. Delčevo
- Association of Commerce eksport-import "IVAL TREJD" DOO, Shtip
- Sans AG Shtip
- DTU "BI METALI"DOO od Municipality Shtip
- DPUP "AJSHE DEM"DOOEL uvoz-izvoz SHTIP
- DPTU "GOKO-KAR"DOOEL VINICA

TDTPU "MARPET" DOO, Municipality Sveti Nikole

DSPPO "OTPAD"DOO, Sveti Nikole

Also, the recycling market for WBA in Macedonia is undeveloped, except for automotive batteries. There is only one entity, Tab Mak, LLC from Probishtip (former VESNA SAP LLC Probishtip) holding an A-integrated environmental permit no. 11-2486/2, in accordance with the Law on Environment and a license for performing the activities of collection, treatment and recovery of automotive batteries (WBA in Macedonia).

2.12 INSTALLATIONS AND FACILITIES FOR WASTEWATER TREATMENT

The wastewater network is mostly located in the urban centers of municipalities. Population coverage ranges from 80% to 100%, while in rural areas it ranges from 0% (septic tanks) to 80%. Some rural areas do not have adequate systems or septic tanks for wastewater. The overall state systems for wastewater disposal is relatively poor because the systems are characterized by leakage of waste water during transport, which increases the risk of contamination of soil and groundwater[9]. In 2010, a waste water treatment plant and the main sewage collector, part of the Urban Water Supply and Sanitation Project of Berovo, were put into operation. The project was financed by the Swiss State Secretariat of Economic Affairs SECO (CHF 10, 1 mio), Ministry of Environment and Physical Planning (CHF 0,600 mio) and the Municipality of Berovo (CHF 0,400 mio). Other project components included improvement of the water supply through replacement of the main water supply pipeline, renovation of the treatment plant for drinking water and construction of the reservoir and institutional strengthening of the public utility "Usluga" from Berovo[10]. The table below lists the wastewater treatment facilities.

Table 2-9: Waste water treatment facilities in East Region

Characteristics	Berovo	Sveti Nikole
Population	14,000	18497
Sewerage	-	95%
Year of Construction	2010	2000

[9] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[10] http://www.swiss-cooperation.admin.ch/macedonia/en/Home/Local_Events/Waste_Water_Treatment_Plant_Berovo_Is_Put_into_Operation.
http://www.swiss-cooperation.admin.ch/macedonia/en/Home/Water_and_Environment/Water_and_Wastewater_Management/Berovo_Urban_Water_Supply_and_Sanitation

Characteristics	Berovo	Sveti Nikole
Process*	M, B, C	M, B, C
Funded by	Swiss Government	USA donation
Capacity (Е.Ж)	12,000	15,000
Status	operational	operational

* Mechanical-M; biological-B; chemical-C;

2.13 HOSPITALS AND CENTRES FOR PUBLIC HEALTH

Health care is provided through an extensive network of health care organizations, on three levels: primary, secondary, and tertiary. Hospital health care is delivered by public hospitals, specialized hospitals, institutes, and specialized departments (clinics) in the Skopje Clinical Center, as well as by private hospitals[11].

The availability of primary health services reaches the national average level, while a higher level of health care is less available and one has to use the services offered in other regions, which increases costs and reduces efficiency this type of service to the citizens of this region. Hospital care in the East Region is organized through a network of general hospitals. Tertiary health care for residents of the Eastern Region, is located in Skopje. In view of the relatively small territorial distance of all settlements to the capital Skopje, this solution still provides access to all citizens to needed medical services.[12]. The following table presents the bed utilization rate in various health facilities.

Table 2-10: Hospital beds utilisation rate, 2011

Facility	No of beds*	Maximum number of beds per year**	Bed utilisation rate***
Kocani – General Hospital	137	50,005	46.42
Stip - Clinical hospital	459	167,535	40.83
Obesevo (Prevention, Treatment and rehabilitation of lungs)	72	26,280	8.06

(Source: Health Insurance Fund[13])

Note: (*)Total hospital beds - all hospital beds health facility (Free or used) that are regularly maintained, staffed immediately available care of acutely ill patients

[11]The World Bank - IEG Public Sector Evaluation (2013). PROJECT PERFORMANCE ASSESSMENT REPORT - FORMER YUGOSLAV REPUBLIC OF MACEDONIA - HEALTH SECTOR MANAGEMENT PROJECT (P086670) [pdf]. http://goo.gl/bAfErH

[12] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[13] http://www.fzo.org.mk/WBStorage/Files/Prilog%20iskoristenost%20na%20kapacitetiet%20DSG%202011.pdf

(**)Maximum Number of beds / day - refers to the maximum number of hospital days of stay potential or days, because they represent statistical Probability. All beds are filled every day throughout the year. If each hospital bed is filled every day utilization will be 100%.

(***)Rate of utilization of hospital beds -represents the percentage of available hospital beds that were used during the year. It is measure the intensity of hospital resources used by the acute hospital patients and the result is always expressed as a percentage. It is calculated by the following formula:

Rate of utilization of hospital beds used = Total hospital beds / day X 100 /Maximum number of beds / day

Also, a medical map was developed in 2007 (http://www.medicinskamapa.gov.mk/index.php?c=6)

2.14 INDUSTRIAL SECTOR

The main centers of industrial activities in East Planning Region are the Municipalities of Shtip, Berovo, Delcevo and Kochani. The Public Collection Enterprises (PCEs) are the responsible bodies for the collection of non hazardous industrial wastes in the East Region which are finally disposed to the municipal landfill.

In the municipality of Kochani is active a significant number of legal entities (companies) that perform various activities, which can be divided into several categories:

- Clothing manufacturing facilities
- PVC and ironmongery installations
- Metallurgic installations
- Wood Processing facilities
- Printing installations
- Greenhouse facilities
- Vegetables processing facilities

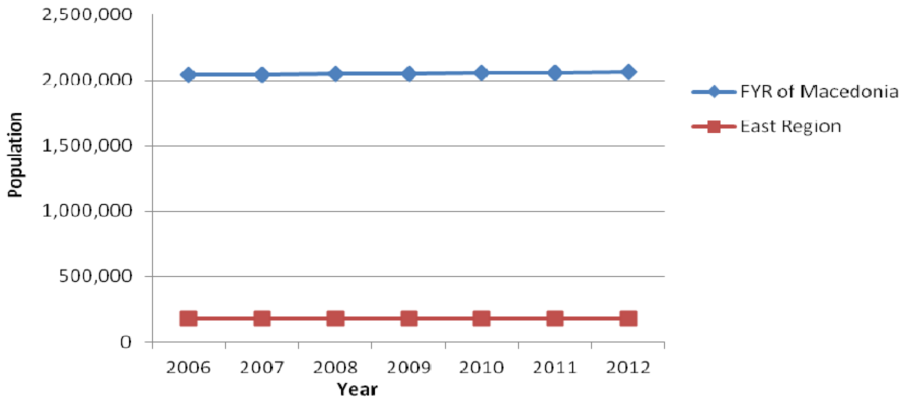
- **In the municipality of Delcevo** are active a few legal entities (companies) producing industrial non – hazardous waste. The main industrial sector of activity is the clothing manufacturing companies. The PCE regularly collects the generated wastes which are finally disposed to the city dumpsite.
- **In the municipality of Berovo** there is a small number of legal entities (companies) who perform activities which produce a considerable amount of waste, most significant industrial activity are the clothes manufacturing facilities. There wastes are collected from the PCE and finally are disposed to the municipal dumpsite.
- **In the municipality of Macedonian Kamenica** is active a small number of legal entities (companies) who perform activities that produce a significant amount of waste. The most important industrial activity in the area belongs to clothing manufacturing sector.
- Once or twice per month or as required by clothing industries, textile waste are collected and disposed to the municipal landfill. The process is attended by representatives of Customs Agency and representative of PCE.

- **The municipality of Shtip** is the core of clothing industrial activity of the East Planning Region. Within Shtip municipality are operational about 85 clothes manufacturing facilities (of different production capacities). The textile wastes are collected by the PCE and are disposed under Customs Agency supervision to the municipal landfill "Tresna Skala" in Shtip.
- **In the municipality of Probistip** are operational a few clothing manufacturing facilities which produce a small amount of non hazardous wastes (textiles). The produced textiles are collected regularly by the PCE and disposed to the municipal landfill.
- The main industrial activity of the area is connected with the two mining fields and a battery factory which are active and operational.
- The **Indo Minerals and Metals d.o.o.el** (Zletovo Mine), which produces lead and zinc concentrates for export.
- The second operational mine is **Strmos AD – Nonmetal mine** which is located in the area of Strmos and it produces marbles.
- **The TAB MAK d.o.o.** is a significant battery factory situated in Macedonia and is producing batteries sold under house TAB brand VESNA and STARTER VESNA with annual capacity of 1.000.000 to 1.500.000 pieces (depending on battery types).

2.15 POPULATION – BASIC DEMOGRAPHIC DATA

According to the data from the last Census of Population, Households and Dwellings in 2002, the East Planning Region had 181,858 inhabitants. According to population estimates (on 30.06.2012) from the State Statistical Office, the overall population of East Region has slightly decreased (178,814 inhabitants), while the overall population of the country has slightly increased.

Figure 2-18: Population 2006-2012, according to estimates



Population changes are usually a result of the direct influence of natural changes (births and deaths) and mechanical changes (migration). The following table presents basic demographic date for the Region.

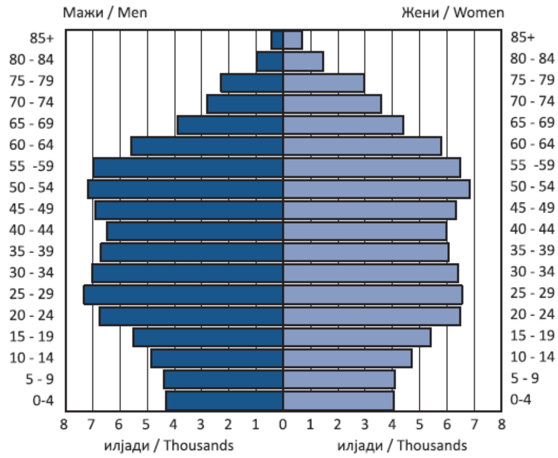
Table 2-11: Basic demographic data, East Region, 2012

Number of municipalites	11
Number of setlements	217
Total populaton, Populaton Census, 2002	181,858
Estmated populaton, 2012	178,814
Populaton density, 2012	50.6
Number of dwellings, Population Census, 2002	72,248
Average number of persons per household, Population Census, 2002	3.1
Live births, 2012	1,656
Deaths, 2012	1,936
Natural increase, 2012	-280
Immigrants from abroad, 2012	227
Emigrants to abroad, 2012	60
Number of beds, 2012	1,721
Number of tourists, 2012	18,865
Number of nights spent, 2012	37,358

(Source: State Statistical Office (2013) "Regions of the Republic of Macedonia, 2013)

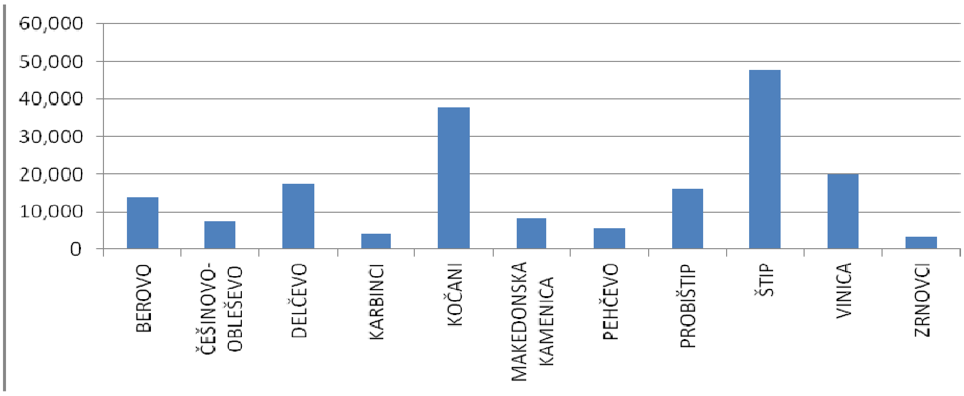
Regarding the age structure of the population, the young population (0-14) has a share of 15%. As a result of the unfavorable age structure and the low fertility, the number of deaths exceeds the number of births.

Figure 2-19: Estimate of population in the East Region as at 30.06.2012, according to gender and five-year age groups, NUTS 3[14]



The most populated Municipality of the region is Štip Municipality and the least is Zrnovci.

Figure 2-20: Population of East Region Municipalities (2002)



[14] State Statistical Office (2013) "Regions of the Republic of Macedonia, 2013" (http://www.stat.gov.mk/PrikaziPublikacija_1_en.aspx?rbr=411)

2.16 CONCLUSION

Due to the permanent process of depopulation, a large number of displaced villages, villages with population size of 100 villages with exceptionally high index of aging. This condition leads to a concentration of about 66% of the population in urban areas[15].

As a result of the unfavorable age structure and the low fertility, the number of deaths exceeds the number of births.

The relatively poor condition of the road network in the East Region and the low coverage of the railway network are negative factors for the development of the region, particularly in terms of encouraging economic growth through investment.[16].

The Zletovica Basin Water Utilization Improvement Project is expected to contribute to further economic development in East Region, as a stable water supply is critical for industrial and manufacturing development[17].

The East region is a predominantly mountainous region and covers the far east of the Former Yugoslav Republic of Macedonia. Due to the specific geological characteristics of mountain ranges, the region has a developed lead and zinc mining industry. Another important industry is the textile industry and a large number of textile manufacturing plants are located in this region.

Mountainous, border and rural areas identified as areas with specific development needs are located in all 11 units of local government in the East Region. According to the Decision on determining the areas with specific development needs in the country in the period 2009-2013[18], Settlements in mountainous, border, rural and other areas that lag behind in development in the Eastern Region are:

Table 2-12: Areas with specific development needs[19].

Municipality	Settlements		
	Mountainous	Border	Rural areas
Berovo	Budinarci Vladimirovo Yards Mitrashinci Ratevo Rusinovo Smojmirovo Machevo	Yards	

[15] http://www.rdc.mk/eastregion/index.php/za-nas/za-regionot

[16] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[17] http://www.jica.go.jp/balkan/english/office/topics/topics130322.html

[18] Official Gazette of the Republic of Macedonia br.79/09 June 24, 2009

[19] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

Municipality	Settlements		
	Mountainous	Border	Rural areas
Vinica	Kalimanci Lucky Trsino Blatec Grljani		
Delcevo	Bigla Vetren Vratislavci Dramche Crab Kosovo Dabje New Istvenik Selnik Stamer Star Istvenik Turija Puddle Gabrovo	Zvegor Vratislavci Dramche Selnik Crab Vetren Gabrovo Stamer City Puddle Star Istvenik	
Zrnovci			Vidoviste Zrnovci Morodovis
Karbinci	Vrteshka Ebeplija Junuzlija Kalauzlija Kepekcheklija Kurfalija Kuchica Muratlija Pripechani Prnalija		Argulica Batanje Vrteshka Large Gaber Upper Balvan Upper Trogerci Lower Balvan Lower Trogerci Ebeplija Junuzlija Kalauzlija Karbinci Kepekchelija Kozjak Krupiste Kurfalija Litters Kuchica Small Gaber Michak Muratlija New Karaorman Odzhalija Pripechani Prnalija Radanje Ruljak Tarinci Crvulevo

Municipality	Settlements		
	Mountainous	Border	Rural areas
Kocani	Bezikovo Upper Gradce Glavovica Jastrebnik Kostin Dol Leskos Nebojani Nivichani Novo Selo Polaki Intersection Pripor Pantelejmon Rajchani Vraninci Rechani		
Macedonian Kamenica	Dulica Kosevica Kostin Dol Bulb Moshtica Sasa Todorovci Cera	Sasa Moshtica Kosevica Kostin Dol	
Pehchevo	Negrevo Pancharevo Crnik Robovo Umlena	Pancharevo Crnik Negrevo	
Probishtip	Grizilevci Zelengrad Jamiste Kundino Lesnovo Marchino		
Cesinovo - Oblesevo			Bath Burilcevo Vrbica Zhigance Kuchichino Lepopelci New Villagers Oblesevo Sokolarci Spancevo Teranci Ularci Cesinovo Ciflik
Stip	Kalapetrovci Kosevo Nikoman Pocivalo Shashavarlija		

3. DATA ON THE REGIONAL PLAN

3.1 BACKGROUND FOR THE GENERATION OF WASTE

3.1.1 Population in urban and rural areas

As there are not available current data about the distribution of urban and rural population at the regional level we accept the distribution according census 2002, presented in the table below.

Table 3-1: Number and share (in %) of the urban and rural population at the regional level, census 2002

Region		Total	Urban	Rural
Republic of Macedonia	Number	2 022 547	1 147 006	875 541
	%	100	56.7	43.3
East	Number	181 858	120 547	61 311
	%	100	66.3	33.7

Source: Rural Labour Market Developments in the Former Yugoslav Republic of Macedonia by Verica Janeska & Štefan Bojnec, published in Factor Market Working Paper, No. 5, September 2011

In East region rural population is 10% lower than average in the country.

According to World bank's data, rural population in Macedonia for the period 2002 - 2012 is about 41% of the total population (*http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS/countries?order=wbapi_data_value_2009%20wbapi_data_value%20wbapi_data_value-first&sort=asc&display=default*). So an assumption is made, that the distribution urban-rural population on regional level is kept on the same level for the period.

For the purpose of the Regional Waste Management Plan, Eurostat's urban – rural typology was applied in order to estimate the distribution of urban and rural population at the municipal level. A settlement is considered urban if it has at minimum 5,000 inhabitants[1].

Table 3-2: Number and share (in %) of the urban and rural population at the municipal level (2012)

	Berovo	Češinovo-Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
Total Population (2012) – number of inhabitants	13,181	7,125	16,673	4,040	38,058	7,729	5,068	15,480	48,578	19,521	3,098	**178,551**
% Urban Population	50%	0%	66%	0%	74%	63%	0%	67%	91%	54%	0%	**64.8%**
% Rural Population	50%	100%	34%	100%	26%	37%	100%	33%	9%	46%	100%	**35.2%**
Urban Population – number of	6,591	0	11,004	0	28,163	4,869	0	10,372	44,206	10,541	0	**115,746**

[1] Eurostat (2013). Rural development statistics by urban-rural typology. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Rural_development_statistics_by_urban-rural_typology

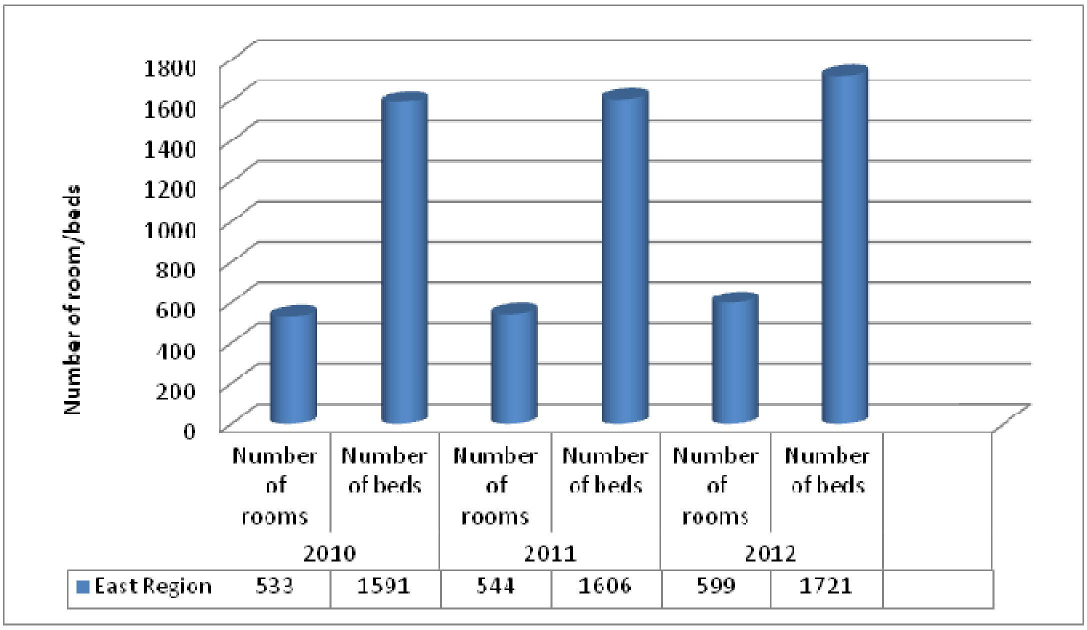
	Berovo	Češinovo-Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
inhabitants												
Rural Population – number of inhabitants	6,591	7,125	5,669	4,040	9,895	2,860	5,068	5,108	4,372	8,980	3,098	**62,805**

Češinovo-Obleševo, Karbinci, Pehcevo and Zrnovci are predominantly rural municipalities.

3.1.2 Tourism

The number of room and beds in East Region is presented in the following graph..

Figure 3-1: Capacity for accommodation - Number of rooms and beds in East Region, 2010-2012

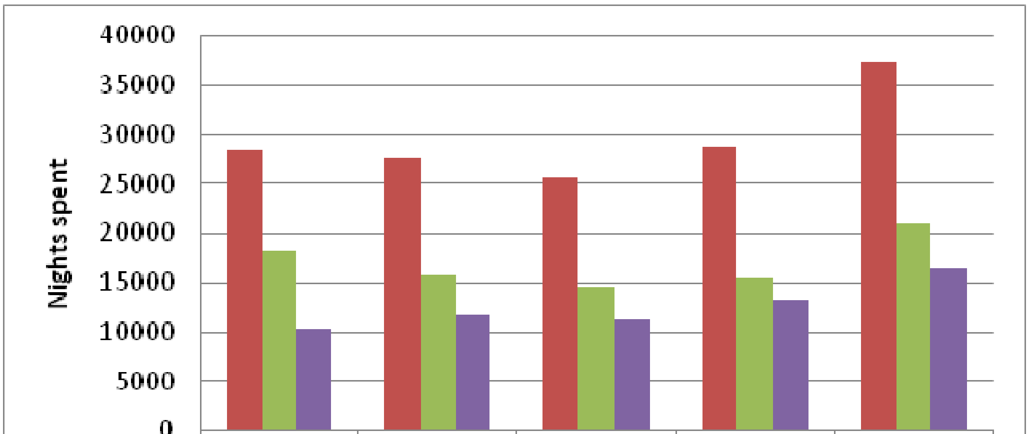


Source: State Statistical Office, own processing

According to the State Statistical Office, a tourist is any person who temporarily spends at least one night in some accommodation establishment not located in his or her usual place of residence. Nevertheless, a certain number of tourists and their nights spent are not included because some tourists, particularly those in private rooms, cottages and those staying with relatives and friends, remain unreported. A domestic tourist is a person with permanent residence in the FYR of Macedonia who is temporarily present at some other place, different from his/her usual place of residence, and who spends at least one night in some accommodation establishment. A foreign tourist is considered to be anyone, permanently resident outside the FYR of Macedonia, who is temporarily present in the Republic of Macedonia and who spends at least one night in some accommodation establishment[2].

The following diagrams present the number of tourists and the number of nights spent by tourists in East Region, during the period 2008-2012. In 2012 there was an increase in the number of total tourists, when compared with the year 2011 (35.6%).

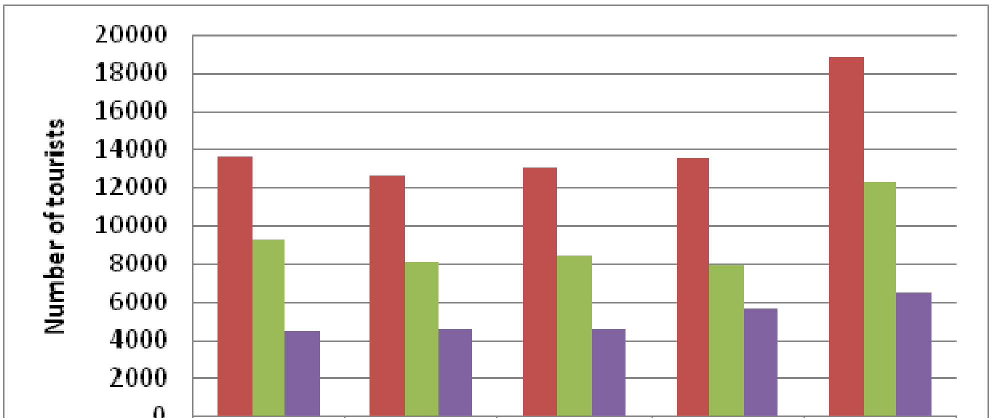
Figure 3-2: Number of nights spent by tourists in East Region, 2008-2012



	2008	2009	2010	2011	2012
Total	28449	27509	25687	28852	37358
Domestic	18137	15742	14504	15614	20930
Foreign	10312	11767	11183	13238	16428

Source: State Statistical Office, own processing

Figure 3-3: Number of tourists in East Region, 2008-2012



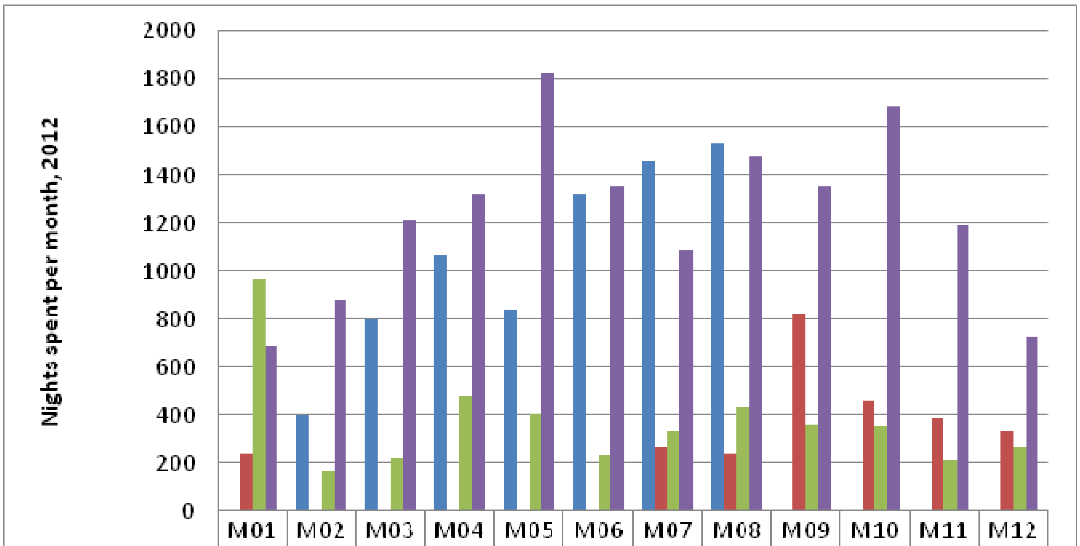
	2008	2009	2010	2011	2012
Total	13739	12680	13054	13615	18865
Domestic	9230	8135	8463	7948	12275
Foreign	4509	4545	4591	5667	6590

Source: State Statistical Office, own processing

[2] http://www.stat.gov.mk/MetodoloskiObjasSoop_en.aspx?id=69&rbrObl=25

The following figure presents the number of nights per municipality per month for the year 2012. There were no tourists registered in Delchevo, Zrnovtsi, Makedonska Kamenitsa, Pehchevo and Cheshinovo – Obleshevo. According to the State Statistical Office, the data for Probishtip, Karbintsi and the missing data for Vinitsa and Berovo are confidential.

Figure 3-4: Number of nights per month per municipality in East Region, 2012



	M01	M02	M03	M04	M05	M06	M07	M08	M09	M10	M11	M12
Berovo Total	0	396	798	1068	845	1320	1461	1537	0	0	0	0
Vinitsa Total	243	0	0	0	0	0	269	243	823	460	386	335
Kochani Total	968	170	225	482	405	239	334	436	359	355	213	270
Shtip Total	687	879	1214	1322	1828	1356	1087	1477	1354	1685	1190	732

Source: State Statistical Office, own processing

UNEP's "Manual for Water and Waste Management: What the industry can do to increase its performance"[3] stated that every international tourist in Europe generates at least 1 kg of solid waste per day and tourists from developed countries probably produce more. According to the "Environmental initiatives by European tourism businesses - Instruments, indicators and practical examples - A contribution to the development of sustainable tourism in Europe", an analysis of 36 hotels in the 2 to 4-star categories in Germany and Austria showed that 1.98 kg of waste is generated on average per overnight stay[4]. Finally, according to the study "Stepping forward, a resource flow and ecological footprint analysis of the South West of England", an estimate on the quantities of waste generated by tourists was derived, based on the assumption that an average tourist in Europe generates approximately 1.2 kg of waste per bednight (CREM, 2000). The quantity of generated waste was estimated by multiplying this figure by the number of bednights spent by tourists[5].

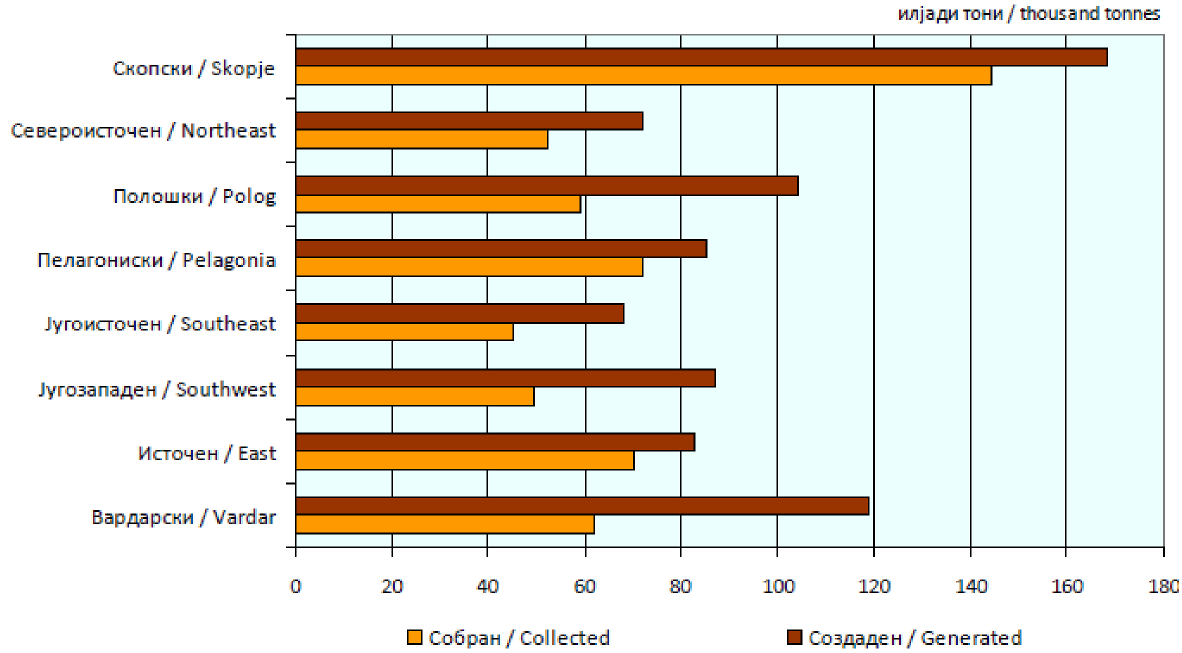
[3] UNEP (2003). Manual for Water and Waste Management: What the industry can do to increase its performance [pdf]. Retrieved from: http://www.unep.fr/shared/publications/pdf/WEBx0015xPA-WaterWaste.pdf
[4] Hamele, H., Eckardt, S. (2006). Environmental initiatives by European tourism businesses - Instruments, indicators and practical examples - A contribution to the development of sustainable tourism in Europe [pdf]. Retrieved from: http://sutour.ier.uni-stuttgart.de/englisch/downloads/sutour_lores_en.pdf
[5] http://www.steppingforward.org.uk/tour/waste.htm

In East Region, the majority of the tourists are domestic. It is assumed that 1kg of waste is generated on average per overnight stay, as proposed by UNEP, which is close to the country's average waste generation per capita per day (1.04[6]). Therefore, in 2012, 37,358 nights were spent by tourists in East region and 37,358 kg waste was generated by the tourist sector.

3.1.3 Existing data on waste generation

The following chart presents the collected and generated municipal waste by regions in 2012.

Figure 3-5: Collected and generated municipal waste by regions, 2012



Source: State Statistical Office (http://www.stat.gov.mk/pdf/2013/5.1.13.17.pdf)

The amount of waste generated in East Region represents 10.5% of the amount of waste generated at country level.

Estimated quantities of generated waste in 2005 are shown in the following table. In 2005, two-thirds of waste is generated in the mining sector. In terms of special waste streams, the estimated national generation of waste oil amounted to 8,000 t/year, mostly from metallurgy[7].

Table 3-3: Estimated quantities of generated waste at country level, 2005

Waste stream	Tonnes	%
Waste from mining	17,300,000	66.40%
Agricultural waste - animal by-products	4,900,000	18.81%
Industrial non-hazardous waste	2,120,000	8.14%

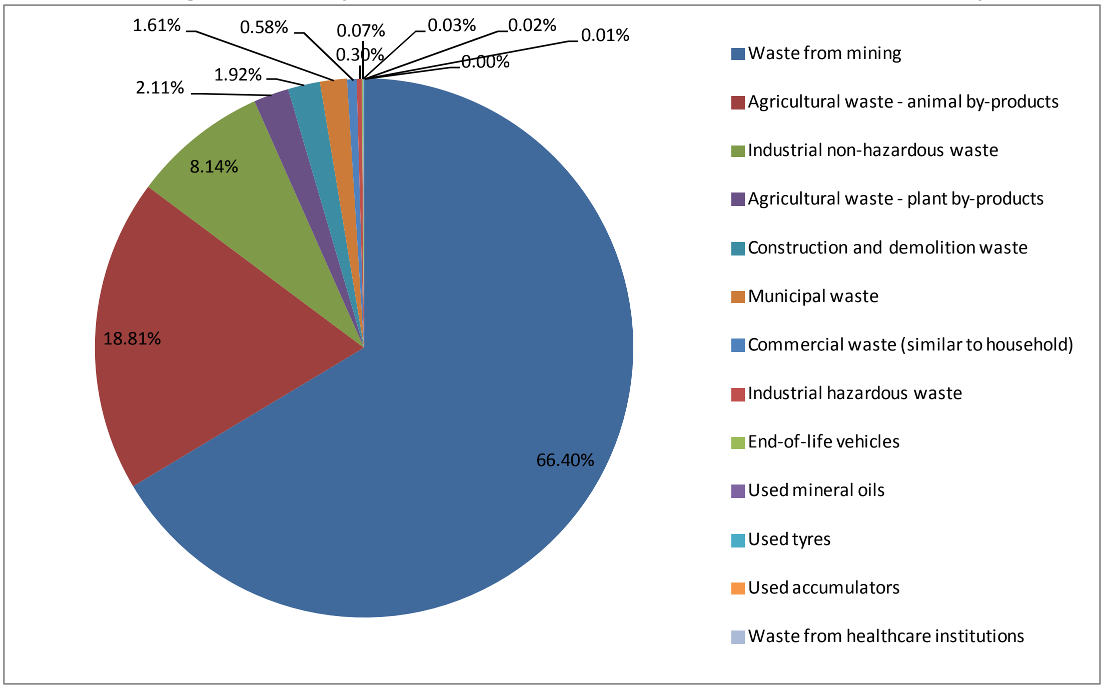
[6] State Statistical Office (2014). Environmental Statistics 2013 [pdf]. Retrieved from: http://www.stat.gov.mk/PrikaziPublikacija_1_en.aspx?rbr=457

[7] United Nations Economic Commission for Europe (2011) "2nd Environmental performance review of the Former Yugoslav republic of Macedonia" Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

Waste stream	Tonnes	%
Agricultural waste - plant by-products	550,000	2.11%
Construction and demolition waste	500,000	1.92%
Municipal waste	420,000	1.61%
Commercial waste (similar to household)	150,000	0.58%
Industrial hazardous waste	77,500	0.30%
End-of-life vehicles	17,500	0.07%
Used mineral oils	8,000	0.03%
Used tyres	5,000	0.02%
Used accumulators	3,500	0.01%
Waste from healthcare institutions	1,000	0.00%
Total	**26,052,500**	**100.00%**

Source: UNECE, 2011, adopted from MoEPP, 2011

Figure 3-6: Proportional share of different waste streams at country level, 2005



According to the data of the State Statistical Office, the total amount of generated waste in the sections Mining and quarrying, Manufacturing and Electricity, gas, steam and air conditioning supply in the FYR of Macedonia in 2010 was 1,876,208.41 tonnes and in the East Region 862,454 tonnes. The highest amount at country level (1,017,007.14 tonnes or 54.2%) was generated in the Manufacturing section in the division Manufacture of basic metals – 946,318.96 tonnes, as opposed to 2005, where the highest amount was generated in the Mining and quarrying sector.

In East Region, the highest amount was generated in the section Mining and quarrying (854,627 tonnes or 99,1% at regional level). The amount of waste generated in the section Mining and quarrying in East Region represent more than 99,9% of the total amount of waste generated at country level in the same sector. Due to the specific geological characteristics of mountain ranges, the region has a developed lead and zinc mining industry. The lowest amount of waste (0.01%) was generated in the section Electricity, gas, steam and air conditioning supply.

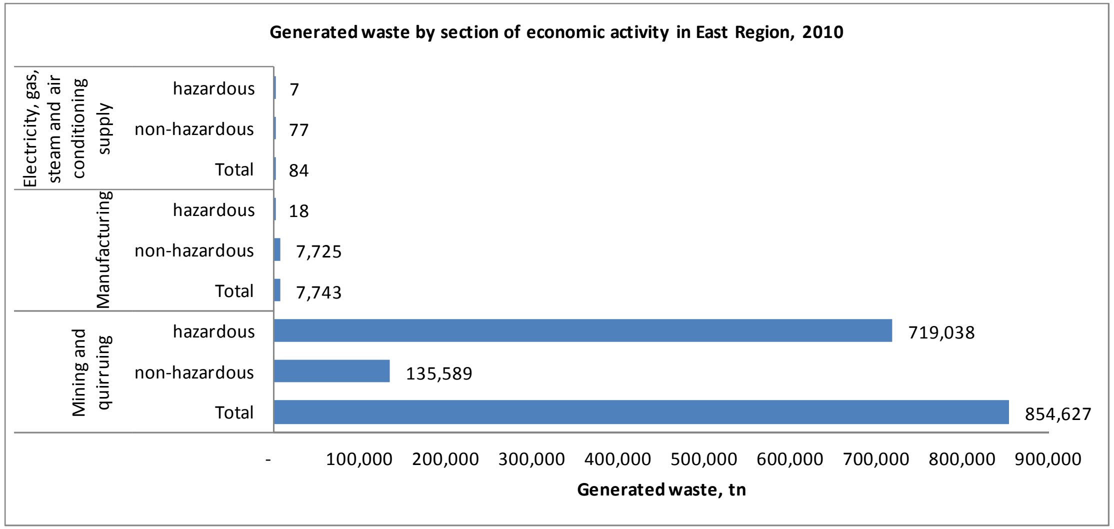
The total amount of generated hazardous waste was 719,063 tonnes, or 83.4% of the total amount of generated waste. The highest amount of hazardous waste (719,038 tonnes) was registered in the Mining and quarrying section.

Table 3-4: Generated waste by sector of economic activity in East Region, 2010, tonnes

	Total (tn)			Mining and quarrying (tn)			Manufacturing (tn)			Electricity, gas, steam and air conditioning supply (tn)		
	Total	non-hazardous	hazardous	Total	non-hazardous	hazardous	Total	non-hazardous	hazardous	Total	non-hazardous	hazardous
Republic of Macedonia	1,876,208	1,150,017	726,191	854,856	135,807	719,049	1,017,007	1,009,918	7,089	4,346	4,292	54
East Region	862,454	143,391	719,063	854,627	135,589	719,038	7,743	7,725	18	84	77	7

Source: State Statistical Office

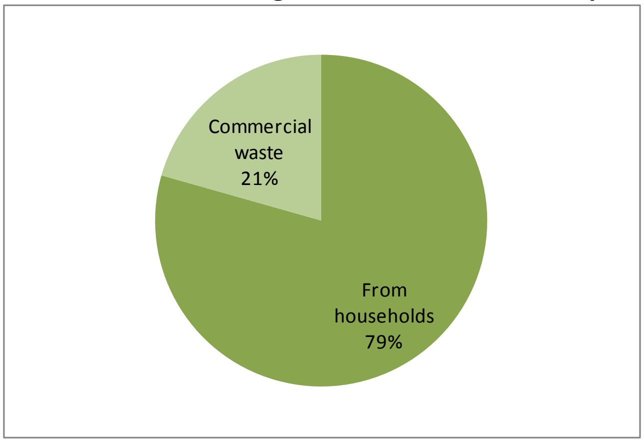
Figure 3-7: Generated waste by section of economic activity in East Region in 2010



Businesses that create hazardous waste are required to submit an annual report on the handling of hazardous waste to the Ministry of Environment and Physical Planning. The data obtained for 2012 at country level from 56 business entities show that the total quantity of hazardous waste generated is 1,555,480.7 tn or 7161.04 m^3. The quantity of hazardous waste that businesses undertake the disposal or removal on their own, amounts to 1,455,457 tn or 458,8 m^3 or approximately 93.5 %. Further removal of hazardous waste out of the place of generation has been reported in the amount of 2136.51 tn or about 1,3 %, including recycling in an amount of 5.8 % or 90,088.6 ton. Temporarily stored hazardous waste amounts to 1067.75 tonnes or 3,031.46 m^3. Businesses imported 815.2 tonnes of hazardous waste , and exported 119.84 tonnes[8].

Regarding the collected municipal waste, according to data of the State Statistical Office, the total amount of collected municipal waste in the FYR of Macedonia in 2012 was 555,760 tonnes. Compared to 2011, the total amount of collected municipal waste increased by 1.02%. The highest amount of collected municipal waste was registered in the Skopje Region - 144 593 tonnes, or 26.0% of the total collected amount in the Republic of Macedonia. Of the total amount of collected municipal waste, 441 223 tonnes, or 79%, were collected from households, and the remaining 21% from legal and natural persons (commercial waste). The total amount of generated municipal waste in the Republic of Macedonia in 2012 was 786,909 tonnes. The annual amount of generated municipal waste per person in 2012 was 382 kg per person, which is 7.0% higher than the same amount in 2011.

Figure 3-8: Collected municipal waste by site of generation, 2012

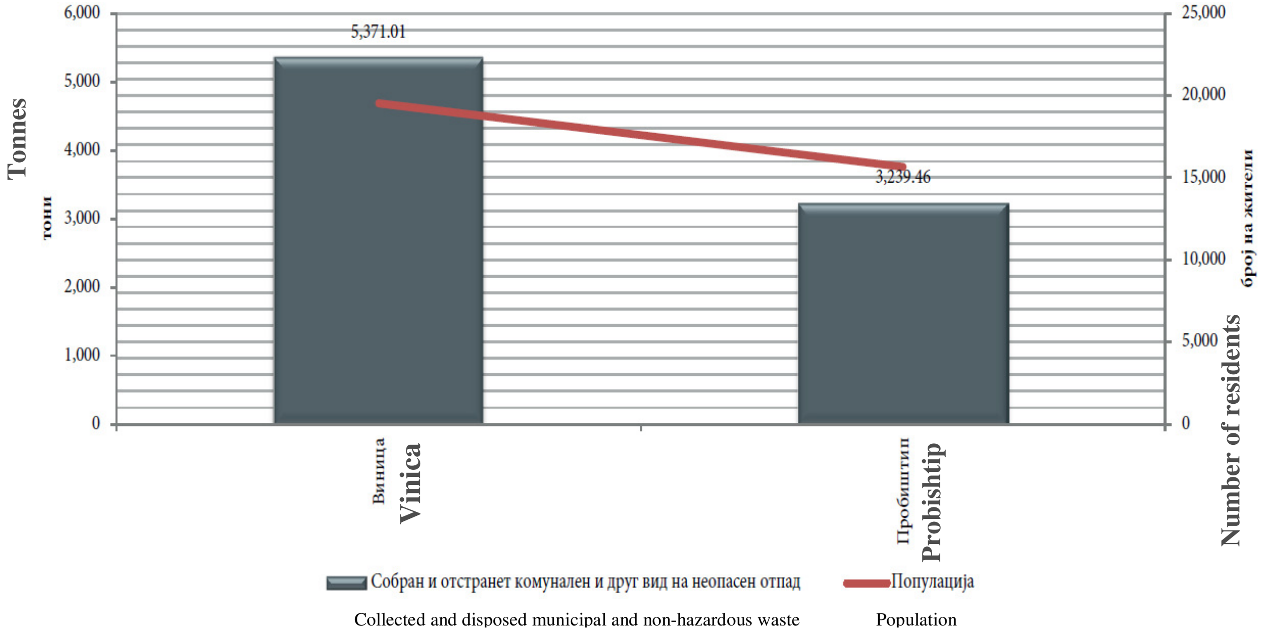


Source: State Statistical Office (http://www.stat.gov.mk/pdf/2013/5.1.13.17.pdf)

The mayors are required to submit an annual report on the handling of hazardous waste in the municipality to the Ministry of Environment and Physical Planning. The data obtained from East Region's mayors are presented in the following graph[9].

[8] Macedonian Environmental Information Center - MEIC (2013). Quality of the Environment – Annual Report 2012
[9] Macedonian Environmental Information Center - MEIC (2013). Quality of the Environment – Annual Report 2012

Figure 3-9: Reported collected and disposed municipal and non-hazardous waste in the municipalities of the East Region in 2012 (MEIC, 2013)



3.1.4 Medical Waste

According to literature data, of the total amount of waste generated by health-care activities, about 80% is general waste comparable to domestic waste. The remaining 20% is considered hazardous material that may be infectious, toxic or radioactive (WHO, 2011). Waste and by-products cover a diverse range of materials, as the following list illustrates (percentages are approximate values):

- infectious waste: waste contaminated with blood and its by-products, cultures and stocks of infectious agents, waste from patients in isolation wards, discarded diagnostic samples containing blood and body fluids, infected animals from laboratories, and contaminated materials (swabs, bandages) and equipment (such as disposable medical devices);
- pathological waste: recognizable body parts and contaminated animal carcasses;
- sharps: syringes, needles, disposable scalpels and blades, etc.;
- chemicals: for example mercury, solvents and disinfectants;
- pharmaceuticals: expired, unused, and contaminated drugs; vaccines and sera;
- genotoxic waste: highly hazardous, mutagenic, teratogenic1 or carcinogenic, such as cytotoxic drugs used in cancer treatment and their metabolites;
- radioactive waste: such as glassware contaminated with radioactive diagnostic material or radiotherapeutic materials;
- heavy metals waste: such as broken mercury thermometers.

Infectious and anatomic wastes together represent the majority of the hazardous waste, up to 15% of the total waste from health-care activities. Sharps represent about 1% of the total waste but they are a major source of disease transmission if not properly managed. Chemicals and pharmaceuticals account for about 3% of waste from health-care activities while genotoxic waste, radioactive matter and heavy metal content account for around 1% of the total health-care waste.

The major sources of health-care waste are:

- hospitals and other health-care establishments
- laboratories and research centres
- mortuary and autopsy centres
- animal research and testing laboratories
- blood banks and collection services
- nursing homes for the elderly.

In line with the current legislation in the field of medical waste management, health institutions that create medical waste are required to submit an annual report on the treatment of waste to the Ministry of Environment and Physical Planning.
According to data submitted by the health institutions in the FYR of Macedonia, the declared quantity of medical waste generated in 2012 was 444.78 tons.

European Waste Catalogue (EWC) codes are used to categorise all types of waste and are applicable to all types of clinical waste. The following table presents the generated quantities according to the types of medical waste[10]. The share of the various categories is different from the suggested by literature data, as the amount share of waste whose collection and disposal is subject to special requirements in order to prevent infection is 68,4%.

Table 3-5: Generated medical waste according to EWC code

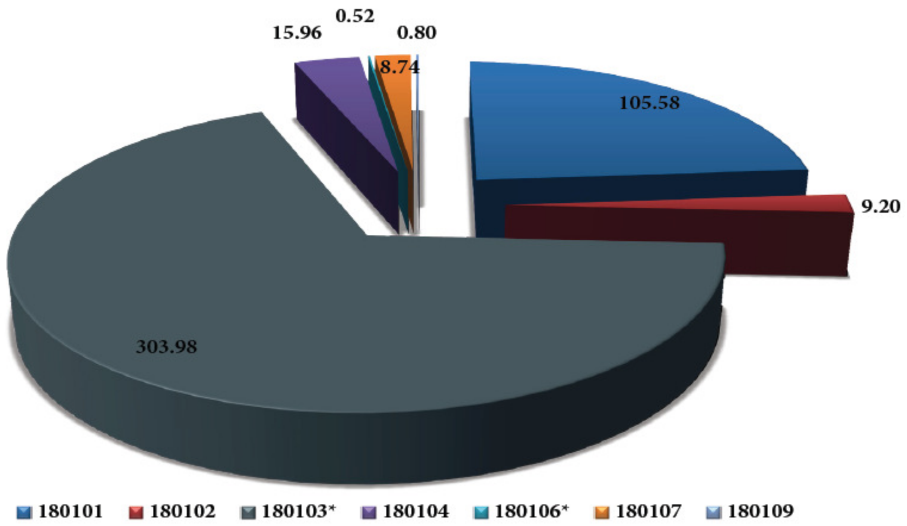
EWC code	Description	Quantity
18-00	Wastes from natal care, diagnosis, treatment or prevention of diseases in humans	444,78
18-01-01	Sharps, but not including those included in code 18-01-03*	105,58
18-01-02	Body parts and organs including blood bags and blood preserves (excluding those in category 18 01 03*)	9,20
18-01-03*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection	303,98
18-01-04	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection	15,96
18-01-06*	Chemicals consisting of dangerous substances	0,52
18-01-07	Chemicals not mentioned in 18-01-06	8,74
18-01-08*	Cytotoxic and cytostatic medicines	

[10] Macedonian Environmental Information Center - MEIC (2013). Quality of the Environment – Annual Report 2012

EWC code	Description	Quantity
18-01-09	Medicines other than those mentioned in 18 01 08*	0,80
18-01-10*	Amalgam waste from dental care	

Source: MEIC, 2013

Figure 3-10: Quantity of generated medical waste from health facilities reported in 2012 in the FYR of Macedonia - Quantity in tonnes



According to the submitted reports the shipped medical waste is 442.75 tons, while the waste treated and neutralized automatically amounts to 8.74 tons. According to the Annual Report, it should also be emphasized that the displayed amount of waste and do not represent the total amount of medical waste generated at the level of the Republic of Macedonia.

High-income countries generate on average up to 0.5 kg of hazardous waste per bed per day; while low-income countries generate on average 0.2 kg of hazardous waste per hospital bed per day[11].

According to the "Strategy on Biomedical (Healthcare) Waste Management" [12], regarding generated HCW amounts the figures fall in to two distinctive groups; Group 1 comprising hospitals etc. conducting "traditional" treatment and therapy where this kind of waste is generated in bigger amounts, and Group 2 where the treatment typically only will generate small amounts, like for instance in mental hospitals, rehabilitation healthcare facilities, etc.

An average value for HCW generation of 0.2 kg/bed-day for hospitals and specialised institutes performing secondary and tertiary healthcare services in the Republic of Former Yugoslav Republic of Macedonia was used. This figure was based on measured quantities at the "Drisla" landfill for the area of Skopje and Kumanovo. However, only for establishments in Skopje the figure of 0.24

[11] WHO (2011). Waste from health-care activities - Fact sheet N°253 [web page]. Retrieved from: http://www.who.int/mediacentre/factsheets/fs253/en/

[12] BCRC Bratislava (2008). Strategy on Biomedical (Healthcare) Waste Management – Former Yugoslav Republic of Macedonia [pdf]. Retrieved from: http://archive.basel.int/centers/proj_activ/tctf_projects/015-7.pdf

kg/bed was used, based on actual measured amounts at the "Drisla" gate. The daily estimated quantities were multiplied by the number of beds for each hospital.

An average of 0.34 kg/patient/day were used for the first group and 0.03 for the second group respectively. This figure was multiplied by reported number of treated patients in the year.

As already mentioned in par. 2.13, hospital care in the East Region is organized through a network of general hospitals. Tertiary health care for residents of the East Region, is located in Skopje. In view of the relatively small territorial distance of all settlements to the capital Skopje, this solution still provides access to all citizens to needed medical services.[13].

Table 3-6: Stip General Hospital – Number of beds, number of hospitalised patients per year, produced waste quantities per year

Indicator	Value	
Number of beds for patients	450 beds	
Number of hospitalized patients per year	2012 year	2013 year
	3,4% less than 2013	12,804
Produced waste quantities per year	hazardous waste 2013	20,277 kg
	non-hazardous waste 2013	1,200 m^3

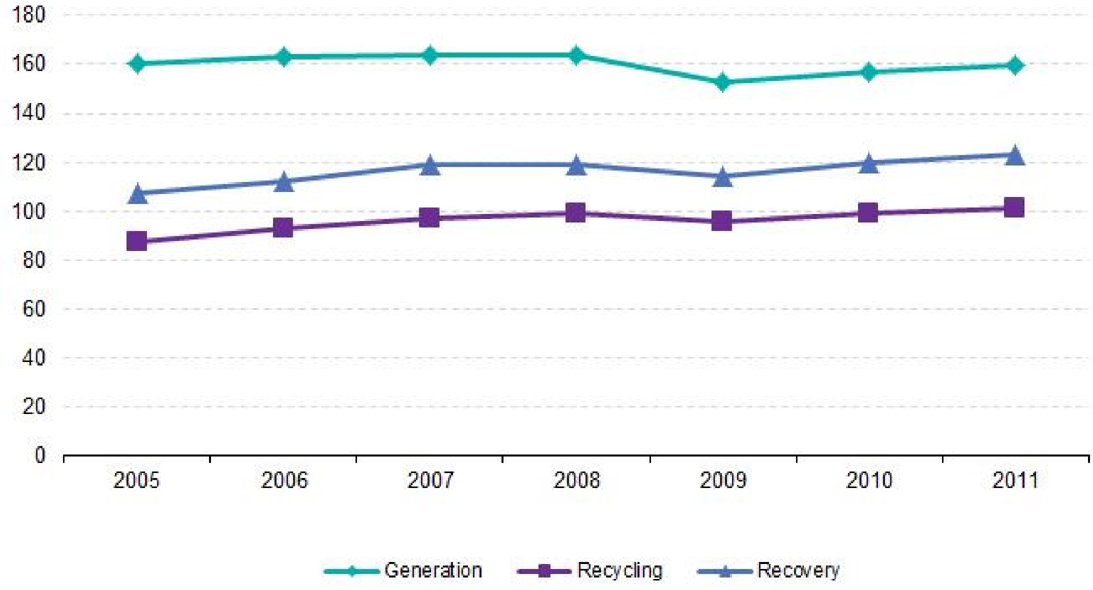
3.1.5 Packaging Waste

Regarding the packaging waste generation factor on European level, the following figure depicts the development of the quantity per capita of packaging material. The generation of packaging material per capita in the EU-27 in 2005 was 160.4 kg. The generation peaked in 2007 at 163.8 kg per capita and afterwards shrank to 153.1 kg per capita in 2009. In 2010 the packaging generated has somewhat recovered to 156.8 kg per capita and increased to 159.4 kg per capita in 2011[14].

[13] СОВЕТ ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН (2009). ПРОГРАМА 2009 – 2013 - ЗА РАЗВОЈ НА ИСТОЧЕН ПЛАНСКИ РЕГИОН [doc]. Retrieved from: www.rdc.mk/eastregion/docs/programazarazvojnaipr.doc

[14] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Packaging_waste_statistics

Figure 3-11: Development of packaging waste generated, recycled and recovered in EU-27 (kg/capita)



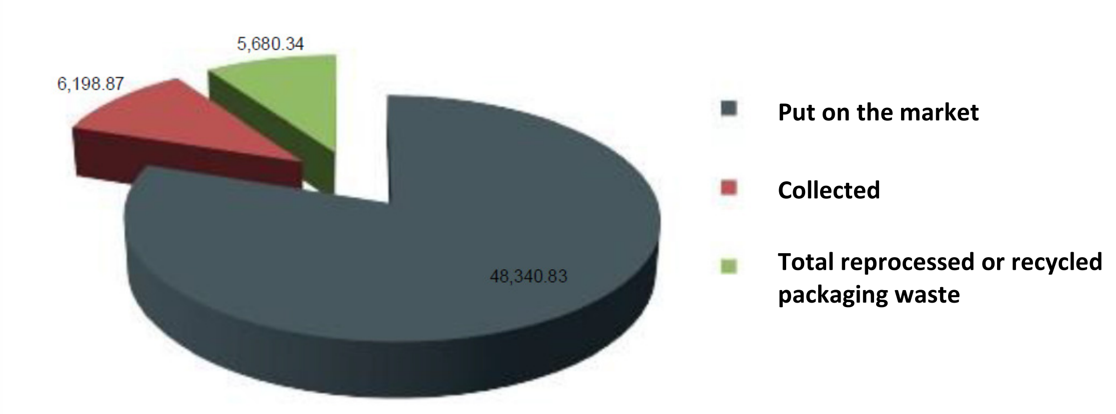
According to the annual reports submitted to the Ministry of Environment and Physical Planning for 2011, it can be seen that the total amount of packaging placed on the country's market amounted to 48,340.83 tons[15].

Table 3-7: Packaging placed on the county's market (tonnes) and packaging waste recycled (tonnes) in 2011, by material

Type of material	Placed on the Market	Recycled (or exported for recycling)	Recycling rate
Glass	9,241.36	29.00	0.31%
Plastic	13,963.12	2,657.06	19.03%
Paper and cardboard	16,660.45	2,927.32	17.57%
Metal	1,691.37	66.96	3.96%
Wood	2,973.93		
Composite materials	2,808.09		
Other/packaging not selected by type	1,002.51		
Total	**48,340.83**	**5,680.34**	**11.75%**

[15] Macedonian Environmental Information Center - MEIC (2013). Quality of the Environment – Annual Report 2012

Figure 3-12: Collection and treatment of packaging waste in 2011 at country level, quantity in tonnes



Packaging placed on the market in 2011, by type, amounts to 48,340.83 tonnes. There were 1,002.51 tonnes of packaging which was not reported by its type. The total amount of collected packaging waste was 6,198.87 tonnes, of which 4,166.19 tonnes were packaging waste from municipal sources and 2,032.68 tonnes of packaging waste from other sources.

The amount of recycling in 2011 was 2 625.89 tonnes in FYR Macedonia, an amount which relates to recycled plastic material, whereas the exported amount for recycling and other types of processing waste was 3 054.45 tonnes. Specifically, the amounts exported for recycling, by type, were 2 927.32 tonnes of paper and cardboard, 29 tonnes of glass, 66.96 tonnes of metal and 31.17 tonnes of plastic.

In total, 5,680.34 tonnes were recycled, which corresponds to 11.75 % of the packaging placed on the market. Specifically, by type of material, the recycling of glass packaging, in relation to the glass packaging placed on the market, is equal to 0.31 %; the recycling of plastic packaging, in relation to the plastic packaging placed on the market, is equal to 19.03 %; the recycling of paper and cardboard packaging, in relation to paper and cardboard placed on the market, is equal to 17.57 %; and the recycling of metal packaging, in relation to the amount of metal packaging placed on the market, is equal to 3.96 %.

In FYR Macedonia there are four legal entities which have permissions for treatment of packaging waste (collective handlers)[16], according to article 21 of the Law on managing packaging and packaging waste (Official Gazette of the Republic of Macedonia no. 161/09, 17/11, 41/11, 136/11, 6/12 and 39/12):

1. Pakomak
2. Euro-Ekopak

[16] EEA (2013). Municipal *Waste Management in the former Yugoslav Republic of Macedonia* [pdf]. Retrieved from http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.eea.europa.eu%2Fpublications%2Fmanaging-municipal-solid-waste%2Fmacedonia-fyr-municipal-waste-management&ei=YGL4UrfQAoeS0QX21YHIBQ&usg=AFQjCNFqABALaJnInndJ6h7kYbRyQBb7rg&sig2=0RZmZC76_06MuYHIKqyPw&bvm=bv.60983673,d.d2k

3. Ekosajkl
4. Eko-pak hit

More data on the legal entities, the equipment and the companies that take part in the schemes are provided in par. 3.3.4

Basic data on the collective schemes for the year 2012 are presented in the following table. Specific data for each region were not provided.

Table 3-8: Data on the collective handlers of packaging waste at country level- 2012

General Data	PAKOMAK	EURO ECO PACK	EKOSAJKL	EKO-PAK HIT
Number of companies that are members of the system	583	no data	42	48
Number of companies reporting to waste system	468	no data	42	16
Total reported quantities of waste (in tons)	**40,557**	**8,263**	**1,120**	**682**
Total reported amount of collected and recovered packaging waste (in tons)	**7595**	**9.2**	**211**	**132**
Percentage of recycled waste compared to the reported (in accordance with Article 35 paragraph (1)	18.7%	0.11%	18.8%	19.4%
Percentage of waste recycled compared to the reported (in accordance with Article 35 paragraph (1)	/	/	/	/

The following table presents the collected packaging waste in 2013 by Pakomak.

Table 3-9: Collected packaging waste in 2013 by Pakomak at country level

Month/tn	*Paper*	*Plastic*	*Glass*	*Metal*	*Wood*	*Composites*	Total (tn)
January	259.80	259.79					**519.60**
February	259.41	351.32			0.20		**610.93**
March	426.87	438.57			5.08		**870.51**
April	562.88	299.74		2.28	22.54		**887.44**
May	575.23	582.47	24.50		9.65		**1,191.85**
June	608.72	639.21	256.06	0.15	7.91		**1,512.05**
July	496.63	462.88	555.30		9.88		**1,524.70**
August	439.24	233.03	412.15		6.03		**1,090.45**
September	166.50	195.66			1.10		**363.25**
Oktober	192.41	48.50	79.41		0.36		**320.68**
November	170.44	25.83	26.62		0.66		**223.55**
December	145.04	32.14	33.22		1.73		**212.13**
to 31.12.2013	**4,303.17**	**3,569.14**	**1,387.26**	**2.43**	**65.14**	**0.00**	**9,327.13**
% Share	**46.1%**	**38.3%**	**14.9%**	**0.0%**	**0.7%**	**0.0%**	**100.0%**

3.1.6 Waste Batteries and accumulators

The definitions from the Law on Batteries and Accumulators and Waste Batteries and Accumulators (Official Gazette of the Republic of Macedonia No. 140/10, 47/11 and 148/11) will be used[17]:

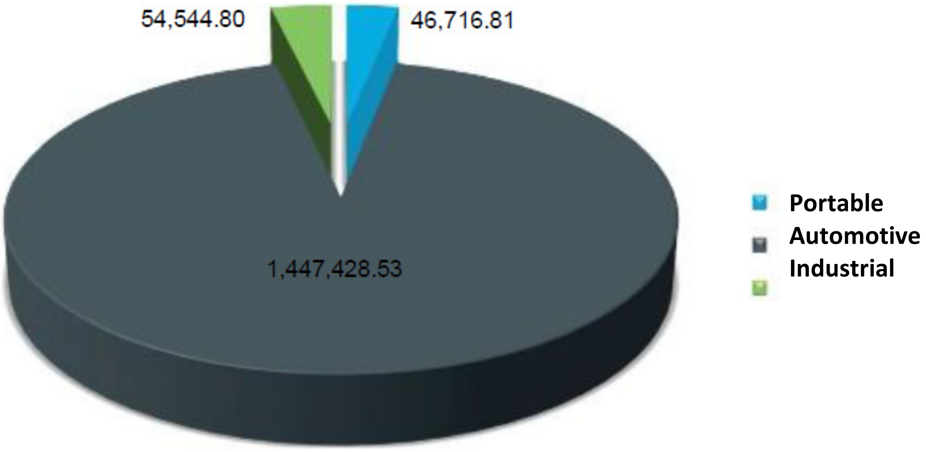
- Battery or accumulator means any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more battery cells (non-rechargeable), or consisting of one or more secondary battery cells (rechargeable);
- Battery pack means any set of batteries or accumulators that are connected together and/or encapsulated within an outer casing so as to form a complete unit that the end user is not intended to split up or open;
- Portable battery or accumulator means any battery, button cell, battery pack or accumulator that:
  - is sealed; and
  - may be hand-carried; and
  - is neither an industrial battery or accumulator nor an automotive battery or accumulator;
- Button cell means any small round portable battery or accumulator whose diameter is greater than its height and which is used for special purposes such as hearing aids, watches, small portable equipment and back-up power;
- Automotive battery or accumulator means any battery or accumulator used for automotive starter, lighting or ignition power;
- Industrial battery or accumulator means any battery or accumulator designed for exclusively industrial or professional uses or used in any type of electric vehicle.

Also, portable batteries are divided into primary and secondary/rechargeable.

There is no manufacturing of batteries the FYR of Macedonia. According to the annual reports submitted to the Ministry of Environment and Physical Planning, the total amount of batteries and accumulators placed on the country’s market is 1,548.690.13 kg (portable – 46,716.81 kg, automotive- 1,447,428.53 kg and industrial – 54,544.80 kg). Automotive batteries have the largest share in terms of quantity - 93.46%[18].

[17] Mattson, C., Eklund, L., Maznevska, K.A, Apostolova, I. (2013). Assessment of waste batteries and accumulators management in the Republic of Macedonia.
[18] Macedonian Environmental Information Center - MEIC (2013). Quality of the Environment – Annual Report 2012

Figure 3-13: Quantity of batteries and accumulators placed on the market at country level, in 2011, in kg



According to the annual reports for 2011, the quantity of collected portable, automotive and industrial waste batteries and accumulators is 29.43 kg, 2,601,994 kg and 2,389.90 kg respectively. The automotive batteries have the largest share of the collected waste batteries and accumulators - 99.9 %. The total amount of exported waste batteries and accumulators for treatment and recycling consists almost entirely of automotive waste batteries – 1,270,200 kg.

Table 3-10: Waste batteries and accumulators collected, recycled and treated or exported for treatment (kg) in 2011 at country level (MEIC, 2013)

	Waste batteries and accumulators collected, kg	Waste batteries and accumulators recycled and treated, kg	Waste batteries and accumulators exported for treatment and recycling, kg
Portable	29.43	0.00	0.17
Automotive	2,601,994.00	2,365,584.00	1,270,200.00
Industrial	2,389.90	0,00	0.00
Total	**2,604,413.33**	**2,365,584.00**	**1,270,200.17**

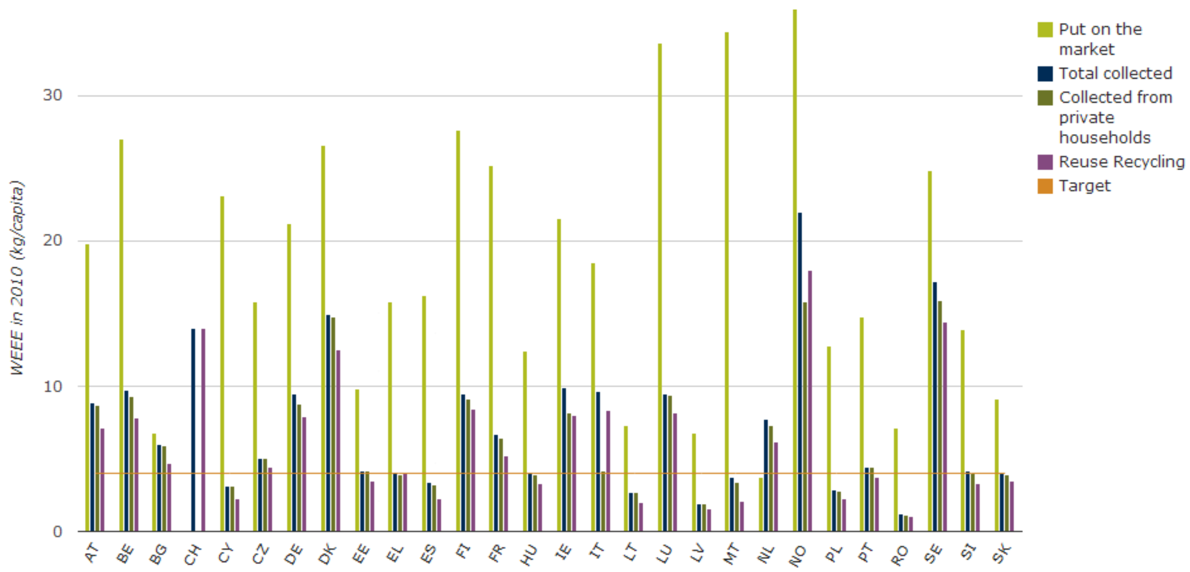
The collected WBA are taken over by companies that are licensed to collect hazardous waste, issued in accordance with the Law on Waste Management. Two companies in Macedonia have licences for handling waste batteries and accumulators (collective schemes): "OBA Recycling"-Stip and "Nula Otpad"-Skopje. According to the reports submitted to MOEPP/EA for 2012, 696,047 kg waste automotive batteries were collected by OBA Recycling, and 315,606 by Nula Otpad. The recycling market for WBA in Macedonia is undeveloped, except for automotive batteries. Tab Mak, LLC from Probishtip (former VESNA SAP LLC Probishtip) is holding an A-integrated environmental permit no. 11-2486/2 in accordance with the Law on Environment and a license for performing the activities of collection, treatment and recovery of automotive batteries. [19]

[19] Mattson, C., Eklund, L., Maznevska, K.A, Apostolova, I. (2013). Assessment of waste batteries and accumulators management in the Republic of Macedonia.

3.1.7 Waste electrical and electronic equipment (WEEE)

Waste electrical and electronic equipment (WEEE) is currently considered to be one of the fastest-growing waste streams. WEEE contains a number of hazardous substances and at the same time valuable materials. There is also a time lag between the point at which a product is put on the market and when it is discarded. While there is a possible environmental advantage of using new products or their components in certain EEE from an energy efficiency point of view, from a resource efficiency point of view it is often better to use products longer. Due to the life span of the majority of EEE products the comparison of the amount put on the market and the amount collected in the same year is just an indicative number. Ideally, a collection rate would have to be calculated as rate of the WEEE generated, but this data does not exist. Data indicates that while reuse and recycling of the collected waste electrical and electronic equipment (WEEE) seems to be on track in the majority of the EU and EFTA member countries, the collection of the WEEE has shown varying but generally improving results. It appears that the amounts of WEEE that are collected, are largely reused (either as a whole appliance or components) or recycled although there is still room for improvement in some countries. However, more attention should be given to the improvement of collection systems. The level of collection is still very low in many countries, especially when compared to the amount put on the market.[20].

Figure 3-14: Electric and electronic equipment put on the market, WEEE collected and recycled/reused in 28 European countries (kg/capita/year), in 2010



The recast Directive (2012/19/EU), which entered into force on 13th of August 2012, introduces stepwise higher collection targets that will apply from 2016 and 2019[21]. The existing binding EU collection target is 4 kg of WEEE per capita, representing about 2 million tons per year, out of

[20] http://www.eea.europa.eu/data-and-maps/indicators/waste-electrical-and-electronic-equipment/assessment-1

[21] http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/key_waste_streams/waste_electrical_electronic_equipment_weee

around 10 million tonnes of WEEE generated per year in the EU. By 2020, it is estimated that the volume of WEEE will increase to 12 million tons.[22]

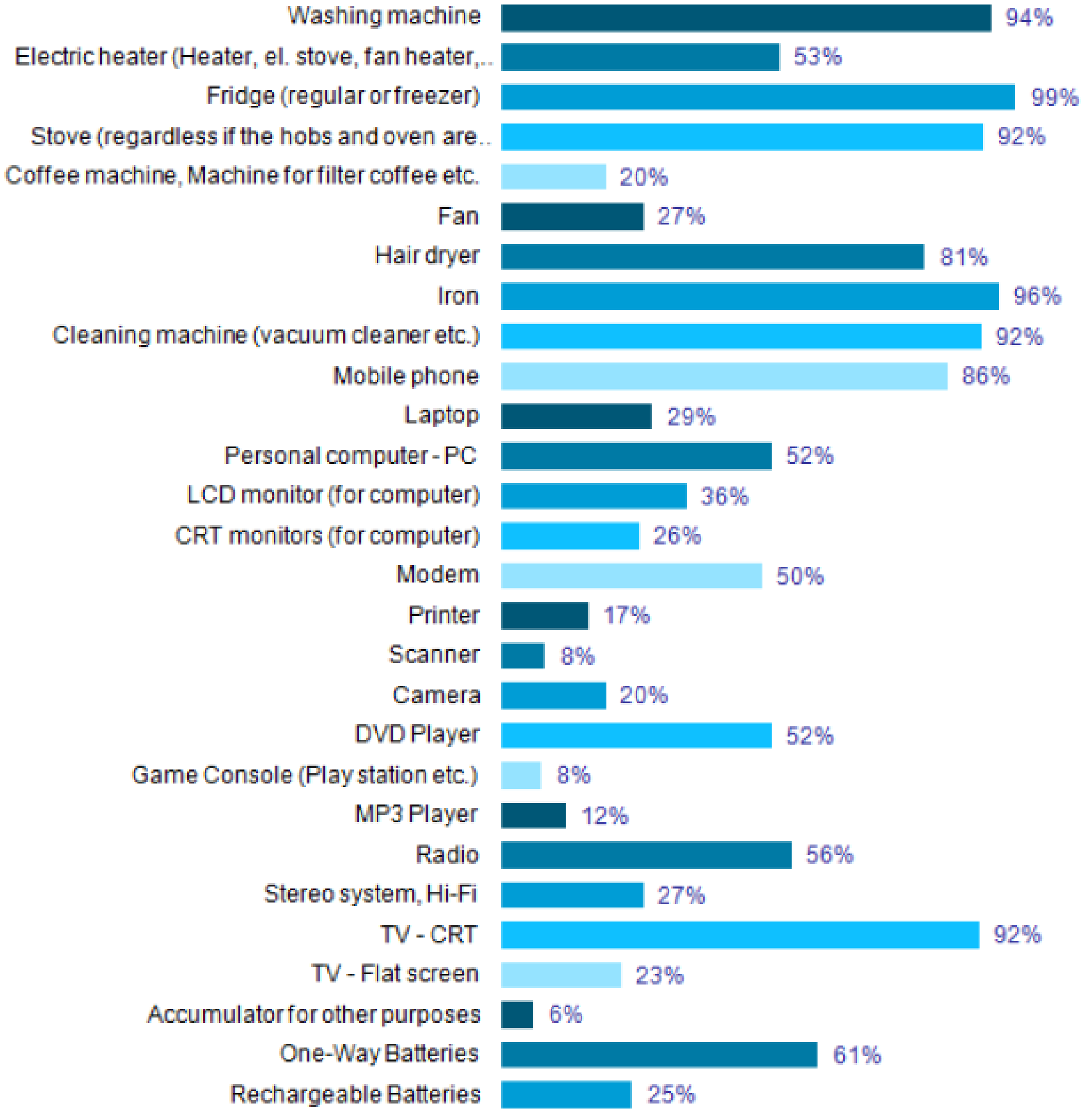
A European citizen has an average of 362 kg WEEE at his disposal. Subdivided into the specific fractions, the main portions contain "white goods (135 kg), cooling units (63 kg), TV/HiFi equipment (86 kg) and computers (37 kg)[23].

There are various methods to determine the generated WEEE quantities.[24]

According to a household survey conducted within the 2-year project "Balkan E-Waste Management Advocacy Network (BEWMAN)", initiated by Metamorphosis Foundation (www.metamorphosis.org.mk) and co-financed by the European Union's IPA 2008 Programme of the Civil Society Facility[25], the highest percentage, or 99% of the total population have refrigerator, 94% have washing machine, 92% have oven, 53% have some electric heating element, while only 20% have electric coffee machine.

[22] http://ec.europa.eu/environment/waste/weee/index_en.htm
[23] http://ec.europa.eu/environment/waste/weee/pdf/final_rep_unu.pdf, http://www.wtert.eu/default.asp?Menue=1&ArtikelPPV=23470
[24] http://www.srcosmos.gr/srcosmos/showpub.aspx?aa=8522
[25] http://www.eco-innocentre.mk/en/sections/electronics/documents/e-wasteassess

Figure 3-15: Appliances that are in use in households, total



Source: E-Waste Assessment in Macedonia, 2011

Figure 3-16: Household products that are not in use, but still kept within the household

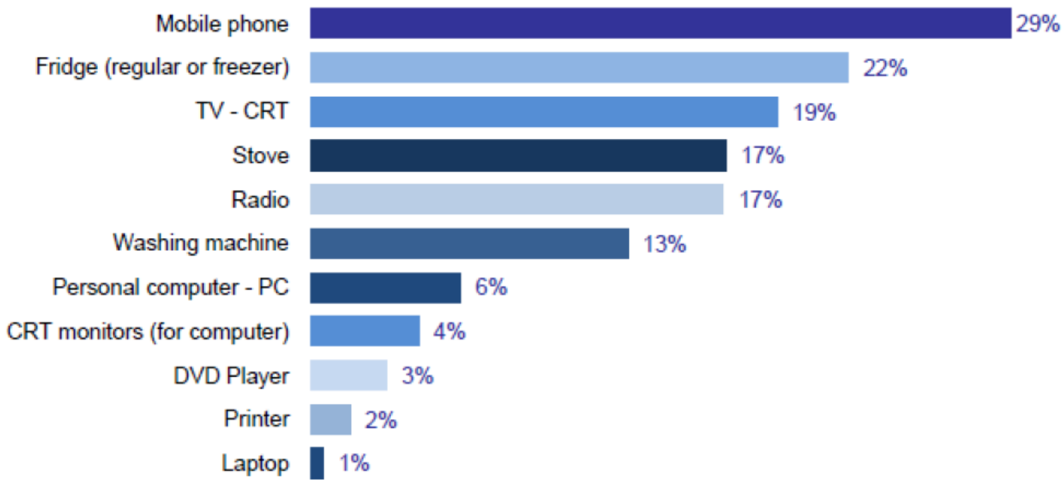
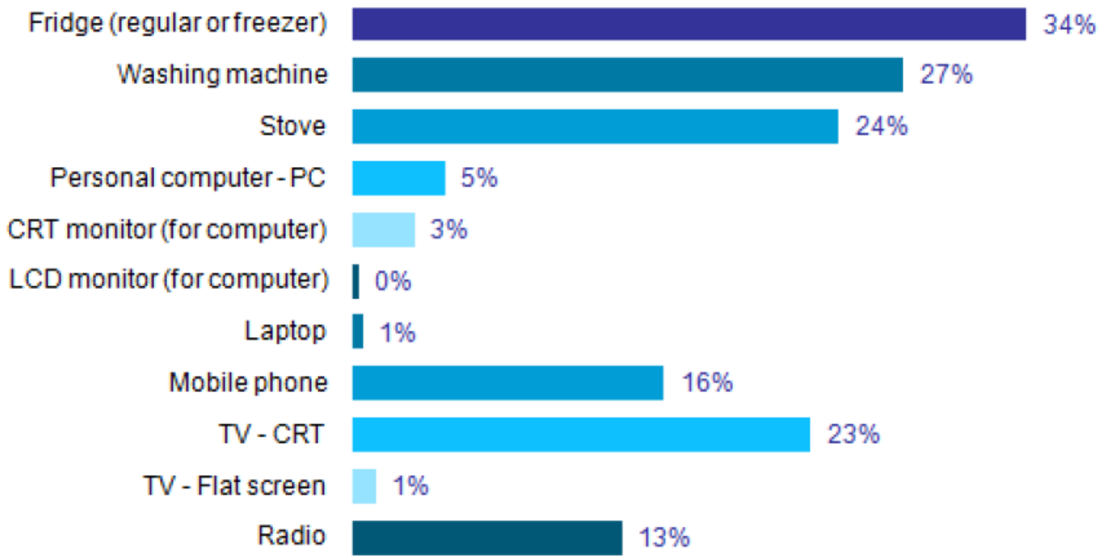


Figure 3-17: Household appliances that have been disposed from the household



40% of the total population that removed a refrigerator from home (which is 34%) gave the refrigerator as a donation/gift, while 30% gave it or sold it to a street dealer. The situation is similar with those 27% of the households that removed the washing machine from their home. 33% of them gave the mashing machine as a donation/gift, while 35% gave it/ sold it to a street dealer.

FYR Macedonia's WEEE Law takes effect from 2014. The law enforces take-back obligations on EEE producers and requires them to pay a high environmental fee from 2015 if they fail to meet collection targets through individual or collective waste plans. In September 2013 the first application to act as a compliance organisation for WEEE, was submitted by Nula Otpad (Zero Waste). Nula Otpad was issued a license to manage waste batteries in October 2012[26].

[26] http://www.b2bweee.com/publications/news/201-weee-registration-deadline-in-fyr-macedonia-remains

3.1.8 Construction and demolition waste (C&D)

Construction and demolition (C&D) waste has been identified by the EC as a priority stream because of the large amounts that are generated and the high potential for re-use and recycling embodied in these materials. Indeed, a proper management would lead to an effective and efficient use of natural resources and the mitigation of the environmental impacts to the planet. According to an EC study on C&D waste[27], there are several recent sources who provide with estimates of C&D waste arising in Europe.

Source	Total C&D waste arising (million tonnes)	C&D waste (tn) per capita
[WBCSD 2009] (2002 data)	510	1.1
[ETC/RWM 2009](2004 data)	866	1.8
[EUROSTAT 2010] (2006 data)	970	2.0

Available estimates are therefore highly variable. ETC/SCP working paper – Present recycling levels of Municipal Waste and C&D Waste in the EU, published in April 2009, gave estimates of per capita generation levels in all MS, with the exception of Romania and Slovenia. These data show important differences between MS: generation per capita ranges from 0.04 tonnes per capita (Latvia) to 5.9 tonnes per capita (Luxembourg).

A cross-analysis with an economic indicator (waste generated per € added value in the construction sector) also results in important differences (0.02 to 5.02 thousand tonnes of C&D waste per million Euros added value in the construction sector).

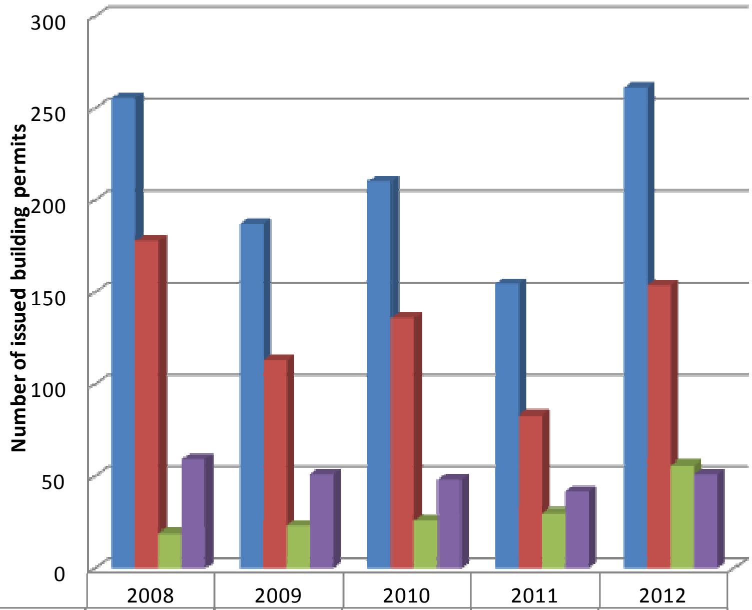
Six countries (Denmark, Finland, France, Germany, Ireland and Luxembourg) reported high quantities of C&D waste generation (over 2 tonnes per year per capita). Seven countries (Bulgaria, Greece, Hungary, Latvia, Lithuania, Poland and Slovakia) report very low levels of C&D waste generation (below 500 kg per year per capita). According to the study, these high geographical variations cannot be assumed to reflect actual arising of C&D waste. The quality of the available data is therefore the main issue in estimating the quantities of C&D waste generated.

The resulting ranges of quantities of C&D waste arising are the following: C&D waste (excluding excavation material): 0.63 to 1.42 tonnes per capita per year C&D waste + excavation waste: 2.3 to 5.9 tonnes per capita per year. Very low levels of generation reported in some Members States probably reflect a very incomplete reporting of C&D waste arising. As a result, these quantities were assumed to be underestimated and the average generation rate per capita for other countries was applied (0.94 tonne per capita per year, excluding excavation material). It must be stressed that the uncertainty is extremely high. According to State Statistical Office, construction and demolition waste (including excavated soil from polluted areas) at country level in 2010 was

[27] Monier, V., Hestin, M., Trarieux M., Mimid, S., Domrose, L., Acoleyen, Van M., Hjerp, P., Mudgal, S. (2011). Study on the management of construction and demolition waste in the EU. Contract 07.0307/2009/540863/SER/G2, Final report for the European Commission (DG Environment)

1,316.86 tonnes[28] or 0.64 kg/capita/year (1,316.86tn/2,055,004 inhabitants in 2010). These quantities are underestimated. Furthermore, according to the waste survey conducted in East Region during the elaboration of the Assessment Report, the C&D waste had a share of 1.39% in total waste generation or 628.7 tonnes per year or 3.5 kg/capita/year. Also, the number of issued building permits in East Region does not follow a steady pattern since 2008.

Figure 3-18: Number of issued building permits in East Region (2008-2012)



	2008	2009	2010	2011	2012
Number of issued building permits, Total	256	187	210	155	261
Of that, Buildings	178	113	136	83	154
Of that, Civil engineering	19	23	26	30	56
Of that, Reconstruction	59	51	48	42	51

3.1.9 Agricultural waste

The basins of Pijanec and Maleshevo are favorable for growing fruits and vegetables. The following table presents the production of fruits and vegetables and the crop production in East Region. Also, coefficients that indicate the ratio of residue quantity to product yield and the moisture content of each type of residue according to literature, are presented in the following table.

Figure 3-19: Crop production and residues in East Region

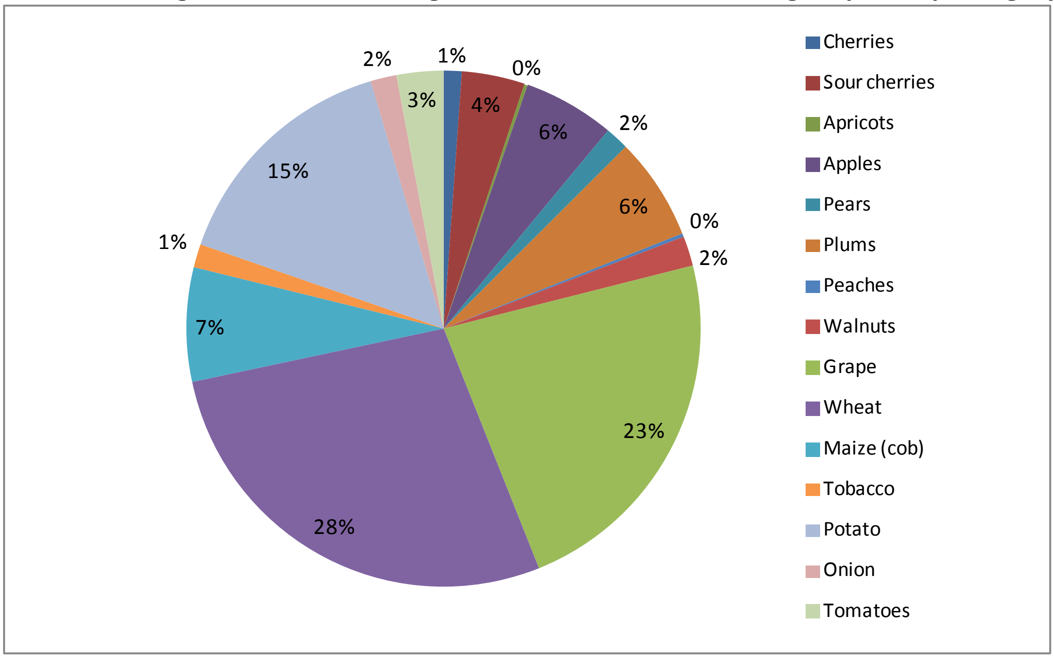
Category	Production in 2012, tn	Product/ Residue Ratio	Moisture (%)	Residues in 2012 (tn)
Fruits and grape				
Cherries	750	1.20	40	625
Sour cherries	2,613	1.20	40	2,178
Apricots	323	2.84	40	114
Apples	3,797	1.20	40	3,164

[28] http://www.stat.gov.mk/pdf/2012/5.1.12.17.pdf

Category	Production in 2012, tn	Product/ Residue Ratio	Moisture (%)	Residues in 2012 (tn)
Pears	1,031	1.26	40	818
Plums	7,817	2.20	40	3,553
Peaches	298	2.51	40	119
Walnuts	559	0.54	40	1,035
Grape	15,146	1.20	45	12,622
Crops				
Wheat	15,271	1.00	15	15,271
Maize (cob)	14,851	3.75	50	3,960
Tobacco	731	0.91	85	803
Potato	20,863	2.50	60	8,345
Onion	2,241	2.50	50	896
Tomatoes	5,374	3.33	80	1,614
Pepper	8,041	n/a	n/a	
Cucumbers	825	n/a	n/a	
Total	**100,531**			**55,117**

Source: State Statistical Office / Apostolakis et al, 1987 and EUBIONET - Biomass survey in Europe-Country report of Greece, 2003[29] / Liantinioti, Kalliopi T. (2011). Assessment of the potential for production and exploitation of biogas in the Municipality of Metsovo.

Figure 3-20: Share of agricultural residues in East Region per crop category, 2012



29 http://www.afbnet.vtt.fi/greece_biosurvey.pdf

3.1.10 Industrial Waste

East Planning Region is presenting a considerable industrial activity which covers many different production sectors (Mining and Quarrying, Manufacturing and Electricity – Gas – steam and air conditioning supply).

According the data provided by the State Statistical Agency (2010) and focusing on the non – hazardous industrial waste, in the East Planning Region is produced 143.391,19 tn of non hazardous industrial wastes, almost the 12.47% of the overall country production. In more details the previous mentioned data are summarized in the following Table.

Table 3-11: Industrial Waste in East Planning Region (2010)

	Mining and quarrying waste (tn)	Manufacturing waste (tn)	Electricity, gas, steam and air conditioning supply waste (tn)	Total industrial waste (tn)
East Planning Region	854.626,73	7.743,17	84,15	862.454,05

Table 3-12: Industrial Hazardous Waste in East Planning Region (2010)

	Mining and quarrying hazardous waste (tn)	Manufacturing hazardous waste (tn)	Electricity, gas, steam and air conditioning supply hazardous waste (tn)	Total hazardous waste (tn)
East Planning Region	719.038,03	17,87	6,95	719.062,85

Table 3-13: Industrial non-Hazardous Waste in East Planning Region (2010)

	Mining and quarrying non – hazardous waste (tn)	Manufacturing non – hazardous waste (tn)	Electricity, gas, steam and air conditioning supply non – hazardous waste (tn)	Total non – hazardous waste (tn)
East Planning Region	135.588,70	7.725,29	77,20	143.391,19

Source: *State Statistical Office (http://www.stat.gov.mk)*

The main centers of industrial activities and the legal entities in East Planning Region were presented in par. 2.14 of the Regional Waste Management Plan.

Based on the adopted law, "Decree determining installations requiring an integrated environmental permit timetable for submitting operational plans "(Official Gazette 89/2005), are specified the **criteria and deadlines** that operators of installations must fulfill in order to submit requests for integrated environmental permits or licenses to comply with the operational plan. This is done in order to give sufficient time for operators to achieve compliance requirements for their installations according to Best Available Techniques (BAT) approved by the European Commission. The deadline for achieving this targets is April 1, 2014, pursuant to the Stabilisation and Association Agreement.

The criteria in the regulation, divide the type of installation in Type A and B - installations, depending on the installation capacity and type of production. Type A – installations are based on the same criteria set for capacity given in the IPPC directive and described in Annex 1 of IPPC Regulation.

Given that B installations are not covered by the Directive, the local legislation has gone a step further than the directive and covers them with Annex 2 of the Legislation, stating that there is an essential difference in the conditions to be meet by A and B installations.

License A – installations must comply with BAT notes, known as BREF documents (Best Available Techniques Reference document) approved by the European Commission. To date, about 30 have been approved BREF documents. BAT notes are comprehensive documents that provide a complete and integrated view within a given sector.
However, these documents do not provide an accurate description of the BAT nor prescribed emission limit values. They only make recommendations. The final decision on what constitutes BAT for a particular installation, on-site, is the result of negotiations between the Authority and the operator.
B - installation (Installations with a capacity smaller than those in Annex 1 to the Regulation and are given in Annex 2 of the Regulation), must comply with the emission limit values for substances of zagaduvchki poodleni media prescribed by law or regulations. They will be recommended but not legally obligatory usoglesuvanjeto with BAT.
In Annex of this report is presented the legal entities that following the IPPC Regulation and depending on the industrial sector of activities, possess License-A and License-B.

LICENSE-A LEGAL ENTITIES

Municipality of Probistip

a. License – A with adjustment plan, Wesnoth SAP, Probistip MEPP.

Municipality of Delcevo

a. License – A with adjustment plan, Granit AD Skopje, Asphaltic Construction Site, Delcevo MEPP.

Municipality of Berovo

a. License – A, Integrated Environmental Permit for Pig Farm, Smojmirovo, Berovo MEPP.

Municipality of Stip

a. License – A with adjustment plan, Minolta d.o.o., Stip MEPP 11-12227/1 since 20.12.2013.

LICENSE-B LEGAL ENTITIES

Municipality of Probistip

a. License – B Integrated Environmental Permit for Strmos Inc. Non – metal mines – Probistip.

Municipality of Stip

a. License – B with adjustment plan for Pelagonija - Engineering Ltd – Stip.
b. License – B with adjustment plan for V.I.T d.o.o. – Stip.

Municipality of Cesinovo – Oblesevo

a. License – B with adjustment plan for "Opalit" Dooel metals, Cesinovo – Oblesevo.
b. License – B with adjustment plan the "MAK MLIN" d.o.o. DPTU Municipality Cesinovo – Oblesevo.

Municipality of Berovo

a. License – B with adjustment plan Inc. "Alkaloid", Berovo.

3.2 SOCIO - ECONOMIC DESCRIPTION OF THE REGION

3.2.1 Labor force and number of employees

A) Labor force in the country

The labor force is the actual number of people available for work. The labor force of a country includes both the employed and the unemployed.

The economically inactive population comprises all persons who were neither "employed" nor "unemployed" during the short reference period used to measure "current activity"and is not part of the labour force. This population is split into four groups:

-Attendant at educational institutions;
- Retired;
- Engaged in family duties;
- Other economically inactive.

Working age population by economic activity in the Republic of Macedonia of the last 4 years is shown on the table below:

Table 3-14: Working age population by economic activity for Macedonia

Economic activity	2009	2010	2011	2012
Labour Force	928 775	938 294	940 048	943 055
Employed	629 901	637 855	645 085	650 554
-Employed (without Employed in agriculture)	513 300	516 334	524 192	523 662
-Active agricultural population	116 601	121 521	120 893	126 892
of which unpaid family workers	64 349	64 111	61 705	55 336
Unemployed	298 873	300 439	294 963	292 502
Inactive population	710 094	710 228	716 166	726 910

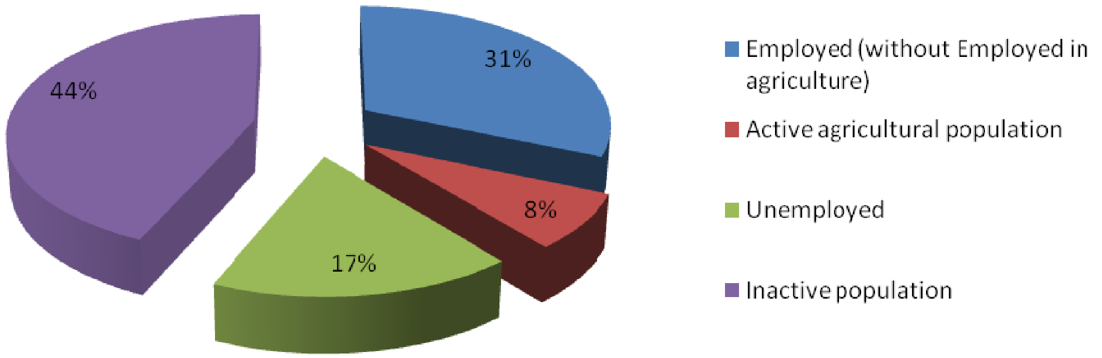
Source: State Statistical Office of the Republic of Macedonia

The economically active population increases in average 1% annually. The highest increase is in active agricultural population which increases in 2010 and 2012 respectively with 4,2% and 5%. Unpaid family workers gradually decrease during this period, as the highest decrease is in 2012 with more than 10% comparing to previous year.

Number of the inactive population also increase slowly in the period, from 0% to 1.5%.

The strucure of the labor force in Macedonia in 2012 is presented in the figure below:

Figure 3-21: Working age population by economic actvity in Macedonia



Largest share takes inactive population with 44% of the working age population. Employed people are 39% and unemployed are 17% of the working age population.

B) Number of employees in each of the major activities in Republic of Macedonia

Summary of the number of employees in each major activities in Republic of Macedonia for the last 3 years is presented in the table …

Table 3-15: Number of employees in each major activities in Republic of Macedonia

	2010	2011	2012
TOTAL	435 078	458 873	474 398
Agriculture, forestry and fishing	12 176	12 394	12 348
Mining and quarrying	3 697	3 989	4 382
Manufacturing	101 093	100 878	101 132
Electricity, gas, steam and air conditioning supply	7 716	7 711	7 833
Water supply; sewerage, waste management and remediation activities	8 392	8 555	9 024
Construction	23 340	26 106	27 575
Wholesale and retail trade; repair of motor vehicles and motorcycles	77 010	83 679	87 064
Transportation and storage	22 696	26 453	28 441
Accommodation and food service activities	13 988	16 267	18 359
Information and communication	8 523	9 823	9 972
Financial and insurance activities	8 404	8 513	8 843
Real estate activities	1 566	1 714	2 000
Professional, scientific and technical activities	12 036	13 783	15 692
Administrative and support service activities	12 552	13 319	14 610
Public administration and defence; compulsory social security	42 474	43 258	44 006

	2010	2011	2012
Education	35 193	36 099	36 002
Human health and social work activities	31 200	32 505	32 775
Arts, entertainment and recreation	7 648	7 375	7 986
Other service activities	5 374	6 452	6 354

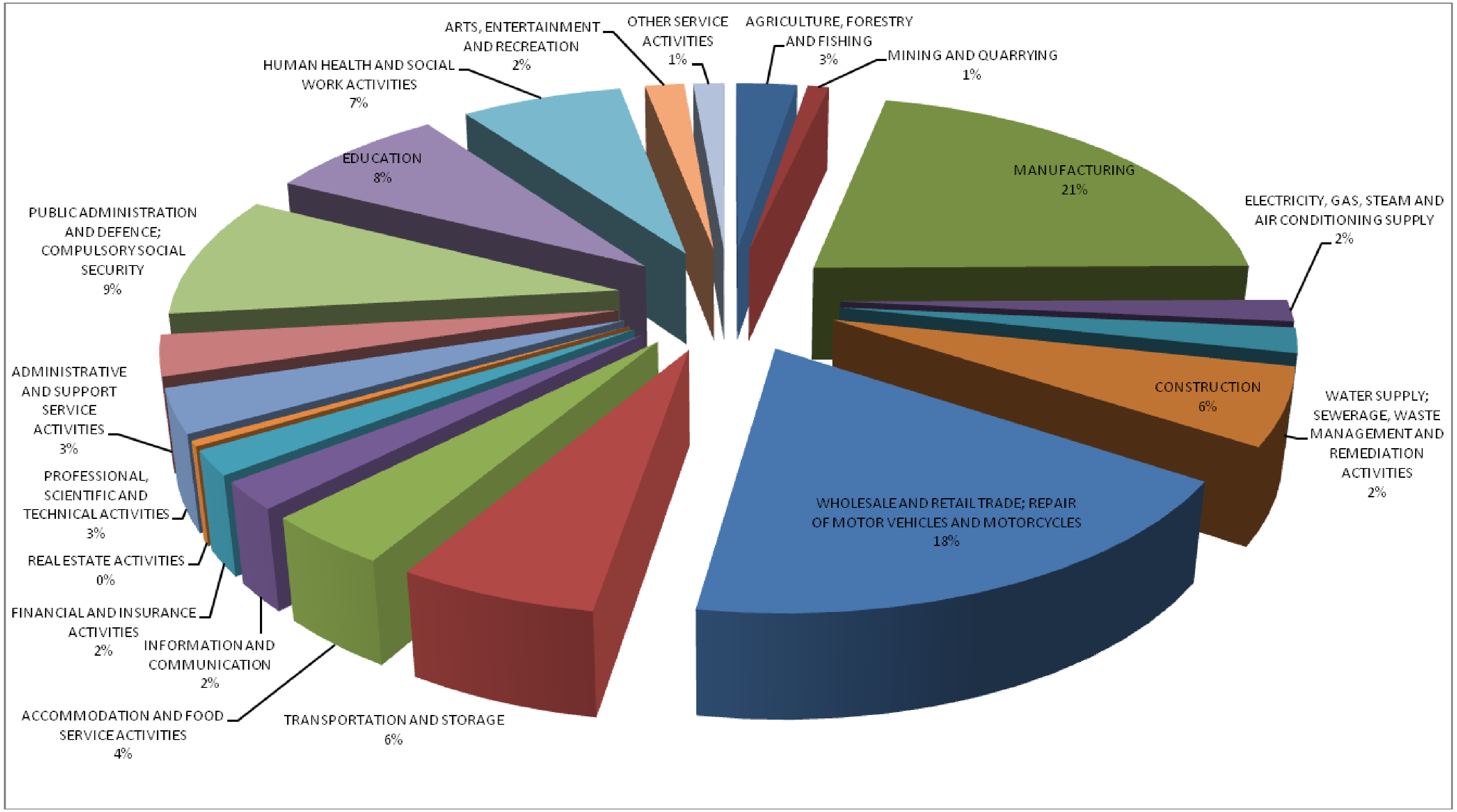
Source: State Statistical Office of the Republic of Macedonia

Detailed information about the number of employees by sections and divisions of activities in Republic of Macedonia is shown in Annex 1.

The largest increase durin period 2010-2012 is in the transportation and storage, accommodation and food service activities and professional, scientific and technical activities with average about 15% per year.

Distribution of the number of employees by sectors is shown in the figure below:

Figure 3-22: Distribution of the number of employees by sectors in 2012



The largest number of the employees is in Manufacturing, about 21.3%, followed by Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles with share of 18.4% of the employees. Less are the employees in Real estate activities and Mining and Quarrying.

C) Average wage

Data provided by the State Statistical Office shows that average nominal wage growth has decelerated during the past two years. When inflation (as measured by the Consumer Price Index) is taken into account, the country's average real salary only turned to growth in 2013, after two years of real decrease. The average salary for 2013 (according to preliminary data) is set to be approximately 21 132 MKD.

Table 3-16: Average monthly salary, Republic of Macedonia

	2005	2006	2007	2008	2009	2010	2011	2012	2013[30]
Monthly salary, average for the year, MKD	12.600	13.518	14.586	16.095	19.958	20.554	20.848	20.903	21.132
Monthly salary growth, y/y, %		7,29%	7,90%	10,34%	24,01%	2,98%	1,43%	0,26%	1,10%
CPI Growth, y/y, %	0,50%	3,20%	2,30%	8,30%	-0,80%	1,60%	3,90%	3,30%	0,30%
Real salary growth, %		4,1%	5,6%	2,1%	24,8%	1,38%	-2,5%	-3,1%	0,8%

Source: State Statistical Office of the Republic of Macedonia

Net wage per employee (MKD per year) by sectors in the period 2005-2013 in Republic of Macedonia is shown in Annex 3.

East region (compared to Republic of Macedonia)

A) Labor force in East region

The East region registers the second lowest average unemployment rate among all Macedonian regions and second high employment rate. The 2012 growth would have been even higher if amendments in legislation, changing the way unemployment is calculated, had not taken place. The high proportion of agricultural activity in the regional economy is underestimate unemployment rates, as employment in the agricultural sector is traditionally less accounted for in official statistics.

Structure of the labor force in East region is better than that in Republic of Macedonia.

Data for population, working age population and labor force in Macedonia and East region in 2012 is in the following table.

[30] Preliminary data

Table 3-17: Labor force in Macedonia and East region in 2012

	measure	Republic of Macedonia	East Region
Population	number	2 061 044	178 814
Unemployment rate, total	%	31	18,50
Working age population	number	1 669 966	149 857
Activity rate	%	56,5	61,5
Employment rate	%	39,0	50,1
Labour Force	number	943 056	92 162*
Employed	number	650 554	75 078*

Source: State Statistical Office of the Republic of Macedonia

*Note: * data are calculated on the basis of % provided by State Statistical Office of the Republic of Macedonia.*

The activity rate in the East region in 2012 was above the activity rate at national level. Unemployment in the East region is significantly lower than the unemployment of the country.

Figure 3-23: Labor force in East region compared to Macedonia

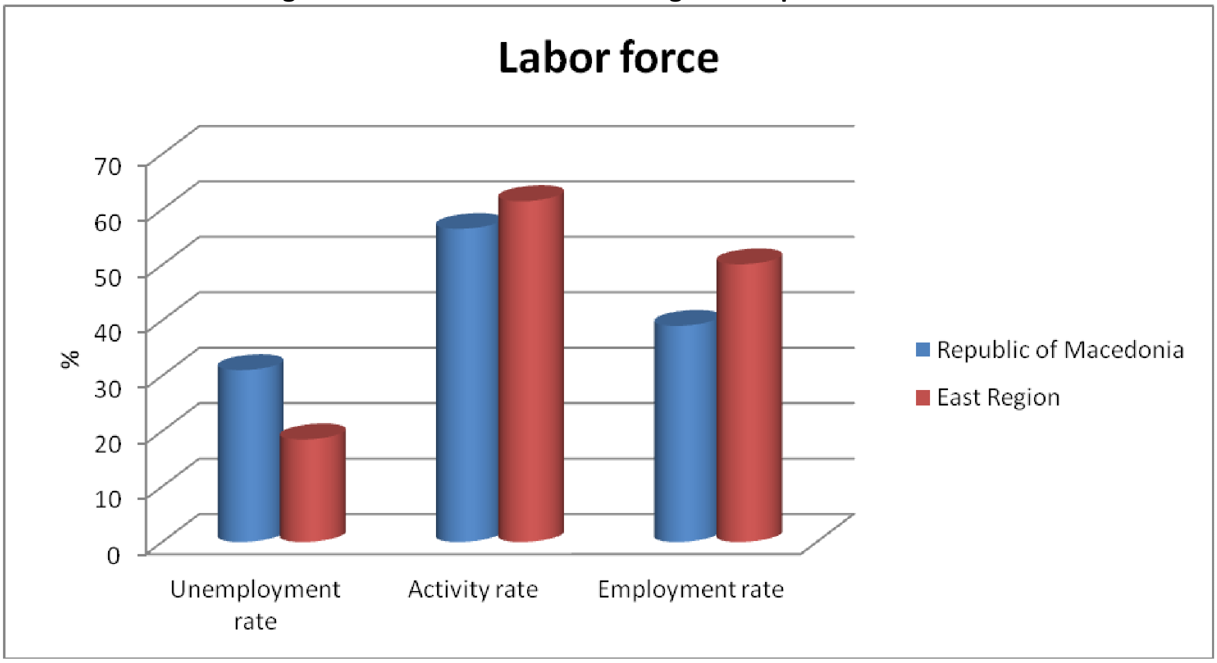
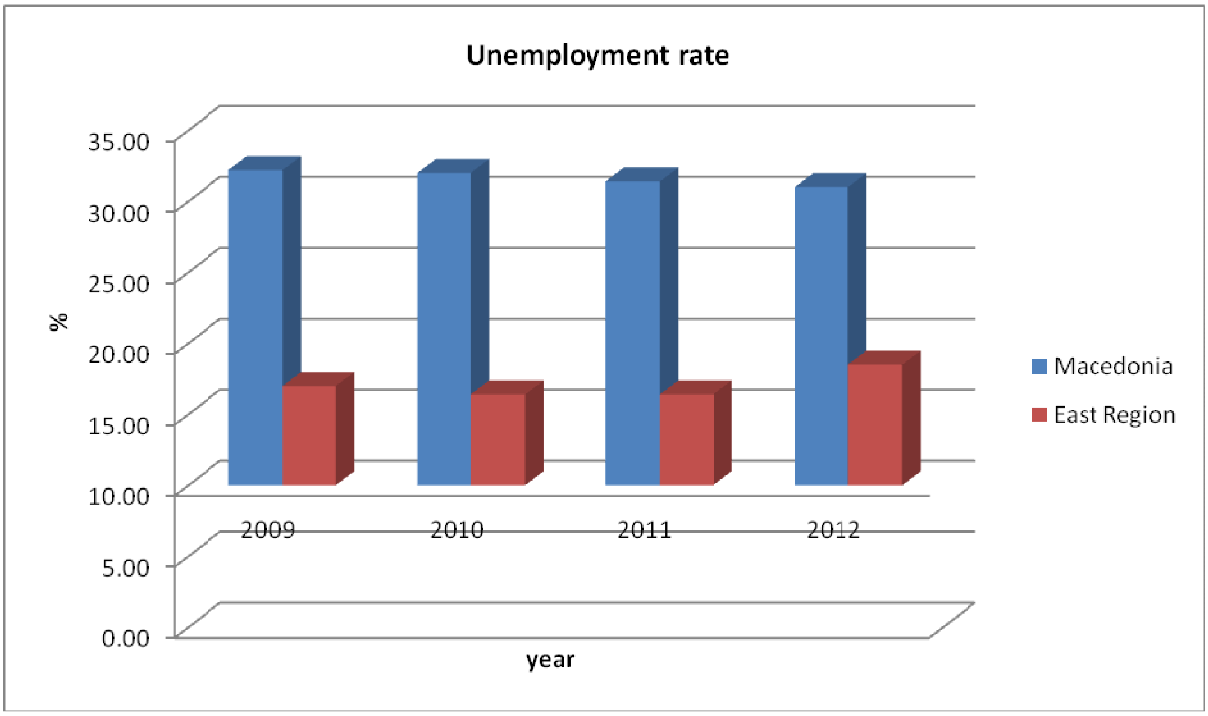


Figure 3-24: Unemployment rate in Macedonia and East region



Data provided from the local municipalities shows great discrepancies between them. The unemployment rate in Probistip reaches 32% in 2012, dropping from 38% in 2008. The situation is similar in Zrnovci, where unemployment dropped from 36% in 2008 to 31% in 2012. Unofficial data suggests that unemployment in Berovo is higher, although no such official data is attained. Lowest unemployment rates are recorded by Vinica and Stip municipalities – 13.4% and 11.4% respectively. Average unemployment figures (provided by the State Statistical Office of the Republic of Macedonia) show average unemployment rate of about 18.5%, significantly lower than the national average, however on a worsening trend.

3.2.2 Gross Domestic Product

Despite the steady growth of 2.8 percent in 2010-2011, Gross Domestic Product (GDP) growth in the Republic of Macedonia stagnated in 2012. In the wake of this flat growth in 2012, GDP growth for the country is projected to reach 2.5 percent in 2013. The east region has improved its relative weight in the country's economy from 7-th in the period 2000-2008 to 4-th in 2011 where it recorded 8.1% of the country's value added. The largest industries in the region are the textile and apparel industry, wood industry, trade and agriculture. The dominant agricultural activity in the East region is crop growing, and the most important crop is rice. The region is also a producer of raw materials with the lead-zinc ore from the mines Zletovo, Dobrevo and Makedonska Kamenica having the greatest economic significance. According to the official statistical data, the manufacturing industry has a dominant role in production in region with 67% employing 70% of the total number of employees. Services participate with approximately 30% in production and 20% in employment, with the rest accounted to agriculture 5%.

Table 3-18: Gross Domestic Product, in million MKD

	2009	2010	2011	2012
Republic of Macedonia	410.734	434.112	459.789	458.621
y/y, %	-0,24%	5,69%	5,91%	-0,25%
East region	30.683	37.171	37.092	
y/y, %	2.07%	21.15%	-0.21%	

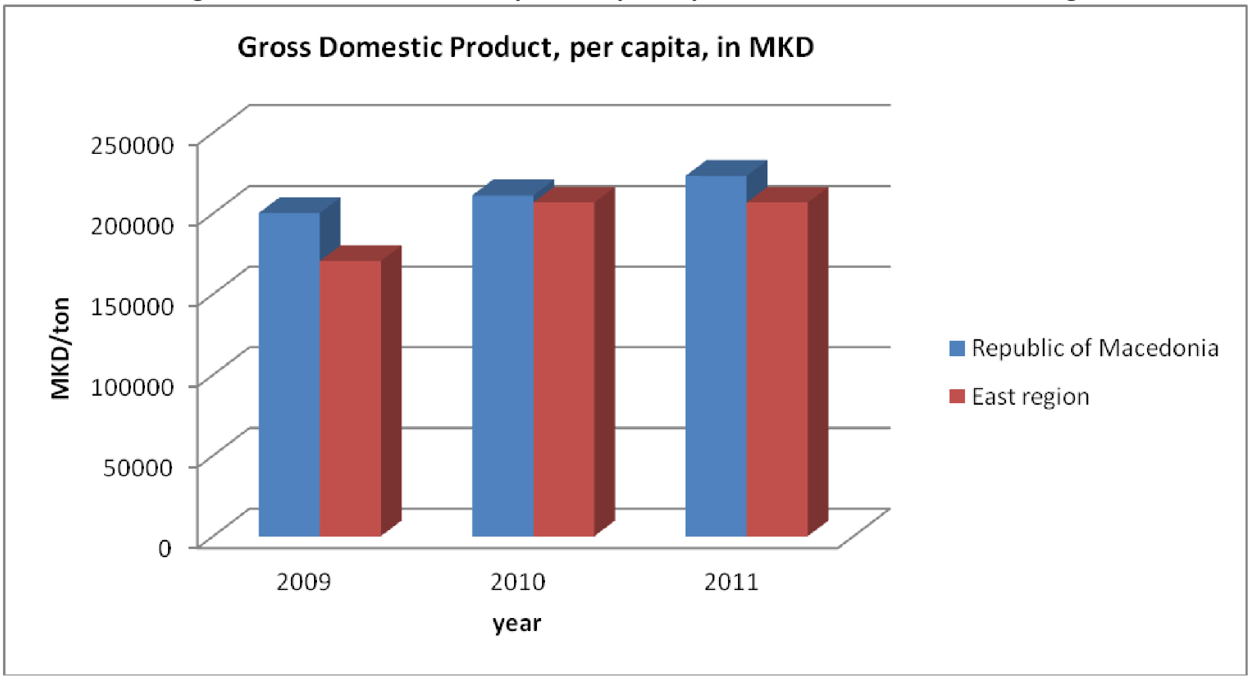
Source: State Statistical Office of the Republic of Macedonia

Table 3-19: Gross Domestic Product, per capita, in MKD

	2009	2010	2011
Republic of Macedonia	200.293	211.246	223.357
y/y, %	0%	5%	6%
East region	170.486	206.770	206.773
y/y, %	-14%	4%	34%

Source: State Statistical Office of the Republic of Macedonia

Figure 3-25: Gross domestic produst per capita for Macedonia and East region



Gross value added by sector of activity, by year for Republic of Macedonia (2010-2011) and East region (2000 -2011) is in Annex 4 .

3.2.3 Average income and available assets by decile group

B) Average income of employees by sector in Republic of Macedonia and East region

According to the data of the State Statistical Office of the Republic of Macedonia average net and gross wage paid per employee in East region is lower than that in Republic of Macedonia

Table 3-20: Average net wage paid per employee, 2012

	East region	Republic of Macedonia
Average net wage paid per employee, 2012	**14 957**	**20 902**
Agriculture, forestry and fshing	13 927	15 641
Mining and quarrying	22 786	22 180
Manufacturing	11 213	15 300
Electricity, gas, steam and air,conditoning supply		35 818
Water supply; sewerage, waste management and remediaton activities	15 550	18 677
Constructon	13 702	16 375
Wholesale and retail trade; repair of motor vehicles and motorcycles	13 553	18 982
Transportaton and storage	14 673	21 191
Accommodaton and food service	12 346	15 063
Informaton and communicaton	20 276	35 481
Financial and insurance actvites	29 691	37 397
Real estate actvites	22 031	24 998
Professional, scientfc and technical activities	18 788	28 096
Administratve and support service activities	13 523	14 066
Public administraton and defence; compulsory social security	23 861	24 966
Educaton	21 083	21 235
Human health and social work activities	20 069	22 399
Arts, entertainment and recreaton	17 685	17 731
Other service actvites	18 827	23 155

Source: State Statistical Office of the Republic of Macedonia

Table 3-21: Average gross wage paid per employee, 2012

	East Region	Republic of Macedonia
Average gross wage paid per employee, 2012	**22 054**	**30 669**
Agriculture, forestry and fshing	20 291	22 610
Mining and quarrying	35 058	33 257
Manufacturing	16 504	22 407
Electricity, gas, steam and air,conditoning supply	:	53 495
Water supply; sewerage, waste management and remediaton activities	22 595	27 352
Constructon	19 967	23 852
Wholesale and retail trade; repair of motor vehicles and motorcycles	19 786	27 418
Transportaton and storage	21 396	31 078
Accommodaton and food service	17 969	21 869
Informaton and communicaton	29 850	51 409
Financial and insurance actvites	44 119	55 077
Real estate actvites	32 404	36 825
Professional, scientfc and technical activities	27 570	40 408
Administratve and support service activities	19 946	20 512
Public administraton and defence; compulsory social security	35 258	36 899
Educaton	31 071	31 270
Human health and social work activities	29 401	32 871
Arts, entertainment and recreaton	25 658	26 050
Other service actvites	27 667	33 984

Source: State Statistical Office of the Republic of Macedonia

Both on national and regional level the highest wage is in Financial and insurance actvites. On national level it is followed by the wages in Electricity, gas, steam and air,conditoning supply and Informaton and communicaton and on regiona level by wages in Mining and quarrying and Public administraton and defence; compulsory social security.

Average wage paid per employee in East region in 2012 is 72% of the average wage paid per employee in Macedonia. On the other hand, the unemployment rate in East region is lower than the average in the country.

C) Available assests by decile groups

Since for the detrmining of waste tariff for household it is very important the estimation of the number and income of low income households based on the lower 3 deciles of a distribution of income for those households, subject to the payment of collection and disposal fees, the decile groups by available assets are reviewed.

Decile groups by available assets for Republic of Macedonia are in the next table.

Table 3-22: Total available assests on average, per household for 2012, MKD

		Decile groups by available assets						
	average	first	third	fourth	fifth	sixth	eighth	tenth
AVAILABLE ASSETS	328 444	69 534	155 936	199 741	248 930	303 639	423 882	856 070
Monetary income	317 756	67 744	147 431	189 578	239 123	294 125	410 349	831 924
Income on the basis of regular work	206 599	10 568	53 988	86 850	142 367	200 170	282 207	617 320
Income on the basis of part-time work	9 919	6 347	9 262	20 908	9 812	12 117	11 507	4 215
Income on the basis of pension scheme	63 113	33 194	58 123	58 135	61 546	50 528	75 679	92 039
Other income on the basis of social insurance	6 538	9 767	4 124	7 687	4 735	6 663	5 243	9 127
Income from abroad	6 759	507	4 861	1 474	3 956	5 261	6 928	30 885
Net income from agriculture	15 910	929	2 811	4 476	7 286	12 390	20 458	66 695
Property renting and selling	1 107	-	219	900	1 215	587	1 584	4 447
Donations, gifts and similar contributions	825	2 295	2 179	742	1 541	988	52	8
Loans (Borrowings)	1 149	1 482	5 005	198	-	1 781	373	-
Savings decrease	5 815	2 635	6 859	8 207	6 666	3 437	6 319	7 188
Other incomes	23	19	-	-	-	202	-	-

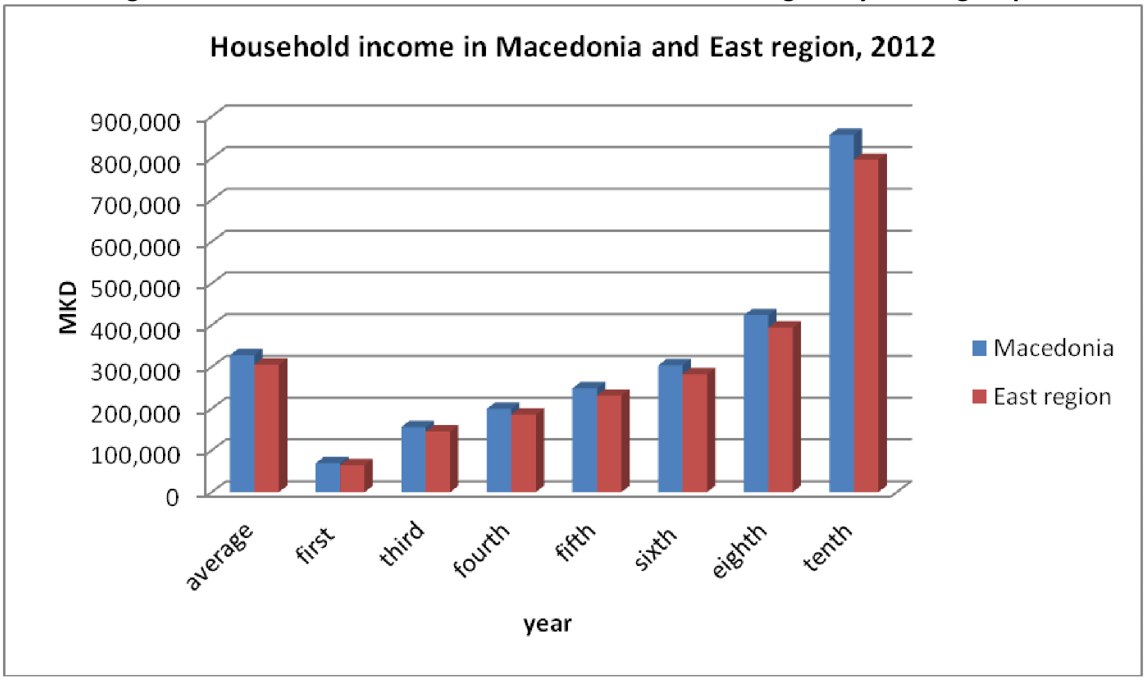
Source: State Statistical Office of the Republic of Macedonia

The State Statistical Office annual paper Household Consumption in the Republic of Macedonia 2012 paper stipulates that on average, the Macedonian household has Total available assets about 328 444 MKD available annually, of which 14.4% (45757 MKD/282 EUR/) for "Housing, water, electricity, gas and other fuels".

According to data from the State Statistical Office of the Republic of Macedonia, the average household size for the East region is 3,1 persons per household, 14% lower than the country average 3.6 persons per household. The average household size varies from 2.7 in Pehcevo to 3.2 persons per household in Makedonska Kamenica.

As there is no official data on average household income or expenditure on regional or municipality level, an annual income per household for the East region is estimated, considering GDP per capita in the East region. GDP per capita for the East region is 206 773 MKD - 93% of the average country GDP per capita, which is 223 357 MKD. Based on this assumption, the annual income per household by decile groups for East region is calculated with the same assumption (93%) and is presented on the Figure below.

Figure 3-26: Houshold income in Macedonia and East region by decile groups



Only 3.54% of the population has received social cash benefits in 2012 (Annex 6), lowest in the country, demonstrating the better relative position of the region compared with the country average. However, some individual municipalities have below average household income.

3.2.4 Distribution of the rural-urban population in Republic of Macedonia

A) Republic of Macedonia

a) Population and labor force in Republic of Macedonia

Distribution of the rural-urban population in Republic of Macedonia in 2009 is presented in the next table:

Table 3-23: Distribution of the rural-urban population in Republic of Macedonia in 2009

	Macedonia	Rural areas	Urban areas
Population	2 051 213	840 997*	1 210 216
Economically active population	928 775	378 153**	550 622
Employed	629 901	258 433**	371 468
Employed (without Employed in agriculture)	513 300	N/A	N/A
Unemployed persons	298 873	119 720**	179 153
Inactive population	710 094	315 479**	394 615

Source: State Statistical Office of the Republic of Macedonia
**Source: Calculated on basis of The World bank data*
***Source: Rural Labour Market Developments in the Former YugoslavRepublic of Macedonia by* Verica Janeska & Štefan Bojnec, published in Factor Market Working Paper, No. 5, September 2011

According to the reported data in rural areas lives about 41% of the population of the country. The economically active population in rural areas is 41% of the economically active persons in Macedonia and the unemployed people in the rural area are also 40% of the unemployed persons in Macedonia, wich is comparable to the number of the population in rural areas.

Employed population in the agriculture is 18.5% of the economically active population in Republic of Macedonia. There are not available data for the distribution urban-rural population.

b) Average income per capita and per household

Average annual income per capita and per household in agricultural, non-agricultural and mixed areas is presented on following table.

Table 3-24: Annual average income in Republic of Macedonia per capita and per household, in denars

	Annual averages per household				Annual averages per household member			
	Total	Agricultural	Mixed	Non-agricultural	Total	Agricultural	Mixed	Non-agricultural
AVAILABLE ASSETS	328 444	269 442	393 900	314 975	88 165	76 321	88 120	88 584
Monetary income	317 756	233 142	360 206	310 618	85 296	66 039	80 583	87 358
Revenues on the basis of regular employment	206 599	-	211 102	212 651	55 458	-	47 226	59 806
Revenues on the basis of part-time employment	9 919	3 068	4 911	11 341	2 663	869	1 099	3 190
Revenues on the basis of a pension scheme	63 113	-	54 078	67 427	16 941	-	12 098	18 963
Other revenues on the basis of social insurance	6 538	1 052	8 813	6 189	1 755	298	1 972	1 740
Revenues from abroad	6 759	-	1 654	8 201	1 814	-	370	2 306
Net revenues from agriculture	15 910	122 467	67 586	-	4 271	34 689	15 120	-
Property leasing and selling	1 107	-	586	1 269	297	-	131	357
Prizes, gifts and similar contributions	825	1 011	525	889	221	286	118	250
Loans (Borrowings)	1 149	4 218	5	1 314	308	1 195	1	370
Savings decrease	5 815	101 326	10 946	1 308	1 561	28 701	2 449	368
Other income	23	-	-	29	6	-	-	8
Value of consumption from own production	9 748	36 300	32 771	3 380	2 617	10 282	7 331	951
Income in kind[1)]	941	-	923	977	252	-	206	275

Source: State Statistical Office of the Republic of Macedonia

c) Average expenditures per capita and per household

Average annual expenditures per capita and per household in agricultural, non-agricultural and mixed areas is presented on following table

Table 3-25: Annual average expenditure in Republic of Macedonia per household and per capita, in denars

	Annual averages per household				Annual averages per household member			
	Total	Agricultural	Mixed	Non-agricultural	Total	Agricultural	Mixed	Non-agricultural
USED ASSETS	339 077	252 754	424 689	321 775	91 019	71 594	95 008	90 496
Personal consumption	308 939	237 534	368 226	297 358	82 929	67 283	82 377	83 629
Food and non-alcoholic beverages	134 849	130 104	175 719	125 332	36 198	36 853	39 311	35 248
Alcoholic beverages and tobacco	11 863	12 830	16 423	10 750	3 184	3 634	3 674	3 023
Clothing and footwear	17 457	17 367	19 770	16 912	4 686	4 919	4 423	4 756
Housing, water, electricity, gas and other	48 506	28 187	42 041	50 737	13 021	7 984	9 405	14 269
Furnishing, household equipment and maintenance	13 013	8 481	13 492	13 056	3 493	2 402	3 018	3 672
Health care	10 958	5 798	11 076	11 107	2 941	1 642	2 478	3 124
Transport	22 348	11 419	36 471	19 379	5 999	3 234	8 159	5 450
Communications	13 160	4 892	14 306	13 173	3 533	1 386	3 201	3 705
Recreation and culture	7 491	1 798	7 744	7 627	2 011	509	1 732	2 145
Education	4 959	513	2 628	5 664	1 331	145	588	1 593
Restaurants and hotels	11 788	7 430	14 388	11 322	3 164	2 105	3 219	3 184
Miscellaneous goods and services	12 549	8 715	14 167	12 299	3 369	2 469	3 169	3 459
Membership fees, taxes, customs duties	5 344	3 118	3 394	5 883	1 435	883	759	1 654
Losses, gifts, contributions and other	4 091	220	10 092	2 803	1 098	62	2 258	788
Repayment of loans and debt servicing	11 883	3 999	10 549	12 471	3 190	1 133	2 360	3 507
Flat, house and property expenditures	3 285	2 657	12 140	1 209	882	753	2 716	340
Savings	5 534	5 226	20 287	2 051	1 486	1 480	4 538	577

Source: State Statistical Office of the Republic of Macedonia

B) East region

Table 3-26: Labor force in Macedonia and East region in 2012

	measure	Republic of Macedonia	East Region
Population	number	2 061 044	178 814
Population –urban	number	1 216 016*	118 554*
Population -rural	number	845 028*	60 260*
Unemployment rate, total	%	31	18,50
Unemployment rate, urban	%	30,8	19,8
Unemployment rate, rural	%	31,4	16,2

Source: State Statistical Office of the Republic of Macedonia

**Calculated on basis of The World bank data*

In East region, unemployment in the rural areas is with 3,5% lower than the unemployment in urban area. This is an exception for the country.

b) Average income per capita and per household

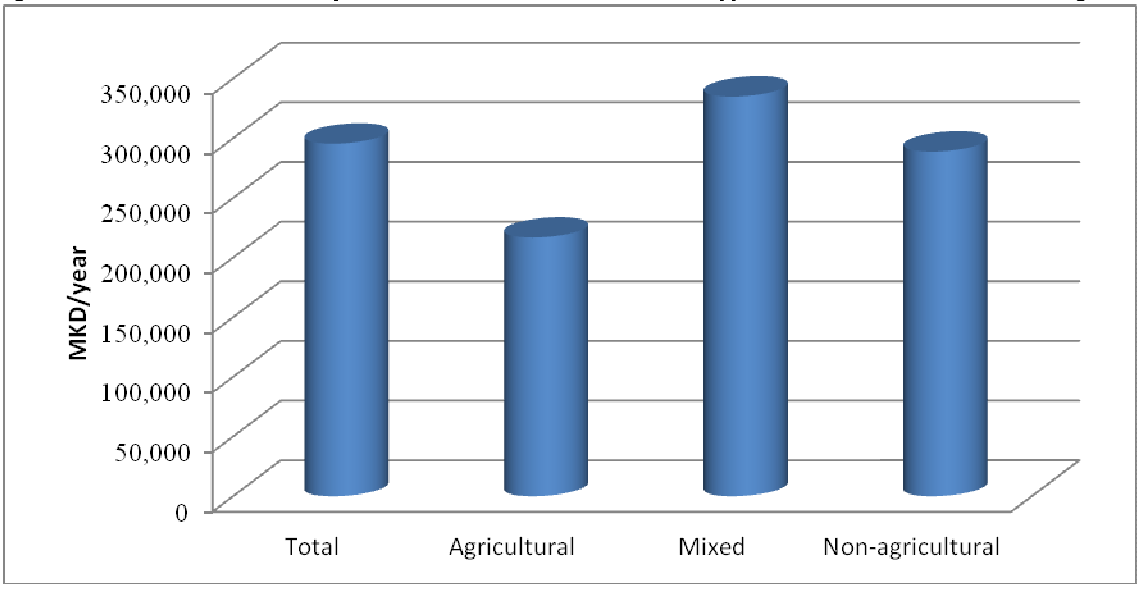
As data for the income on regional level is not provided, an annual income per household in agricultural, non-agricultural and mixed areas for the East region is estimated, as was mentioned above, considering GDP per capita in the East region, which is 93% of the average country GDP per capita.

Based on this assumption, the annual income per household for East region is calculated with the same assumption (93%) and is presented on the Figure below.

Table 3-27: Annual income per household for East region.

	Total – average for the region	Agricultural	Mixed	Non-agricultural
East region	295 513	216 822	334 991	228 874

Figure 3-27: Annual income per household in the different types of settlements in East region



3.3 DESCRIPTION AND ASSESSMENT OF THE CURRENT CONDITIONS IN WASTE MANAGEMENT WITHIN THE REGION

3.3.1 Institutional Framework

Ministry of Environment and Physical Planning

The Ministry of Environment and Physical Planning (MoEPP) performs environmental tasks related to the legal harmonization process; the preparation of national strategies and action plans; inspection and enforcement including intervention if needed against the bigger polluters; and nationwide monitoring, information systems and cadastres.

MoEPP sets the overall framework for policies and legislation, sometimes however giving the local self-government units (LSGUs) a certain amount of leeway with regard to implementation while ensuring due consideration of specific local conditions. Moreover, international coordination is managed at the national level both in relation to EU and international conventions and in relation to assistance provided through the international or bilateral donor community.

MoEPP has grown significantly in recent years in terms of human capacities. A new Department on waste management was established within the Environmental Administration in MoEPP in August 2010.

At present, MoEPP is organized into nine departments or sectors further broken down into units as well as three bodies within MoEPP as constituent parts, i.e. the State Environmental Inspectorate, the Administration for Environment, and the Office for the Spatial Information System. These bodies function as separate entities under MoEPP supervision, and operate in accordance with legal regulations and other legal acts governing environmental issues. In the performance of its duties, the Minister is further assisted by a Deputy Minister, a State Secretary and thematic State advisors.

The Sector of EU (former Department for Legislation and Standardization) is now responsible for approximation, monitoring and reporting to the Commission. The Sector for EU (SEU) has the responsibility to coordinate all policy and legislative work in MoEPP, including EU approximation. The SEU - Unit for harmonization with EU legislation and negotiation is responsible for coordinating MoEPP's work on preparation of legislation in line with the EU acquis . The coordination and monitoring of the EU integration is within the SEU - Unit for coordination monitoring and evaluation of the progress made.

A separate Sector on Cooperation and Project Coordination is responsible for Instruments for Pre-Accession Assistance (IPA) and for international cooperation. The Sector for Sustainable Development and Investments is also active and involved in the preparation of technical documentation, and will be in further implementation of IPA capital infrastructural investments/projects. The new structure separates funding from the policy/legislation preparation.

At central level the MoEPP interacts with the following institutions:

- Ministry of Health (MoH) with regards to management of medicinal waste (i.e. clinical waste);
- Ministry of Economy (MoE) with regards to the implementation of the financial and economic instruments, the management of specific waste streams;
- Ministry of Finance (MoF) - the financial and economic instruments as well as monitoring their implementation;
- Ministry of Transport and Communications (MoTC) – with regards to the activities of the communal enterprises;
- Ministry of Agriculture, Forests and Water Management (MoAFWM) – in the field of policy making and planning;
- Institute for Standardisation – for setting of and checking compliance with technical standards with regards to equipment

At local level the main responsibilities are vested with the municipalities as local self -government units. The communal enterprises carry out waste management activities and provide waste collection, transportation and disposal service for the communal waste.

State Environmental Inspectorate

The State Environmental Inspectorate (SEI) is a body within MoEPP. It inspects the enforcement of technical and technological measures for protection against air, water and soil degradation and pollution of flora and fauna, protection of geodiversity and biodiversity, and areas protected by law (national parks, monuments of nature, forest park, ornithological reserves, etc.), protection of the ozone layer, protection from harmful noise in the environment, and protection from ionizing radiation.

The current organogram is under revision with a new "regional" approach relying on decentralization of both types of inspectors (nature protection and environment protection). Moreover, the plan foresees that environmental inspectors will have to specialize in one of the sectors among IPPC, Seveso and waste management.

In addition to the National State Inspectors, 50 per cent of municipalities (approx. 45) have appointed local environmental inspectors. The work of the local inspectors is supervised by the State inspectors, and comes under the areas for which the LSGUs have jurisdiction Office for Spatial Information System.

Office for the Spatial Information System

The establishment of Office for Spatial Information System (SIS) is one of the basic mechanisms for ensuring a basis for mapping the geolocation of the systematized data and information with regard to the environment, precisely, environmental media and areas. Establishing SIS should be the basic function of the Office for SIS.

This system basically features a few functions, such as:

- A mapping basis for daily evidence and management of data and information obtained from the environmental media databases, which are maintained and managed;

- A basis for the adoption of strategic decisions in the area of environmental protection and management;
- Media for presentation of data and information.

Administration for Environment

The 2005 Law on Environment, for the purpose of carrying out expert activities related to environmental media and areas, prescribes the establishment of the Administration of Environment (AE) as a body responsible for expert activities in the area of environment.

The Administration of Environment performs professional activities in the area of nature protection, in waste, water, air, soil, noise protection and in other environmental areas. It will also regulate the environmental impact assessment (EIA) procedure for projects and the procedure concerning integrated environmental permit issuing and compliance permit issuing; it will manage the Cadastre of Environment and the Register of Pollutants and Polluters, including their characteristics. The Administration of Environment will be responsible for the monitoring of environmental performance as well as for permit issuing procedures and other activities stipulated by law.

The Administration for Environment is an integral part of MoEPP. The Director is appointed by the Government and as of January 2011, he supervises more than 60 people working in the Administration. Although appointed by the Government, AE is under MoEPP administrative supervision. The Administration for Environment started with a staff of about 25-30 people and is growing both in terms of human capacity as number of units.

The former Yugoslav Republic of Macedonia is the only country in South-East Europe (excluding Bosnia and Herzegovina) not to have established an Environmental Protection Agency (EPA). Several EU countries have established such an institution separately from the authority responsible for environment management although sometimes strictly connected to the former- as in the case of Austria for example where UBA is a separate company entirely owned by the Government represented by the Ministry of Environment. EPAs in other EU countries typically have the following statutory mandates:

- Implementing environmental laws;
- Informing the public about environmental protection;
- Providing scientific support to the Government;
- Liaising with EEA when preparing the state of the environment reports or other environmental assessments[31].

At the moment, the above functions are performed by the Administration for Environment, the State Inspectorate and the Office of Spatial Information and some departments of MoEPP. Merging these bodies and grouping the functions in a single entity could improve performance and efficiency while at the same time displaying the political commitment to implementation of environmental legislation in the country.

[31] United Nations Economic Commission for Europe (2011) “2nd Environmental performance review of the former Yugoslav republic of Macedonia” Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

Regional Development Centres

The Regional Development Centres (RDCs) in the two project pilot regions are specific stakeholders, and which are not directly involved in the waste management system, but which in the reality have a focal role for the project on the regional level, reflected also in their participation in the PSC. The RDC are active structures, with gained trust among the municipalities of the respective regions, as well as experience in coordinating municipalities for different activities on regional level. The RDC were involved in the setting of the regional waste management bodies/companies as well, being coordinators and providing an acting provisional manager for the regional waste management bodies established. In this position and situation they exercise high influence to all local stakeholders.

The RDC are involved in the project from the beginning of its implementation and have demonstrated a very strong interest and support to the project activities. It is expected that this activeness and support will continue throughout the project implementation period and the RDC will have a central role in coordinating the municipalities for different activities on regional level, support and strengthening of the regional waste management bodies/companies. The interest of the RDC may be defined to a great extent in terms of the Centres' institutional goals and drive towards accumulating experience, influence and trust.

3.3.2 Organisational Framework

Inter-municipal Board for Waste Management

The Inter-municipal Board for Waste Management (IBWM) has been established and is fully operational. The Inter-municipal Board shall be seen as a complementary body to the Inter-municipal Public Enterprise, creating a clear distinction between planning/ contracting and operations, which will result in greater transparency and potentially higher cost efficiency.

Based on the assumption that the Inter-municipal Board for Waste Management is and will be a planning and contracting unit and operation will be conducted on contract between the Board and either the Inter-municipal Enterprise for Waste Management, a private contractor or the municipality/ PCE, the functions of the IBWM can be defined as follows :

- Management;
- Statutory requirements (permits);
- Finance (including tariffs);
- Engineering and procurement (including contracting);
- Planning and PR;
- Supervision of operators.

During the second half of 2011 and the beginning of year 2012 negotiations were concluded on the approach to setting up regional waste management bodies and the Inter-municipal Board for Waste Management (IMBWM) in East Planning Region was established on 23 January 2012. On 23 January 2012 the eleven municipalities of the East Planning Region signed an agreement for establishment of an Inter-municipal Board for Waste Management in the East Planning Region.

The IMBWM is formed by the Mayors of 11 municipalities in the region and 3 staff members have been seconded from various municipalities to work in the Operational Office of the Board. The RWMB is assumed to take responsibility for planning, contracting and monitoring of waste management in the region.

The IMBWM supplements the Inter-municipal Waste Management Enterprise (IWME) "Deponia Iztok Shtip" established in 2009. The company is established as a public enterprise and is assumed to carry out waste management operations to the extent these will be implemented by the public sector under decision by the Board.

Public Communal Enterprises (PCEs)

Currently, the municipalities hold the overall responsibility for waste management and the PCEs are the main service providers of waste management services conducting the daily operation of waste collection services and landfill of waste. Some municipalities have established Public-Private Partnerships (PPP) with local firms for collection of recyclables. The table below presents the PCEs per municipality.

The inventory of the existing waste collection equipment per municipality is presented in Annex I-Inventory of waste collection equipment.

Table 3-28: Public Communal Enterprises (PCEs) in East Region

#	Municipality	Public Communal Enterprises (PCE	Duties
1	Cesinovo-Oblesevo	"Obleshevo"	Waste collection, transport and disposal
2	Delcevo	"Bregalnica"	Waste collection, transport and disposal
3	Kocani	"Vodovod"	Waste collection, transport and disposal
4	Pehcevo	"Komunalec"	Waste collection, transport and disposal
5	Berovo	"Usluga"	Waste Collection- disposal
6	Probistip	"Nikola Karev"	Waste Collection- disposal
7	Stip	"Isar"	Waste Collection- disposal
8	Vinica	"Solidarnost"	Waste collection, transport and disposal
9	Zrnovci	"Ilinden" "Vodna Kula"	Waste Collection- disposal Waste collection, transport and disposal
10	Karbinci	"Plachkovica"	Waste Collection- disposal
11	Makedonska Kamenica	"Kamena Reka"	Waste Collection- disposal

The Municipality of Berovo has established a Public-Private Partnership (PPP) with a local firm for collection of PET bottles in 4 settlements of the municipality.

The following are the private companies that operate in the Municipality of Probishtip:

1. "Otpad familija Todevi" which performs transport and disposal, and temporary storage for the Municipality of Probishtip,

Company Todevi purchases and stores ELVs. It also performs the following:

a. Purchase and processing of used batteries (melting)
b. Storage and delivery in a safe place
c. Storage and delivery in a safe place
d. Public storage dump
e. Storage and delivery in a safe place

It serves 5000 inhabitants, i.e. 30 % of the municipality population.

2. “TA DAmipak” which produces cardboard packaging.

3. Tab Factory for batteries and accumulators Purchases and processes (melts) waste car batteries.

4. Car repair shop Zoki, AR Meche, Gogo trans, Creshovo topche and Boki trans store waste oils and transport them to a safe place.

5. Tire repair Ficho stores used tires and transports them to a safe place

3.3.3 Waste Tariffs

3.3.3.1 Legal Basis of the Waste Management System

A. ***The Law on Waste Management,*** *(Consolidated text of the Law on Waste Management by the Legislative - Legal Committee meeting held on 21 January 2011, published in the Official Gazette of Republic of Macedonia, №9 from 25 Jan 2011)*

Municipal waste is waste generated by individuals from households (household waste) and commercial waste.

According to Article 120 Sources of funding are as follows:

- The implementation of waste management plans and programs in the Republic of Macedonia is financed with funds from the budget of the Republic Macedonia, credits, donations, funds of the legal entities and individuals managing waste, fees and other sources of funds, established by law .
- Funds for construction of buildings, facilities and installations for storage and disposal of hazardous waste shall be provided from the budget of the Republic Macedonia, legal and natural persons that manage waste, loans, donations and other sources of funds established by law .
- Funds for construction of landfills for disposal of non-hazardous and inert waste shall be provided from the budgets of the Municipalities and the City of Skopje, funds of the legal and natural persons managing waste, loans , grants and other sources of funds, determined by law.

Article 121 defines the Fees for the services:

- The fee for collection and transportation of municipal waste shall be approved by the Council of the City of Skopje or Municipalies.
- The fees for collection and transport shall be determined on the basis of quantity and type of waste and expressed in the following units: MKD per square meter, MKD per cubic meter and MKD per kilogram.
- For legal and natural persons who create commercial waste, the price for collection and transportation of waste is determined by concluding special

agreement a service provider based on quantity and type of waste expressed as a MKD per kilogram or MKD for cubic meter of waste.

- In setting the fee for the service, at the proposal of the Mayors of Municipalities, the Councils of the Municipalities shall determine incentive fees for households, legal entities and individuals on the basis of established systems for waste selection with aim to reduce the total amount of waste, intended for disposal of landfill.
- The fee of waste disposal shall be set in accordance to the amount of waste delivered for disposal expressed in MKD per ton of generated waste.
- When setting the fee for the services provided, care shall be taken to include the costs for the provided service.

The state administration is responsible for the affairs of the environmental care of all costs involved in the construction and operation of a landfill, including the cost of guarantee or the equivalent, and estimated costs of closure and after-care of the landfill site for at least 30 years.

Tariffs of waste disposal landfill are set as follows:

- The cost of disposal determines the Tariff for waste disposal of the operator.
- Tariffs for disposal of waste is established on the basis of the calculation of the full cost of investment, construction, operation, maintenance of the landfill and the costs of care for landfills after their closure.
- The Government shall approve the fee for the disposal of hazardous waste.
- The Municipal Council shall approve the cost and Tariff for disposal of municipal and other non-hazardous waste.

B. *Methodology for calculation and formation of integrated waste management*

*(**Source:** The Ministry of Environment and Physical Planning, http://www.moepp.gov.mk/WBStorage/Files/Metodologija%20za%20presmetuvanje%20i%20odobruvanje%20na%20cenata%20za%20itegr.upravuvanje%20so%20otpad.pdf)*

Tariffs are calculated separately for each household and business entity in accordance with existing services and the availability of facilities. The calculation of the cost is comprehensive and includes any activity for treatment and management of waste.

The price is determined on the basis of full cost recovery and the "polluter pays" principle in accordance with the Law on Waste Management.

Based on calculations made by the operator of the tariff level and the units are approved by the Council of the Municipality on a proposal from the mayor.

Current prices by decision of the Municipal Council, can be revised in minimum 6 months and a maximum of 2 years from the entry into force of this methodology.

The cost of services is determined on a monthly basis and includes all costs in accordance with the calculation made by the operator.

The tariff is based on the following elements:

- quantities of collected waste
- number of individuals in the territory of the municipalities

- number of entities classified according to the activity (amount and type of waste);
- dynamic collection;
- distance from installations.
- kind of container for waste disposal and type of utility specifically vehicle.

The price should be the same for all users of the same services or facilities on the territory of which the operator performs a service.

General costs for waste management:

- General Administration of waste management;
- Publicity and public relations;
- Information management;
- Monitoring and supervision of integrated waste management.

Collection costs

The price for the service is based on ***capital*** and ***operating costs*** of the service.

Capital costs include the following costs:

- land;
- purchase of machinery and equipment (special utility vehicles, trailers, tippers, construction machinery, etc..);
- equipment;
- waste containers.

Operating costs include costs of daily operation and maintenance of the waste management. Operating costs are divided into fixed and variable. Fixed costs do not depend on the quantity of collected waste. Variable costs depend on the quantity of collected waste.

In the part of **individuals (households)** there are three categories of service users:

- individual residential units
- collective housing units
- households in rural areas

The individual and collective housing unit price for the service can be: MKD/m2, MKD/m3 and MKD/ kg.

With regard to **legal persons** there are the following three categories of users:

- large legal entities (manufacturing facilities, shopping centers, factories, banks, hotels, insurance companies, warehouses and other legal entities) for which the unit cost of the service can be MKD/m^2 and MKD/m^3.

- Small legal entities (supermarkets, grocery, offices, restaurants, etc.), categorized based on the type and quantity of waste unit price for the service can be MKD/m^2 and lump sum.
- Schools, kindergartens, health care facilities, retirement homes, religious buildings, etc., for which the unit price of the service can be MKD/m^2 and MKD/m^3.

Landfill costs

Cost of service is based on capital and operating costs of the service, in accordance with Articles 89 and 90 of the Law on Waste Management and the type of waste. Unit price for performing a service is MKD/tone.

Costs for care after the landfill stops working can be recovered by adding a price of landfill entrance. Alternatively, the costs can be financed from the state budget and municipal budgets.

By decision of the Municipal Council current prices can be revised in time of minimum 6 months and a maximum of 2 years from the entry into force of this methodology.

3.3.3.2 Current tariff system in Municipalities

The current system for waste management in the country is primarily focusing on waste collection and disposal. Regular waste collection services are mainly limited to urban areas.

Calculations made by the operator on the tariff level and the units are approved by the Council of the Municipality on a proposal from the mayor.

The fee for collection, transportation and landfill disposal of municipal waste is approved by the Council of the Municipality:

- The costs for collection and transport are determined on the basis of quantity and type of waste that can be determined by the unit as a MKD per square meter, MKD per cubic meter and MKD per kilogram.
- Tariffs for disposal of waste are established on the basis of the calculation of the full cost of investment, construction, operation, maintenance landfill and the costs of caring for landfills after their closure.

There are three categories of waste service users in the part of **households**:

- individual residential units
- collective housing units
- households in rural areas

and three categories of waste service users in the part of **legal entities:**

- large legal entities;
- small legal entities;
- Schools, kindergartens, health care facilities.

Tariffs are calculated separately for each household and business entity in accordance with existing services and the availability of facilities.

Table 3-29: Tariffs in the Municipalities of East region, 2013

	Individuals			Businesses institutions		
Municipality/Fees	**Individual residental unit**	**Collective Facilities**	**Household in villages**	**Large entities**	**Small entities**	**Schools / kindergartens**
Berovo	200 MKD/month	200 MKD/month	200 MKD/month	4.31 MKD/m^2/year	9 MKD/m^2/year	2.61 MKD/m^2/year
Cesinovo-Oblesevo	100 MKD / month		100 MKD / month	300-600 MKD/month		300 MKD / month
Delcevo	2.1 MKD/m^2/year	2.1 MKD/m^2/year		4.0 MKD/m^2/year	4.0 MKD/m^2/year	3.0 MKD/m^2/year
Karbinci	N/A	N/A	N/A	N/A	N/A	N/A
Kocani	1.8 MKD/m^2/year and 0.5 MKD/m^2/year - courtyard	1.8 MKD/m2/year and 0.5 MKD/m^2/year - courtyard	100 MKD / month	3.5 MKD/m^2/year and 1.5 MKD/m^2/year - courtyard	6.3 MKD/m^2/year	3.5 MKD/m^2/year and 1.5 MKD/m2/year - courtyard
Makedonska Kamenica	N/A	N/A	N/A	N/A	N/A	N/A
Probistip	2.4 MKD/m^2/year	1 MKD/m^2/year	N/A	5 MKD/m^2/year	5 MKD/m^2/year	5 MKD/m^2/year
Pehcevo	84 MKD/month or 5.46 MKD/m^2/year	N/A	no charge	5.46 MKD/m^2/year	84 MKD/month or 5.46 MKD/m2/year	2.73 MKD/m^2/year
Stip	1.1 MDK/m^2/month for used area and 0.14 MDK/m^2/month for courtyard	N/A	N/A	1.8 MKD/m^2/month and 0.3 MKD/m^2/month - courtyard	6.8 - 13.8 MKD/m^2/month and 0.3 MKD/m^2/month - courtyard	0.8 MKD/m^2/month
Vinica	For usable living area from 60m^2 to 120m^2 - 2.80 MKD/m^2/year	no charge	For usable living area from 60m^2 to 120m^2 -2.80 MKD/m^2/year 100-150 MKD/month/building 2.80 MKD/m^2 monthly	8 MKD/m^2/month and 1.5 MKD/m^2/month - courtyard		8 MKD/m^2/month and 1.5 MKD/m^2/month - courtyard
Zrnovci	N/A	N/A	100 MKD / month	1000-2000 MKD/month	300-500 MKD/month	N/A

In general the tariff for legal entities is 2-3 times higher than for households. The tariffs for individuals vary from 84 to 200 MKD/month per household or from 1,8 to 2,8 MKD/m2 annually. The tariff of business institutions for large entities is between 3,5 and 5,46 MKD/m2/year or from 300 to 2 000 MKD/month, for small entities – from 4 to 9 MKD/m2/year or from 84 to 500 MKD/month and for schools and kindergartens are from 2,61 to 5 MKD/m2 per year or 300 MKD/month in Cesinovo-Oblesevo. Unusually high are tariffs in Vinica for large entities and schools and kinder gardens - 8 MKD/m^2/month and 1,5 MKD/m^2/month – courtyard.

3.3.3.3 Cost of waste management system

Costs of waste management system are divided into:

- General costs for waste management - General Administration of waste management, Publicity and public relations, Information management, Monitoring and supervision of integrated waste management.
- Collection costs - consists of:
  - ***Capital costs*** of the service, which include the following costs land; purchase of machinery and equipment (special utility vehicles, trailers, tippers, construction machinery, etc..); equipment; waste containers.
  - ***Operating costs*** of the service include costs of daily operation and maintenance of the waste management. Operating costs are divided into fixed and variable. Fixed costs do not depend on the quantity of collected waste. Variable costs depend on the quantity of collected waste.
- Landfill disposal costs

Unit costs per ton are calculated based on quantities of collected waste, which are defined as a percentage of generated waste, taken from the Waste Management Municipal Plan of the Municipality. It is assumed that 75% of generated waste is collected.

For Vinica and Berovo Municipality there are no data for the number of people per households. In the remaining municipalities, the average number of people in a household was used for the calculations.

BEROVO MUNICIPALITY

Berovo municipality has provided annual cost for the waste management system for the period 2008-2012.

Waste management costs

Costs related to general administration of waste management, publicity and public relations, information management and monitoring and supervision of integrated waste management for the studied period are shown in the table below:

Table 3-30: Waste management operating costs, MKD per year

2008	2009	2010	2011	2012
4 115 345	4 016 471	3 420 500	2 931 776	2 661 695

Collection costs

Capital costs of the municipality are between 26 600 and 41 200 MKD per year.

Operational costs are between 2 422 000 and 3 744 000 MKD per year and include variable costs between 266 000 and 411 000 MKD and fixed costs from 330 000 to 213 000 MKD per year.

Collection costs for the period are presented in the table below:

Table 3-31: Collection Costs, MKD

Year	2008	2009	2010	2011	2012
Collected waste, ton	3 368	3 743	4 118	4 125	4 459
Collection Costs, MKD	3 744 963	3 654 987	3 112 655	2 667 914	2 422 141
Unit collection Costs per ton collected waste, MKD	1 112	977	756	647	543

Landfill costs

Annual landfill costs for the period are in the range from 240 000 to 904 000 MKD for disposal of waste on the landfill. In 2009 the costs were significantly higher and maybe they were related to construction or rehabilitation of new landfill in the Municipality.

Table 3-32: Landfill Costs

Year	2008	2009	2010	2011	2012
Landfill costs, MKD	370 382	903 816	307 845	263 865	239 554
Unit landfill costs per ton collected waste, MKD/t	110	242	75	64	54

The higher value per ton during year 2009 is due to the construction of municipal landfill.

Total costs

Total annual waste costs of the municipality are presented in the table below.

Table 3-33: Total Costs

Year	2008	2009	2010	2011	2012
Total waste costs, MKD	8 230 690	8 575 274	6 841 000	5 863 555	5 323 390
Unit waste costs per ton collected waste, MKD/t	2 444	2 291	1 661	1 421	1 194

Total waste costs per ton were decreasing constantly during period 2008-2012.

KARBINCI MUNICIPALITY

Karbinci municipality has provided only the operating costs for waste collection for the period 2008-2012.

Collection costs

Collecting costs of the municipality are between 345 000 and 882 000 MKD/year.

Operational costs include variable costs - between 45 000 and 280 000 MKD and fix costs from 300 000 to 600 000 MKD/year.

Collection costs for the period are presented in the table below:

Table 3-34: Collection Costs, MKD

Year	2008	2009	2010	2011	2012
Collected waste, ton	425	425	425	426	426
Collection Costs, MKD	425 732	345 247	666 211	881 902	819 611
Collection Costs per ton collected waste, MKD	1 003	813	1 567	2 070	1 924

Collection costs per ton are variable for the period 2008-2012.

PEHCEVO MUNICIPALITY

Pehcevo municipality has provided only the operating costs for waste collection for the period 2008-2012.

Collection costs

Collecting costs (without capital costs, if any) of the municipality are between 1 200 000 to 1 430 000 MKD/year.

Operational costs include variable costs - between 94 000 and 169 000 MKD and fix costs from 1 100 000 to 1 260 000 MKD/year.

Table 3-35: Collection Costs, MKD

Year	2008	2009	2010	2011	2012
Collected waste, ton	674	723	772	821	822
Collection Costs, MKD	1 234 550	1 198 150	1 354 690	1 429 440	1 428 940
Collection Costs per ton collected waste, MKD	1 833	1 657	1 755	1 741	1 738

Collection costs per ton were stable during period 2008-2012.

VINICA MUNICIPALITY

Vinica municipality has provided only the variable operating costs for waste collection for the period 2008-2012.

Collection costs

Operating variable costs and unit costs are shown in the table below:

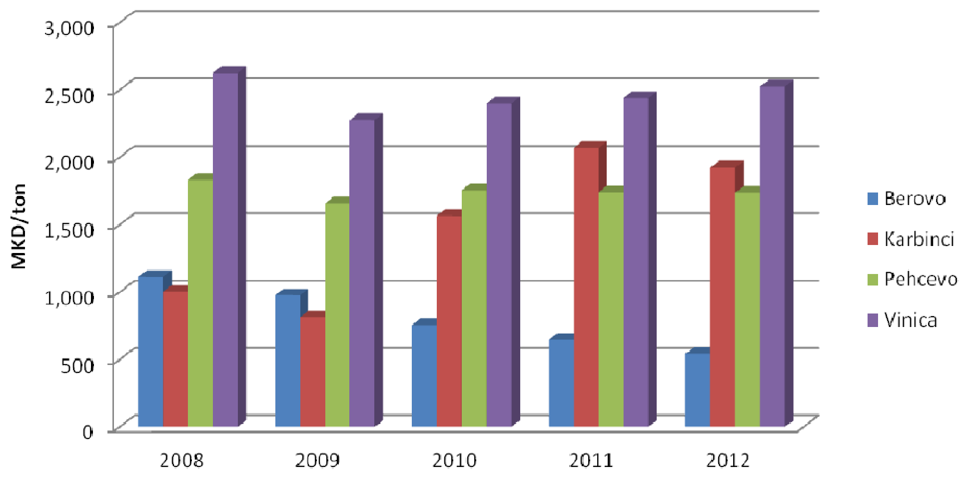
Table 3-36: Collection Costs, MKD

	2008	2009	2010	2011	2012
Collection Costs, MKD	6 093 673	5 731 084	6 505 528	7 091 898	7 352 069
Collected waste, ton	2321	2516	2711	2907	2910
Collection Costs per ton collected waste, MKD	2 626	2 278	2 399	2 440	2 526

Collection costs per ton were stable during period 2008-2012.

The other municipalities of the East region have not submitted data for their costs for waste management. The figure below presents the unit costs for collection of waste at different municipalities at the region.

Figure 3-28: Unit costs for collection of waste



Unit costs for collection in Berovo are significantly lower than unit costs in other municipalities.

3.3.3.4 Revenues from waste service users

The operating revenues are composed of:

- Revenues from waste fees from residential waste generators
- Revenues from waste fees from legal entities

BEROVO MUNICIPALITY

According to the provided data, the revenues increase for the period 2008-2012. Data for the actual revenues received in the Berovo Municipality from individuals and legal entities are shown in the table below.

Table 3-37: Revenues

Year	2009	2010	2011	2012
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	3 743	4 118	4 125	4 459
Revenue from individuals, MKD	3 332 850	3 964 725	4 031 925	4 342 125
Revenue from businesses, MKD	1 003 247	1 172 565	1 293 975	1 307 888
Total waste revenue, MKD	4 336 097	5 137 290	5 325 900	5 650 013
Revenue per ton collected waste, MKD	1 288	1 248	1 291	1 267

Average annual fee per household in the Berovo Municipality is 997 MKD.

Table 3-38: Fees

Municipality	Population	people per household	number of households	fee per household, MKD	Fee per ton collected waste, MDK
Berovo	13 941	3.2	4 357	997	1 267

KARBINCI MUNICIPALITY

According to the provided data, the revenues from fees increase for the period 2008-2012. Data of total revenues received in the Karbinci Municipality are shown in the following table:

Table 3-39: Revenues

Year	2009	2010	2011	2012
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	425	425	426	426
Revenue from individuals	N/A	N/A	N/A	N/A
Revenue from businesses	N/A	N/A	N/A	N/A
Total waste revenue	345 247	666 211	881 902	819 611
Revenue per ton collected waste, MKD	813	1 567	2 070	1 924

Due to lack of provided data the fee per household could not be estimated.

Table 3-40: Fees

Municipality	Population	People per household	Number of households	Fee per household, MKD
Karbinci	4012	3,365	1192	N/A

VINICA MUNICIPALITY

According to the provided data, the revenues increase for the period 2008-2012. Data for the actual revenues received in the Vinica Municipality from individuals and legal entities are shown in the table below.

Table 3-41: Revenues

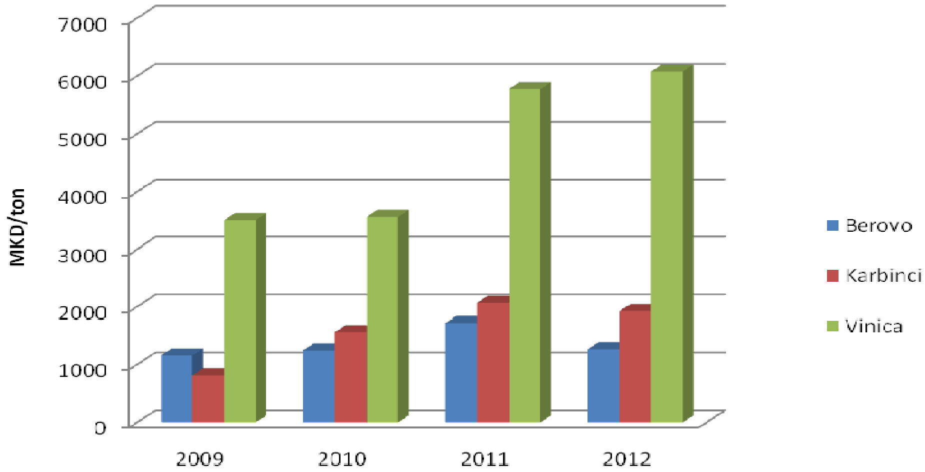
Year	2009	2010	2011	2012
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	2515	2711	2907	2910
Revenue from individuals	6 550 091	7 308 203	10 799 688	11 027 603
Revenue from businesses	2 260 607	2 336 440	5 979 693	6 658 605
Total waste revenues	8 810 698	9 644 643	16 779 381	17 686 208
Revenue per ton collected waste, MKD	3 503	3 557	5 772	6 078

Average annual fee per household in the Vinica Municipality is 1 770 MKD, which is twice higher than in Berovo.

Table 3-42: Fees

Municipality	Population	people per household	number of households	Fee per household, MKD
Vinica	19 938	3.2	6 231	1 770

Figure 3-29: Revenues per ton in East Region



In 2012 the revenues per ton collected waste in East region are from 1300 to 1900 MKD/t, only in Vinica are 6000 MKD/t. The other municipalities of the region have not submitted any data for their waste management revenues.

3.3.3.5 Cost recovery

The operating revenues are composed of:

- Revenues from waste fees from residential waste generators
- Revenues from waste fees from legal entities

BEROVO MUNICIPALITY

According to the provided data, the revenues increase for the period 2008-2012. Data for the actual revenues received in the Berovo Municipality from individuals and legal entities are shown in the table below.

Table 3-43: Revenues

Year	**2009**	**2010**	**2011**	**2012**
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	3 743	4 118	4 125	4 459
Revenue from individuals, MKD	3 332 850	3 964 725	4 031 925	4 342 125
Revenue from businesses, MKD	1 003 247	1 172 565	1 293 975	1 307 888
Total waste revenue, MKD	4 336 097	5 137 290	5 325 900	5 650 013
Revenue per ton collected waste, MKD	1 288	1 248	1 291	1 267

Average annual fee per household in the Berovo Municipality is 997 MKD.

Table 3-44: Fees

Municipality	Population	people per household	number of households	fee per household, MKD	Fee per ton collected waste, MDK
Berovo	13 941	3.2	4 357	997	1 267

KARBINCI MUNICIPALITY

According to the provided data, the revenues from fees increase for the period 2008-2012. Data of total revenues received in the Karbinci Municipality are shown in the following table:

Table 3-45: Revenues

Year	2009	2010	2011	2012
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	425	425	426	426
Revenue from individuals	N/A	N/A	N/A	N/A
Revenue from businesses	N/A	N/A	N/A	N/A
Total waste revenue	345 247	666 211	881 902	819 611
Revenue per ton collected waste, MKD	813	1 567	2 070	1 924

Due to lack of provided data the fee per household could not be estimated.

Table 3-46: Fees

Municipality	Population	People per household	Number of households	Fee per household, MKD
Karbinci	4012	3,365	1192	N/A

VINICA MUNICIPALITY

According to the provided data, the revenues increase for the period 2008-2012. Data for the actual revenues received in the Vinica Municipality from individuals and legal entities are shown in the table below.

Table 3-47: Revenues

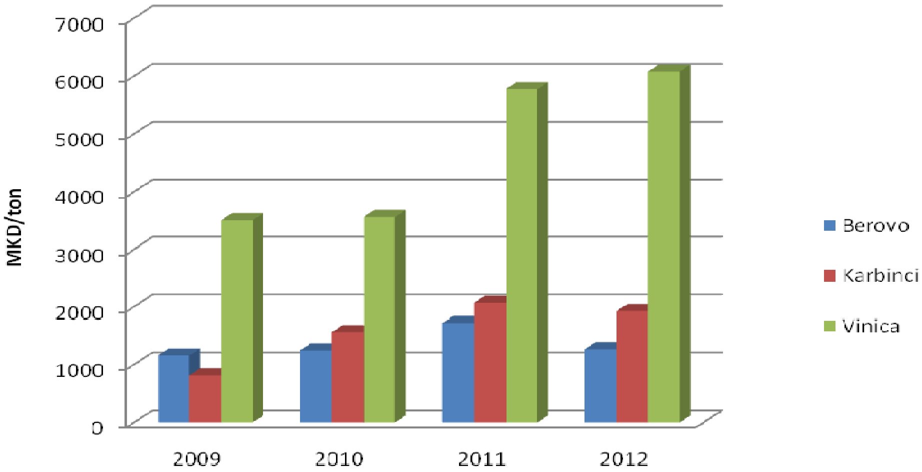
Year	2009	2010	2011	2012
Collection rate,%	N/A	N/A	N/A	N/A
Collected waste, ton	2515	2711	2907	2910
Revenue from individuals	6 550 091	7 308 203	10 799 688	11 027 603
Revenue from businesses	2 260 607	2 336 440	5 979 693	6 658 605
Total waste revenues	8 810 698	9 644 643	16 779 381	17 686 208
Revenue per ton collected waste, MKD	3 503	3 557	5 772	6 078

Average annual fee per household in the Vinica Municipality is 1 770 MKD, which is twice higher than in Berovo.

Table 3-48: Fees

Municipality	Population	people per household	number of households	Fee per household, MKD
Vinica	19 938	3.2	6 231	1 770

Figure 3-30: Revenues per ton in East Region



In 2012 the revenues per ton collected waste in East region are from 1300 to 1900 MKD/t, only in Vinica are 6000 MKD/t. The other municipalities of the region have not submitted any data for their waste management revenues.

3.3.3.6 Affordability

According to the "Application of the Polluter Pays Principle (PPP) in Waste Management Projects" of JASPERS Staff Working Papers, August 2011, it has to be considered that where household income levels are generally low or household income is unevenly distributed, residential waste tariffs can be temporarily set below full cost recovery levels. In general, for EU funded projects, the common practice seems to be the use of an affordability threshold of around 1.5% of the average household income of the lowest income deciles. Tariffs below full cost recovery levels are maintained only as long as affordability limitations persist.

According to the statistical data the average annual income per household in Macedonia for 2012 is 328 444 MKD. As data for the income in the region is not provided, an average annual income per household for the East region is estimated, considering GDP per capita in the Ea st region. GDP per capita for the East region is 206 773 MKD and it is closed to the country average GDP per capita, which is 223 357 MKD. Based on this assumption, the average annual income per household for East region is calculated at 304 057 MKD.

The average income for the first and third deciles is also corrected with the same assumption (93%) and it is 104 365 MKD for East region.

Table 3-49: Affordability

Municipality	Waste fee per household, MKD	Affordability level – 1.5%, MKD	% of affordability level	Criteria
Berovo	997	1 565	64%	Yes
Vinica	1 770	1 565	113%	No

Waste fees for households at the region are affordable in Berovo municipality and not affordable at Vinica municipality. The affordable level allows increasing the waste fee in Berovo by more than 50%. In Vinica Municipality the fees are above the affordability level by 13%.

3.3.4 Waste collection system and coverage

The waste collection, transportation and disposal service is mainly provided by Public Communal Enterprises (PCEs). However, the insufficient liquidity of PCEs prevents investments in suitable infrastructure for waste segregation and treatment, therefore mainly mixed waste is collected and disposed of at municipal, non-EU compliant landfills, with the exception of Štip settlement, where there are separate bins for PET and paper. According to the received questionnaires, the percentage of the population that receives a regular service ranges from 38% (Cesinovo-Obleshevo) to 100% (Stip& Pehcevo). Most of the population that does not receive any collection service lives in rural areas. This has lead to the proliferation of illegal dumpsites located on the outskirts of settlements. The waste collection frequency varies among municipalities. In order to interpret the results, it must be reminded that the most populated Municipality of the region is Štip Municipality and the least populated municipality is the Zrnovci Municipality.

The following table presents an overview of the waste collection coverage in East Region. Data in waste tariffs and waste collection costs/revenues for each municipality were presented in paragraph 3.3.3. Detailed data on the waste collection equipment are provided in Annex I-Inventory of existing waste collection equipment.

Table 3-50: Waste collection coverage

	Berovo	Češinovo - Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
Collection coverage (%)	100%		80%		92%		100%		95%	71%		
Population served (%)	80%	38%	80%	79%	95%	91%	100%	90%	100%	71%	90%	
Total population	13,181	7,125	16,673	4,040	38,058	7,729	5,068	15,480	48,578	19,521	3,098	**178,551**
% Urban Population	50%	0%	66%	0%	74%	63%	0%	67%	91%	54%	0%	**64.8%**
% Rural Population	50%	100%	34%	100%	26%	37%	100%	33%	9%	46%	100%	**35.2%**
Urban Population – number of inhabitants	6,591	0	11,004	0	28,163	4,869	0	10,372	44,206	10,541	0	**115,746**
Rural Population – number of inhabitants	6,591	7,125	5,669	4,040	9,895	2,860	5,068	5,108	4,372	8,980	3,098	**62,805**
Total Population Served	10,545	2,708	13,338	3,192	36,155	7,033	5,068	13,932	48,578	13,860	2,788	**157,197**
% Urban Population Served	50%	0%	66%	0%	74%	63%	0%	67%	91%	54%	0%	**74%**
% Rural Population Served	30%	38%	14%	79%	21%	28%	100%	23%	9%	17%	90%	**26%**

	Berovo	Češinovo - Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
Urban Population Served	6,591	0	11,004	0	28,163	4,869	0	10,372	44,206	10,541	0	**115,746**
Rural Population Served	3,954	2,708	2,334	3,192	7,992	2,164	5,068	3,560	4,372	3,319	2,788	**41,451**
Percentage of Total Serviced Population in East Region												**88.0%**
Total Urban Serviced Population												**100.0%**
Total Rural Serviced Population												**66.0%**

Collective compliance schemes – in accordance with Management of Batteries and Accumulators and Waste Batteries and Accumulators, a system for management of waste batteries and accumulators was established in the Republic of Macedonia, involving collective schemes (legal entity which in accordance with this Law is authorized for handling waste batteries and accumulators on behalf and on the account of the producers). Currently, two collective schemes operate in Macedonia covering together around 15% of the producers in the Republic of Macedonia (Waste Battery Assessment in Macedonia, 2013).

Regarding packaging waste, at the moment in FYR Macedonia there are four legal entities which have permissions for treatment of packaging waste (collective handlers)[32], according to article 21 of the Law on managing packaging and packaging waste (Official Gazette of the Republic of Macedonia no. 161/09, 17/11, 41/11, 136/11, 6/12 and 39/12):

1. Pakomak
2. Euro-Ekopak
3. Ekosajkl
4. Eko-pak hit

Eleven leading manufacturing companies in Macedonia are founders of the Pakomak: Pivara Skopje AD Skopje, Prilepska Pivarnica AD Prilep; Vitaminka AD Prilep; Pelisterka DOO Skopje; Magroni DOO (Ladna, Dobra Voda); Koding Dooel Kavadarci (Gorska Voda) Kozhufchanka DOO Kavadarci ; Vivaks Dooel Skopje; Blagoj GjorevADVeles; VV Tikvesh AD.; VV Stobi AD. Pakomak includes companies that have an obligation to manage their packaging waste and are aware of their social responsibility to provide a healthier environment. Since May 20th, 2011, Pakomak is the 34th national nonprofit company that joins the international network of packaging waste management Pro Europe (http://pro-e.org/), and thus receives the license to use the symbol "Green Dot". Also, it is the first company in Macedonia, licensed by the Ministry of environment for selection and processing of packaging waste (http://www.pakomak.com.mk/PakomakSite/en-zanas.html).
The following companies are members of Pakomak in East Region.

[32] EEA (2013). Municipal *Waste Management in the former Yugoslav Republic of Macedonia* [pdf]. Retrieved from http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.eea.europa.eu%2Fpublications%2Fmanaging-municipal-solid-waste%2Fmacedonia-fyr-municipal-waste-management&ei=YGL4UrfQAoeS0QX21YHIBQ&usg=AFQjCNFqABALaJnInndJ6h7kYbRyQBb7rg&sig2=0RZmZC76 06MuYHIKqyPw&bvm=bv.60983673,d.d2k

Table 3-51: Members of Pakomak in East Region

Company name	ADDRESS
MUNICIPALITY KOCANI	KOCANI
VEMEKS LLC	KOCANI
AQUA TRADE	KOCANI
TING-Inox Ltd	KOCANI
JTD PORCHINI	KOCANI
ANDREI COMPANY LLC	STIP
Elprom KOMERC	KOCANI
DPTU Greenhouses Ltd GOOD-200	KOCANI
LARS LLC	STIP
GSP Ltd	KOCANI
WINERY WINE iMac	STIP
Progress LLC	Cesinovo Oblesevo
ALEKSANDAR.98	KOCANI
ALEX LLC	KOCANI
Aaron CREAM LLC	STIP
FUDIS LLC	STIP
Panevski LLC	KOCANI
JTD 98 MIKOM	KOCANI
Floris LLC	KOCANI
BAGS Mania Ltd	KOCANI
JSC SMIKI GOCE	KOCANI
Jeanette EXPORT LTD	KOCANI
ALEX -3	KOCANI
TP.SHAMPINJONI	KOCANI
RICE GRAINS-CM	KOCANI
MACEDONIA OIL	KOCANI
20th Century LLC	Pehchevo
Bregalnica LLC	DELCEVO
Mondial MACEDONIA	Oblesevo-Cesinovo
NO-FI LLC	DELCEVO
Arlen LLC	DELCEVO
PALTEKS Inc.	DELCEVO
Fur Ltd.	DELCEVO
Viteks DE-DOO	DELCEVO
TREND DESIGN LLC	DELCEVO
Magnolia LLC	KOCANI
NTASHA Dairy LLC	BEROVO
Office EXPRESS LLC	KOCANI

Pakomak currently works with 20 municipalities (approx. 1.1 to 1.2 million inhabitants of the country). There are no data on Pakomak’s collection equipment in East Region. However, the following types of equipment during 2013 are set in use in municipalities, PCE, Industry and Facilities of particular public interest in FYR of Macedonia:

1. One TMV Mercedes Benz with upgrade FAUN for waste collection
2. Two baling presses (City mall)
3. 212 pieces of plastic containers 1, 1 m3

-50 pieces of green containers
-134 pieces of yellow containers for PET bottle
-28 pieces of blue containers for collection of paper
4. 219 pieces 120 L bins
5. 49 pieces 240 L bin
6. 18 double sets of bins for collecting PW for internal use
7. 30 pieces of mesh containers 1m3
8. 300 pieces of cardboard boxes for collection of archival paper

Basic data on the collective schemes for the year 2012 are presented in the following table.

Table 3-52: Data on the collective handlers of packaging waste- 2012

General Data	PAKOMAK	EURO ECO PACK	EKOSAJKL	EKO-PAK HIT
Number of companies that are members of the system	583	no data	42	48
Number of companies reporting to waste system	468	no data	42	16
Total reported quantities of waste (in tons)	**40,557**	**8,263**	**1,120**	**682**
Total reported amount of collected and recovered packaging waste (in tons)	**7595**	**9.2**	**211**	**132**
Percentage of recycled waste compared to the reported (in accordance with Article 35 paragraph (1)	18.7%	0.11%	18.8%	19.4%

EKO-PAK HIT - Kocani cooperates with the following municipalities:

- Kocani
- Vinica
- Zrnovci
- Probishtip
- Makedonska Kamenica

EKO-PAK HIT - Kocani cooperates with the following Companies:[33]

- "Ecoproject-KO" Kocani LLC
- "Unitrade 2002" LTD Bulgaria
- Kiro Dandaro Bitola
- Boiler KOMAPNI Veles
- Brick-SKOPJE MACEDONIA
- PRINTING EUROPE 92 KOCANI
- BREWERY Bitola
- WHEAT RICE CM-KOCANI
- CHEMISTRY KOMERC Veles
- EC-ELSA - Veles

[33] http://www.ekopakhit.com.mk/partneri.html

- TING LLC KOCANI
- BIOMEDIKA - SKOPJE
- OKI promo DELCEVO
- NATASHA Dairy-BEROVO
- Sayaxche 21 Veles
- PIR KOMERC SKOPJE
- ADRIAMED SKOPJE
- KOPRINT SKOPJE
- ENMON Veles
- POSITIVE TRADE - SKOPJE
- POPOVSKI COMPANY SKOPJE
- ARGUS COMPANY-KAVADARCI
- Boiler com-Veles
- Labem - SKOPJE
- FARM TRADE-SKOPJE
- ALEKSPROM - SKOPJE
- Greenhouses GOOD - Kocani
- Fur DELCEVO
- Magnolia-KOCANI
- TA mushrooms - Kocani
- TING-Inox-KOCANI
- LARS LLC STIP
- Almond LLC KAVADARCI
- MACEDONIA oil - Kocani
- Bergomi LLC pix
- Bregalnica LLC DELCEVO
- Tiki Wendt-SKOPJE
- Agon PLUS - SKOPJE
- ANDREI COMPANY - STIP
- KIKI - Kocani
- MM-Investment Winery LOZAR Veles
- Elprom KOMERC – SKOPJE

3.3.5 Waste generation and composition

3.3.5.1 Waste generation index

A waste quantity analysis was performed during the elaboration of the Assessment Report. The collection of data about the total mass of generated waste was carried out by weighing the mass of fully-laden garbage trucks which collect waste in the territory of a municipality. The mass of fully-laden trucks was weighed using a weighbridge of a utility company or other business entities in the territory of the local self-government unit where the procedure is performed. The municipal waste mass was weighed during a period of seven days, successively (Monday to Sunday), including the weekend days.

Data was collected and recorded per dwelling zone – sector where the waste whose mass was weighed was collected. The number of inhabitants covered by the collection procedure was estimated directly in the field and based on statistics. The daily mass of waste per inhabitant of a particular dwelling zone – sector within a municipality, town was determined by dividing the total generated waste mass by the number of inhabitants of the relevant dwelling zone – sector. The daily mass of waste per inhabitant of the entire municipality, town, and/or the city was determined by dividing the total generated waste mass by the number of inhabitants of the relevant municipality.

The obtained waste weightings and results for each municipality are presented analytically in the Assessment Report.

In order to calculate the waste production factor, the following were taken into account:

- The quantity of weighted (collected) waste in each municipality.
- The percentage of served population in each municipality (provided in the questionnaires submitted by each municipality
- The estimated population of 2012, which was used for the calculations (according to publication 2.4.13.13/757 of the Statistical Office of Republic of Macedonia)

The most populated Municipality of the region is Štip Municipality and covers 23.6% of the overall waste production in East Region and is closely followed by Kočani Municipality (20.7%). The pure rural municipalities i.e. Češinovo-Obleševo, Karbinci and Zrnovci have generally lower waste production than the urban areas resulting in small participation in regional waste production. The average daily waste production per habitant of the East Region is 0.254 t/habitant/yr, which very close to the estimated one from previous desk studies.

Table 3-53: Waste generation index per municipality

	Berovo	Češinovo - Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
Waste Weighting (t)	4,147	515	4,044	1,170	8,906	747	2,392	4,124	10,688	2,719	504	**39,955**
Collection coverage (%)	100%		80%		92%		100%		95%	71%		
Population served (%)	80%	38%	80%	79%	95%	91%	100%	90%	100%	71%	90%	
Total population	13,181	7,125	16,673	4,040	38,058	7,729	5,068	15,480	48,578	19,521	3,098	**178,551**
% Urban Population	50%	0%	66%	0%	74%	63%	0%	67%	91%	54%	0%	**64.8%**
% Rural Population	50%	100%	34%	100%	26%	37%	100%	33%	9%	46%	100%	**35.2%**
Urban Population – number of inhabitants	6,591	0	11,004	0	28,163	4,869	0	10,372	44,206	10,541	0	**115,746**
Rural Population – number of inhabitants	6,591	7,125	5,669	4,040	9,895	2,860	5,068	5,108	4,372	8,980	3,098	**62,805**
Total Population Served	10,545	2,708	13,338	3,192	36,155	7,033	5,068	13,932	48,578	13,860	2,788	**157,197**
% Urban	50%	0%	66%	0%	74%	63%	0%	67%	91%	54%	0%	**74%**

	Berovo	Češinovo - Obleševo	Delčevo	Karbinci	Kocani	Maked. Kamenica	Pehcevo	Probištip	Štip	Vinica	Zrnovci	Total
Population Served												
% Rural Population Served	30%	38%	14%	79%	21%	28%	100%	23%	9%	17%	90%	**26%**
Urban Population Served	6,591	0	11,004	0	28,163	4,869	0	10,372	44,206	10,541	0	**115,746**
Rural Population Served	3,954	2,708	2,334	3,192	7,992	2,164	5,068	3,560	4,372	3,319	2,788	**41,451**
Percentage of Total Serviced Population in East Region												**88.0%**
Total Urban Serviced Population												**100.0%**
Total Rural Serviced Population												**66.0%**
t/habitant/year	0.393	0.190	0.303	0.367	0.246	0.106	0.472	0.296	0.220	0.196	0.181	**0.254**
Waste Production (t)	5,184	1,355	5,054	1,481	9,375	821	2,392	4,582	10,688	3,830	560	**45,321**
Urban Waste Production t	2,592	0	3,336	0	6,937	517	0	3,070	9,726	2,068	0	**28,246**
Rural Waste Production t	2,592	1,355	1,718	1,481	2,437	304	2,392	1,512	962	1,762	560	**17,075**
t/habitant/year Urban	0.393		0.303		0.246	0.106		0.296	0.220	0.196		**0.244**
t/habitant/year Rural	0.393	0.190	0.303	0.367	0.246	0.106	0.472	0.296	0.220	0.196	0.181	**0.272**

3.3.5.2 Waste composition

A waste composition analysis was performed together with waste generation analysis. Detailed results per municipality were presented in the Annex of the Assessment Report.

If the waste composition results in East region are compared, it can be concluded that the organic fraction consisted of its two sub-categories and fine fractions, generally have the most significant share for all 11 municipalities in the region.

Share of garden waste is mainly around 17.0%, while some smaller amounts are recorded only for the case of the municipalities of Stip (10.6%) and Kocani (15.2 %). The largest proportion of garden waste has been recorded in the municipality of Berovo (28.7 %). Other biodegradable waste has a much greater variation, from only 18.04 %, in Pehcevo up to 44.5% in the municipality of Stip. Share of paper is mostly in the range of 4.0% to 5.0 % with the exception in case of the municipality Oblesevo-Cesinovo and Zrnovci, where share of this fraction is 7.2% and 1.91 % respectively.

The values for the cardboard are slightly smaller and vary mainly in the range of 3.0% to 5.0 %, where the highest value is recorded in the municipality of Pehcevo (6.7%). Glass in the surveyed municipalities of East region don't have significant share in the composition of waste, except in the case of the municipality of Makednoska Kamenica where is determined share of 8.2 %.

In case of ferrous metal, except for a municipality of Pehcevo, where it's recorded a share of 2.1%, in all other municipality this fraction does not exceed 1.0%. The second subcategory of metal (aluminum and other non-ferrous metals) showed even less presence in the overall composition of waste for all observed municipalities, and value for each of them does not exceed 0.5%. Share of tetrapak fraction, except in the case of the municipality of Stip (1.1%), does not exceed 1.0% for all other municipalities.

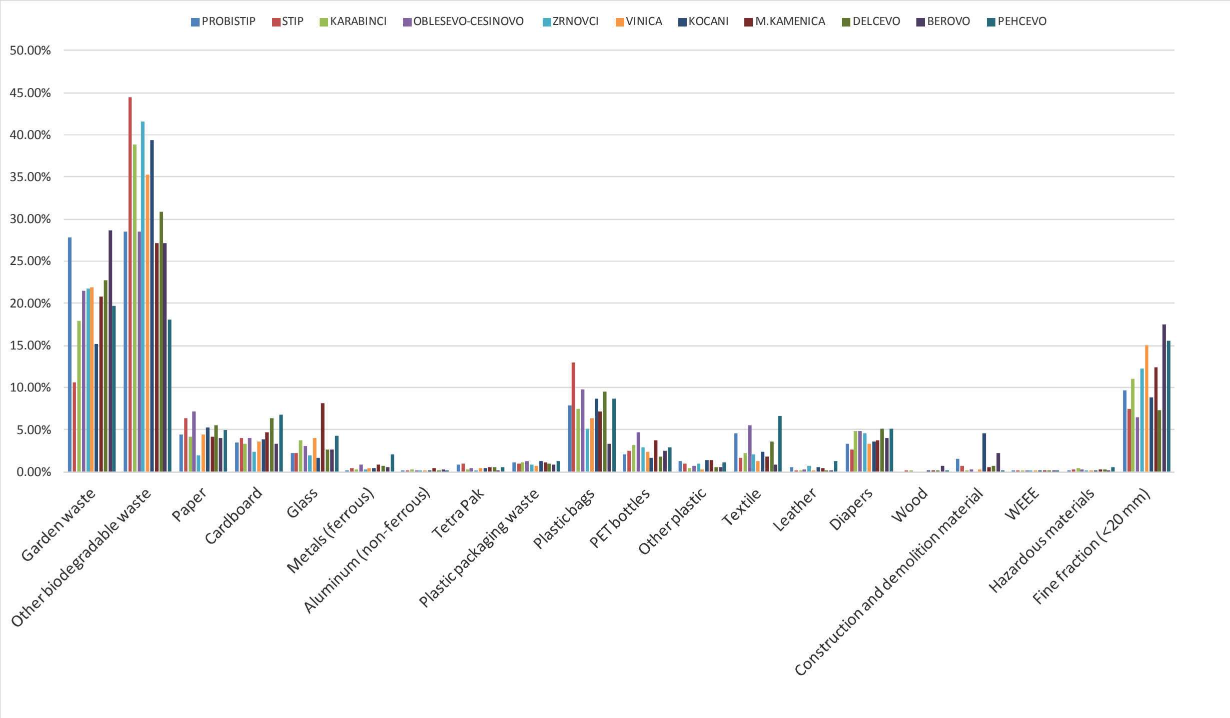
Plastic packaging waste have quite uniform values of mass share for the observed municipalities and it is in the range of about 1.0%. On the other hand, plastic bags and their share greatly varies depending on the municipality, where the highest value was recorded in the municipality of Stip (12.98%), and lowest in the municipality of Berovo (3.4%).

Table 3-54: TAverage waste composition for all municipalities in East region

MUNICIPALITY / WASTE CATEGORY	PROBISTIP	STIP	KARABINCI	OBLESEVO-CESINOVO	ZRNOVCI	VINICA	KOCANI	M.KAMENICA	DELCEVO	BEROVO	PEHCEVO
Garden waste	27.81%	10.58%	17.98%	21.44%	21.77%	21.85%	15.16%	20.84%	22.80%	28.68%	19.71%
Other biodegradable waste	28.56%	44.47%	38.79%	28.51%	41.65%	35.28%	39.37%	27.09%	30.92%	27.13%	18.04%
Paper	4.46%	6.35%	4.18%	7.20%	1.91%	4.42%	5.20%	4.19%	5.52%	4.09%	4.99%
Cardboard	3.50%	4.09%	3.30%	3.99%	2.39%	3.56%	3.87%	4.68%	6.42%	3.37%	6.74%
Glass	2.27%	2.28%	3.79%	3.00%	1.97%	4.01%	1.72%	8.20%	2.70%	2.67%	4.27%
Metals (ferrous)	0.17%	0.51%	0.25%	0.85%	0.35%	0.38%	0.45%	0.90%	0.72%	0.54%	2.05%
Aluminum (non-ferrous)	0.11%	0.13%	0.25%	0.18%	0.12%	0.15%	0.22%	0.45%	0.20%	0.33%	0.15%
Tetra Pak	0.90%	1.05%	0.30%	0.47%	0.19%	0.38%	0.41%	0.60%	0.52%	0.16%	0.59%
Plastic packaging waste	1.14%	1.00%	1.08%	1.21%	0.79%	0.67%	1.32%	1.14%	0.93%	0.81%	1.23%
Plastic bags	7.88%	12.98%	7.42%	9.82%	5.10%	6.35%	8.75%	7.22%	9.48%	3.40%	8.72%
PET bottles	2.14%	2.49%	3.24%	4.75%	2.86%	2.35%	1.75%	3.68%	1.84%	2.55%	2.92%
Other plastic	1.30%	0.96%	0.47%	0.68%	0.93%	0.32%	1.38%	1.46%	0.55%	0.62%	1.11%
Textile	4.55%	1.66%	2.26%	5.52%	2.11%	1.25%	2.33%	1.83%	3.62%	0.85%	6.63%
Leather	0.56%	0.07%	0.20%	0.33%	0.79%	0.20%	0.53%	0.48%	0.19%	0.14%	1.29%
Diapers	3.37%	2.66%	4.79%	4.83%	4.59%	3.38%	3.63%	3.72%	5.12%	4.06%	5.10%
Wood	0.00%	0.03%	0.23%	0.00%	0.00%	0.00%	0.06%	0.15%	0.01%	0.74%	0.09%
Construction and demolition material	1.51%	0.77%	0.06%	0.32%	0.00%	0.28%	4.53%	0.54%	0.69%	2.17%	0.22%
WEEE	0.01%	0.11%	0.03%	0.07%	0.02%	0.03%	0.22%	0.08%	0.12%	0.00%	0.04%
Hazardous materials	0.08%	0.31%	0.40%	0.31%	0.16%	0.13%	0.22%	0.28%	0.35%	0.18%	0.52%
Fine fraction (<20 mm)	9.69%	7.52%	10.98%	6.51%	12.33%	15.00%	8.86%	12.46%	7.30%	17.52%	15.61%

PET bottles generally doesn't have a large share in the observed municipalities waste composition. Except in the case of the municipalities Oblesevo-Cesinovo (4.8%), a Makedonska Kamenica (3.7%) and Karbinci (3.2 %) this fraction did not exceed 3.0%. Other plastic have the largest share in the municipality of Kocani (1.4%), while the lowest value is recorded in Vinica (0.3%). Share of textile is depending on the considered municipality and has different values, from only 0.9% in Berovo, to 6.6% in the municipality of Pehcevo. Leather, expectedly showed a small proportion in the waste composition for the majority of municipalities, except maybe in the case of Pehcevo, where share of a 1.3% of this category has been registered. Share of diapers in the observed municipalities is in the range of 2.7% (Stip) to 5.1% (Delcevo). In case of wood waste category, some noticeable part in the overall composition of the waste was found in the municipality of Berovo (0.7%), while for all other municipalities that share is 0% or very close to that value. Construction and demolition materials showed significant differences depending on the considered municipalities, although generally the value of share for these fractions is nowhere significant. Highest share of C&D waste has been recorded in the municipality of Kocani (4.5%), while in the municipality of Zrnovci this fraction was not found in the samples. WEEE and Hazardous materials for all municipalities have a very small share, barely exceeded 0%. The last category of waste, according to the waste catalog i.e. fine fraction, have values in wide range from 6.0% to 17.5 %

Figure 3-31: Comparison of waste composition for all municipalities within East Region

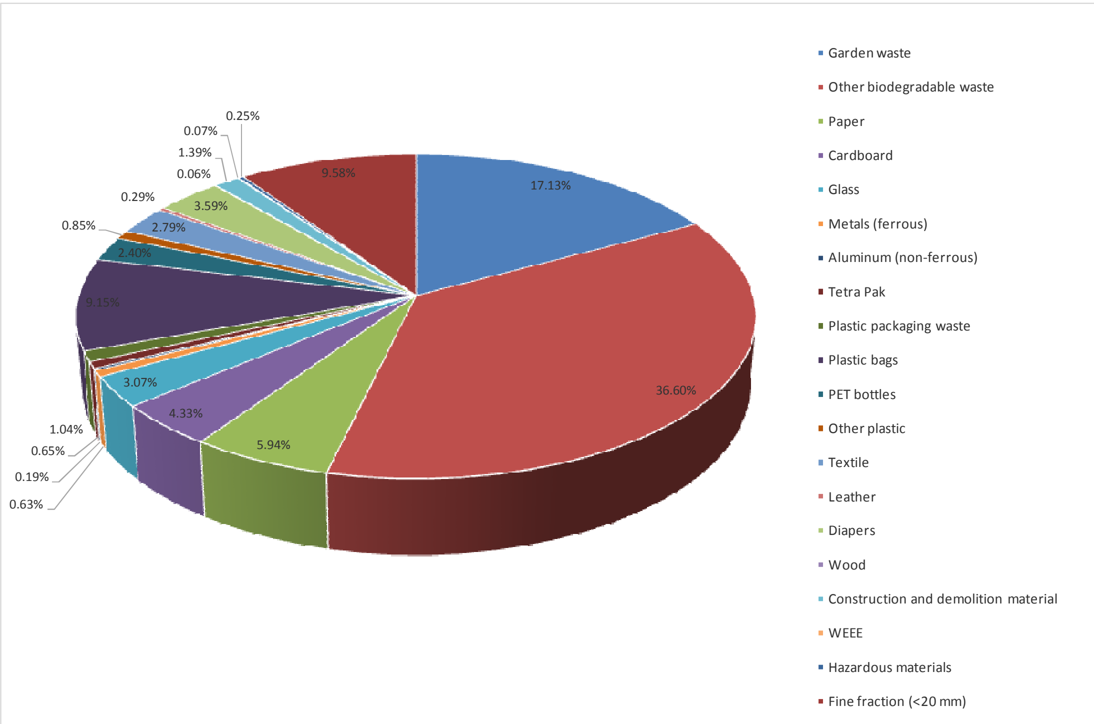


Such obtained result for waste composition shows that the highest share has the organic fraction with 53.73% where garden waste has share of 17.13% and other biodegradable waste has share of 36.6%. Fraction of fine elements has 9.58% and represents great amount causing a negative result, considering that this fraction cannot be used in any waste treatment. Textile and diapers with share of 2.79% and 3.59% respectively also represent non-favorable fractions from treatment and reuse point of view.

Table 3-55: Average waste composition for whole East region

FRACTIONS	TOTAL COMPOSITION/ EAST REGION
Garden waste	17.13%
Other biodegradable waste	36.60%
Paper	5.94%
Cardboard	4.33%
Glass	3.07%
Metals (ferrous)	0.63%
Aluminum (non-ferrous)	0.19%
Tetra Pak	0.65%
Plastic packaging waste	1.04%
Plastic bags	9.15%
PET bottles	2.40%
Other plastic	0.85%
Textile	2.79%
Leather	0.29%
Diapers	3.59%
Wood	0.06%
Construction and demolition material	1.39%
WEEE	0.07%
Hazardous materials	0.25%
Fine fraction (<20 mm)	9.58%
Total	100.00%

Figure 3-32: Average waste composition for whole East region



Observing recyclable fractions, paper and cardboard together have 10.28% (5.94% and 4.33% respectively). Glass has share in expected boundaries and it is 3.07%. Tetrapak materials have small share (0.65%). Metals fractions together takes 0.82% of share, which means that aluminium cans take only 0.19% in total waste composition. Plastics with 4 sub-categories has 13.43% share in total amount and PET bottles with best recycling potential takes 2.4%. Plastic bags share (9.15%) is quite high, while plastic packaging waste and other plastic have share of 1.04% and 0.85% respectively. Wood and WEEE have very low partition in overall region waste composition close to 0.13%. Leather and hazardous material with share of around 0.54% also do not represent significant fractions in terms of mass contributions to overall composition. C&D materials have share of 1.39%.

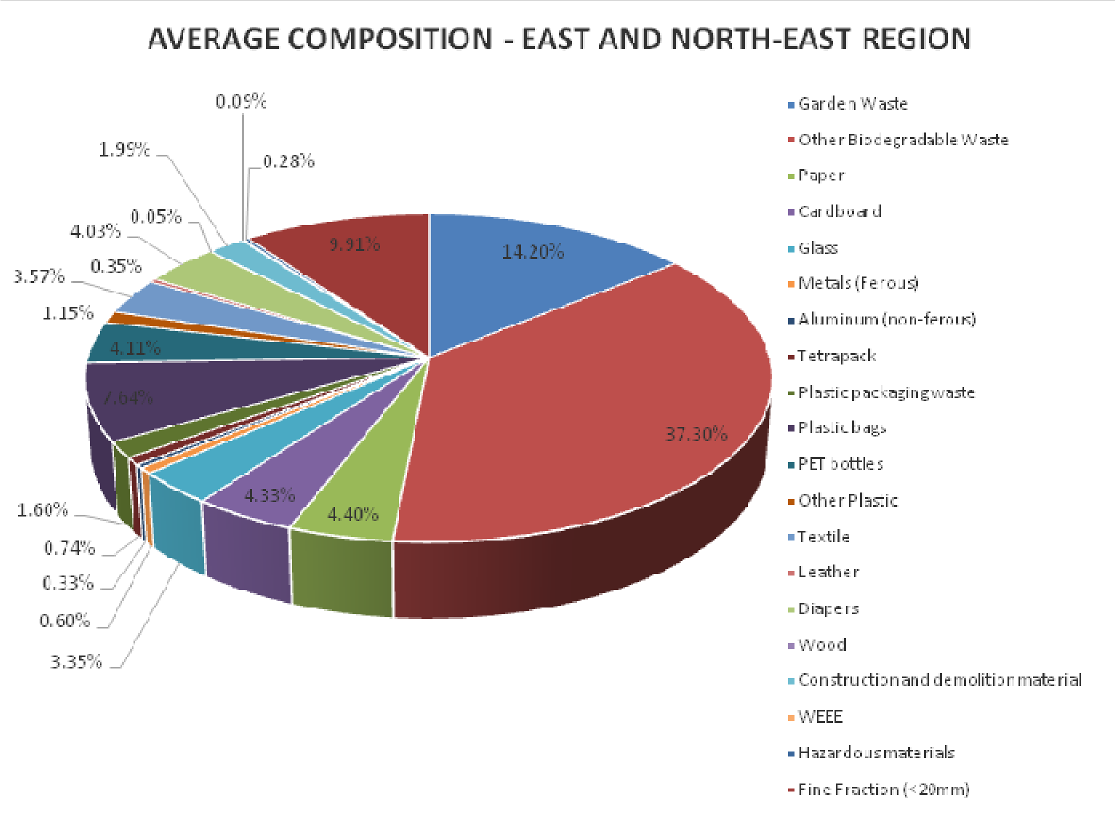
The option of a common integrated waste management system for both regions is examined. Therefore, the average waste composition both for East and North-east Region was calculated.

Table 3-56: Average weighted unified waste composition for East and North-East Region

FRACTIONS	TOTAL COMPOSITION FOR EAST AND NORTH-EAST REGION
Garden waste	14.20%
Other biodegradable waste	37.30%
Paper	4.40%
Cardboard	4.33%
Glass	3.35%
Metals (ferrous)	0.60%
Aluminum (non-ferrous)	0.33%
Tetra Pak	0.74%
Plastic packaging waste	1.60%
Plastic bags	7.64%
PET bottles	4.11%
Other plastic	1.15%
Textile	3.57%
Leather	0.35%
Diapers	4.03%
Wood	0.05%
Construction and demolition material	1.99%
WEEE	0.09%
Hazardous materials	0.28%
Fine fraction (<20 mm)	9.91%
Total	**100.00%**

Such obtained result for waste composition shows that the highest share has organic fraction with 51.49%, where garden waste has share of 14.20% and other biodegradable waste has share of 37.3%. Fraction of fine elements has share of 9.9% and represents great amount causing a negative result, considering that this fraction can't be used in any waste treatment.

Figure 3-33: Average weighted unified waste composition for East and North-East region

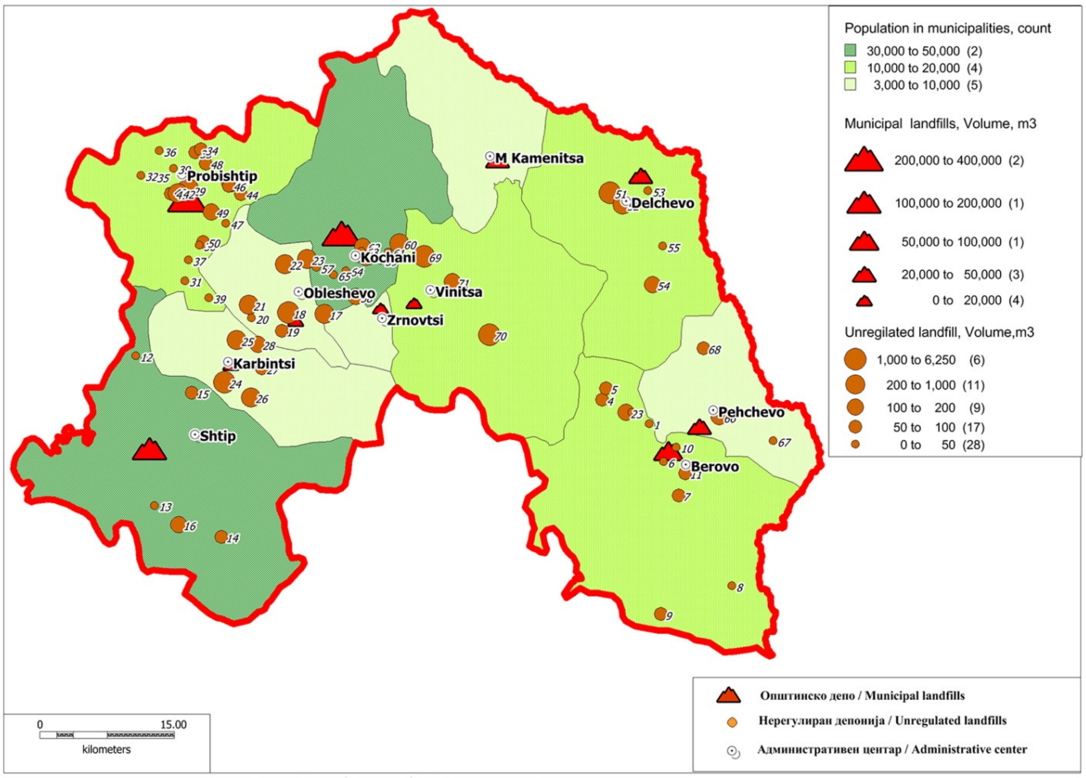


3.3.6 Waste Disposal

The Consultant visited all unregulated dumpsites and municipal landfills in the region and created an appropriate registry. Historical data were gathered and inserted in the registry, along with technical and environmental data. The data were processed and a Detailed Risk Assessment was performed for separate environmental components (ground water, surface water, soil or air). The dumpsites were ranked and prioritized on the basis of different criteria –planning the necessary remedial actions, their distribution in time, application of different types of remediation technologies. A program for remediation of all dumpsites/landfills was prepared including development of typical remediation technologies.

Waste disposal is provided by the PCEs at eleven (11) municipal landfill sites. The sites are operated on a controlled basis, but they are not compliant with EU requirements. Also, with a decision of the Council of Stip, the construction and demolition waste in the municipality is disposed at the old landfill "Krstot". According to the field investigation conducted, there are 71 uncontrolled dumpsites, especially in rural areas. In Karbinci, Greenhouses Eco Oaza Samandov - Tarinci deposit the waste themselves on their own landfill. The distribution of municipal landfills and unregulated dumpsites is presented in the following map:

Figure 3-34: Distribution of municipal landfills and unregulated sites in the Region



For the current project, the Consultant team made an environmental risk assessment (based on-site surveys) and landfills categorization according to their risks was made for the 11 municipal landfills and 71 unregulated dumpsites. GEFA methodology and software was used for the quantitative risk assessment of all landfills. The environmental mediums examined were soil, groundwater and surface water in relation to humans and to flora-fauna. The highest calculated values of **average** risks were used for landfills prioritization and planning of additional investigation activities, while the highest calculated values for **maximum** risks were used for the future required rehabilitation works – detailed inventory of the existing landfill sites can be found in the Assessment Report – Part B.

3.3.6.1 Municipal landfills sites

According to the field investigation conducted, there are 11 municipal landfill sites, especially in urban areas. The following table presents the municipal landfill sites and their main characteristics (area, volume, etc.).

Table 3-57: Municipal landfill sites

ID	Municipal	Settlement	Locality	Longitude	Latitude	Area Landfill, m^2	Landfill Volume, m^3
1	Cheshinovo - Obleshevo	Kucichino	Bukiski dol	22.32887	41.85416	8,000	8,000
2	Shtip	Shtip	Treshtena skala	22.13289	41.72526	16,380	100,000
3	Kochani	Kochani	Tupanec	22.39023	41.94017	21,000	400,000
4	Probishtip	Neokazi	Ozren	22.18318	41.97385	35,000	353,846
5	Karbinci	Karbinci	Bel breg	22.24160	41.81024	4,225	8,320

ID	Municipal	Settlement	Locality	Longitude	Latitude	Area Landfill, m^2	Landfill Volume, m^3
6	Zrnovci	Zrnovci	Sredorek	22.44268	41.86687	2,000	150
7	Vinica	Leski	Chuchulanec	22.48727	41.87208	7,830	12,000
8	Berovo	Berovo	Uvin valog	22.82921	41.72292	10,500	75,000
9	Pehcevo	Pehcevo	Dabova shuma	22.87056	41.74815	15,000	20,000
10	M Kamenica	Kamenica	Kamenichki rid	22.59935	42.01441	7,000	40,000
11	Delchevo	Sredna maala	Ostrec	22.79174	41.99896	24,000	24,000

Prioritization of 11 municipal landfills was made using GEFA software based on the highest calculated values of **average** and **maximum** risks for ground waters, soils and surface waters. All landfills included in the inventory are divided in four (4) groups according to the actions priority:

- Priority group I (minimum risk) – landfills are taken out of the inventory
- Priority group II (medium risk) – additional investigations are needed, but actions are planed for long term. In current situation these landfills stay in the inventory, but monitoring and possible rehabilitation could be performed in long term
- Priority group III (high risk) – additional investigation for environmental impacts is necessary, and based on the obtained results landfills may fall in another priority group. Planned activities should be realized in medium term
- Priority group IV (very high risk) – for these landfills additional detailed investigations for rehabilitation measures should start without delay (short term)

Summarized results of the prioritization and grouping of municipal landfills in terms of the necessary remediation measures and timing of their performance is presented in the following table.

Table 3-58: Summarized results of the prioritization and grouping of landfills in terms of the necessary remediation measures and timing of their performance

Municipality	Settlement	Location	Prioritization in terms of the necessary measures ($R_{max.max}$)			Prioritization in terms of timing of provided measures ($R_{max.avg.}$)		
			Direct investigations for rehabilitation	Additional investigations	Additional investigations and monitoring	Short term	Medium term	Long term
Shtip	Shtip	Treshtena skala	x				x	
Probishtip	v. Neokazi	Ozren	x				x	
Kochani	Kochani	Tupanec	x					x
Cheshinovo Obleshevo	v.Kuchichino	Bukiski Dol	x			x		
Karbinci	v.Karbinci	Bel breg	x			x		
Zrnovci	v.Zrnovci	Sredorek	x				x	
Vinica	Vinica	Chuchulanec	x				x	
Berovo	Berovo	Uvin dol	x				x	
Pehchevo	Pehchevo	Datova Shuma	x					x
Makedonska Kamenica	Makedonska Kamenica	Kamenichki rid	x					x
Delchevo	Delchevo	Ostrec		x				x

3.3.6.2 Uncontrolled dumpsites

According to the field investigation conducted, there are 71 uncontrolled dumpsites, especially in rural areas. The following table presents the main characteristics of the uncontrolled dumpsites (area, volume, etc.).

Table 3-59: Uncontrolled dump sites

ID	Municipality	Settlement	Locality	Latitude	Longitude	Area Landfill, m^2	Volume Landfill, m^3
1	Berovo	Machevo		41.751111	22.802778	10	10
2	Berovo	Budinarci	under bridge of r. Bregalnica	41.762222	22.772222	100	100
3	Berovo	Budinarci	over elementary school	41.762222	22.779444	10	20
4	Berovo	Mitrashinci	under the bridge in village	41.774722	22.739722	25	50
5	Berovo	Mitrashinci	under the bridge	41.786389	22.745278	50	50
6	Berovo	Vladimirovo		41.713056	22.822222	15	45
7	Berovo	Ratevo		41.679167	22.8425	25	50
8	Berovo	Dvorishte		41.588889	22.913889	50	25
9	Berovo	Suvi Laki		41.560556	22.818611	35	70
10	Berovo	Smojamirovo	river	41.7275	22.83917	25	25
11	Berovo	Ciganski Potok		41.701389	22.851111	100	50
12	Stip	Vrsakovo	Reka	41.818889	22.113889	10	10
13	Stip	Dragoevo	Gladno Pole	41.669167	22.138889	40	40
14	Stip	Lakavica	Lakavica reka	41.637778	22.228611	50	50
15	Stip	Chardaklia	Kai Reka	41.781944	22.188889	40	80
16	Stip	Selce	Sred sela	41.65	22.171389	60	180
17	Cesinovo-Oblesevo	Teranci	Teranci Gubrs	41.860556	22.367222	70	210
18	Cesinovo-Oblesevo	Teranci	Stara deponii	41.861944	22.318611	750	1125
19	Cesinovo-Oblesevo	Kuchichino		41.843889	22.31	50	50
20	Cesinovo-Oblesevo	Ularci		41.856667	22.269167	6	12
21	Cesinovo-Oblesevo	Cesinovo	Gorica	41.869722	22.265278	600	900
22	Cesinovo-Oblesevo	Spancevo	Poichanski pan	41.910556	22.313889	100	400
23	Cesinovo-Oblesevo	Banja	Stara Deponii	41.915556	22.343889	200	400
24	Karbinci	Tarinci	Reka	41.792222	22.233056	1250	2250
25	Karbinci	Krupishte	Laki	41.834444	22.249167	250	250
26	Karbinci	Radanie	Tashlak	41.777222	22.268333	300	300
27	Karbinci	Koziak	Likach	41.806111	22.283056	100	50
28	Karbinci	Argilica	Bairak	41.830278	22.277777	28	168
29	Probishtip	Probishtip		41.984722	22.184444	2500	6250
30	Probishtip	Buchishte		41.929444	22.199167	100	30
31	Probishtip	Gajranci		41.893889	22.179722	10	5
32	Probishtip	g. Stubol		41.999444	22.120833	10	20
33	Probishtip	Dobrevo		42.022222	22.193889	50	50
34	Probishtip	Dobrevo		42.025278	22.201389	40	60
35	Probishtip	d. Stubol		41.998056	22.135833	25	25
36	Probishtip	Kundino		42.02389	22.145	14	28

ID	Municipality	Settlement	Locality	Latitude	Longitude	Area Landfill, m^2	Volume Landfill, m^3
37	Probishtip	Lezovo		41.914722	22.184444	20	40
39	Probishtip	Pishica		41.876944	22.211667	50	25
39	Probishtip	Pleshenci		42.006389	22.164722	50	25
40	Probishtip	Strmosh	Krasna selo	41.983333	22.158889	20	20
41	Probishtip	Strmosh	Reka	41.981111	22.160833	50	50
42	Probishtip	Strmosh	Bel Kamen	41.981389	22.170278	50	250
43	Probishtip	Zletovo	bridge	41.988889	22.238611	10	15
44	Probishtip	Zletovo	Tursko rudare	41.980556	22.255	40	80
45	Probishtip	Zletovo	Gorno maalo	41.992222	22.241667	50	250
46	Probishtip	Zletovo	bridge Tursko Rudare	41.988889	22.238889	100	50
47	Probishtip	Bunesh	in the village	41.951111	22.234722	24	36
48	Probishtip	Dreveno		42.011111	22.207778	8	64
49	Probishtip	Ratavica		41.962778	22.215278	150	150
50	Probishtip	Tripatanci	below the bridge	41.932778	22.204167	50	50
51	Delcevo	Delcevo	Way for Kiselica	41.981944	22.750278	5000	5000
52	Delcevo	Delcevo	Along marketplace	41.97	22.767222	400	400
53	Delcevo	Gabrovo		41.983889	22.801389	9	9
54	Delcevo	Trabotivishte		41.89	22.807778	100	100
55	Delcevo	Grad	Bunishte	41.928611	22.821111	25	25
56	Kocani	Trajanovo Trlo		41.918611	22.423333	200	600
57	Kocani	Trkanje		41.907222	22.356111	0	0
58	Kocani	Grdovci		41.878056	22.409167	40	120
59	Kocani	Orizari		41.914444	22.442778	15	15
60	Kocani	Orizari	exit of Orizari	41.931111	22.467778	60	300
61	Kocani	Orizari	Ilin dol	41.922778	22.452222	10	20
62	Kocani	Kocani	Roma neighbourhood	41.928333	22.418611	320	160
63	Kocani	Kocani	Roma neighbourhood	41.923611	22.416944	30	30
64	Kocani	Kocani	Hotel Nacional	41.903889	22.395833	0	0
65	Kocani	Kocani	Madzhirski bavchi	41.899722	22.379444	8	8
66	Pehcevo	Govedarnik	Gagjalnica	41.757778	22.897222	40	160
67	Pehcevo	Ravna Reka	Suv Dol	41.733889	22.969444	0	0
68	Pehcevo	Crnik		41.826389	22.876111	30	90
69	Vinica	Istibanja	Stari Lozja	41.918333	22.500833	360	2160
70	Vinica	Blatec	Pocivalo	41.84	22.588611	300	1800
71	Vinica	Vinichka Krshla	Sushica	41.892778	22.538611	100	100

Prioritization of 71 uncontrolled dumpsites was made using GEFA software based on the highest calculated values of **average** and **maximum** risks for ground waters, soils and surface waters. All landfills included in the inventory are divided in four (4) groups (please see section 3.6.6.1). Summarized results of the prioritization and grouping of uncontrolled dumpsites in terms of the necessary remediation measures and timing of their performance is presented in the following table.

Table 3-60: Summarized results of the prioritization and grouping of uncontrolled dumpsites in terms of the necessary remediation measures and timing of their performance

Municipality	Settlement	Location	Prioritization in terms of the necessary measures ($R_{max.max}$)			Prioritization in terms of timing of provided measures ($R_{max.avg.}$)		
			Direct investigations for rehabilitation	Additional investigations	Additional investigations and monitoring	Short term	Medium term	Long term
Berovo	Budinarci	over elementary school	x					x
Berovo	Mitrashinci	under the bridge in village	x					x
Berovo	Mitrashinci	under the bridge	x					x
Berovo	Ratevo		x					x
Berovo	Smojamirovo	river	x					x
Cesinovo-Oblesevo	Kuchichino		x					x
Cesinovo-Oblesevo	Banja	Stara Deponii	x					x
Delcevo	Delcevo	Way for Kiselica	x					x
Delcevo	Delcevo	Along marketplace	x					
Delcevo	Trabotivishte		x					x
Karbinci	Tarinci	Reka	x					x
Karbinci	Krupishte	Laki	x					x
Karbinci	Radanie	Tashlak	x					
Karbinci	Koziak	Likach	x					x
Karbinci	Argilica	Bairak	x					x
Probishtip	Probishtip		x					x
Probishtip	Buchishte		x					x
Probishtip	Gajranci		x					x
Probishtip	g. Stubol		x					x
Probishtip	Dobrevo	Entrance of the village	x					x

Municipality	Settlement	Location	Prioritization in terms of the necessary measures ($R_{max.max}$)			Prioritization in terms of timing of provided measures ($R_{max.avg.}$)		
			Direct investigations for rehabilitation	Additional investigations	Additional investigations and monitoring	Short term	Medium term	Long term
Probishtip	Dobrevo	Kaj rudnik	x					x
Probishtip	d. Stubol		x					x
Probishtip	Kundino		x					x
Probishtip	Lezovo		x					x
Probishtip	Pishica		x				x	
Probishtip	Pleshenci		x					x
Probishtip	Strmosh	Krasna selo	x					x
Probishtip	Strmosh	Reka	x					x
Probishtip	Strmosh	Bel Kamen	x					x
Probishtip	Zletovo	Tursko rudare	x					x
Probishtip	Bunesh	in the village	x					x
Probishtip	Dreveno		x					x
Probishtip	Ratavica		x					x
Probishtip	Tripatanci	below the bridge	x					x
Kocani	Grdovci		x					x
Kocani	Kocani	Roma neighbourhood	x					x
Kocani	Kocani	Roma neighbourhood	x					x
Kocani	Orizari	exit of Orizari	x					x
Kocani	Orizari	Ilin dol	x					x
Kocani	Trajanovo Trlo		x					x
Kocani	Trkanje		x					x

Municipality	Settlement	Location	Prioritization in terms of the necessary measures ($R_{max.max}$)			Prioritization in terms of timing of provided measures ($R_{max.avg.}$)		
			Direct investigations for rehabilitation	Additional investigations	Additional investigations and monitoring	Short term	Medium term	Long term
Pehcevo	Crnik		x					x
Pehcevo	Govedarnik	Gagjalnica	x					x
Stip	Dragoevo	Gladno Pole	x					x
Stip	Lakavica	Lakavica reka	x					x
Stip	Selce	Sred sela	x					x
Stip	Vrsakovo	Reka	x				x	
Berovo	Machevo			x				
Berovo	Suvi Laki			x				x
Berovo	Vladimirovo			x				x
Cesinovo-Oblesevo	Teranci	Stara deponii		x				x
Cesinovo-Oblesevo	Teranci	Teranci Gubrs		x				x
Cesinovo-Oblesevo	Ularci			x				x
Cesinovo-Oblesevo	Cesinovo	Gorica		x				x
Cesinovo-Oblesevo	Spancevo	Poichanski pan		x				x
Delcevo	Grad	Bunishte		x				x
Probishtip	Zletovo	bridge		x				x
Probishtip	Zletovo	Gorno maalo		x				x
Probishtip	Zletovo	bridge Tursko Rudare		x				x
Kocani	Orizari			x				x
Vinica	Blatec	Pocivalo		x				
Stip	Chardaklia	Kai Reka		x				x

Municipality	Settlement	Location	Prioritization in terms of the necessary measures ($R_{max.max}$)			Prioritization in terms of timing of provided measures ($R_{max.avg.}$)		
			Direct investigations for rehabilitation	Additional investigations	Additional investigations and monitoring	Short term	Medium term	Long term
Berovo	Budinarci	under the bridge of r. Bregalnica			x			
Berovo	Ciganski Potok				x			x
Berovo	Dvorishte				x			x
Delcevo	Gabrovo				x			
Kocani	Kocani	Hotel Nacional			x			
Kocani	Kocani	Madzhirski bavchi			x			
Vinica	Istibanja	Stari Lozja			x			
Vinica	Vinichka Krshla	Sushica			x			

3.4 ANALYSIS OF THE WEAKNESSES OF THE EXISTING WASTE MANAGEMENT SYSTEM

3.4.1 Legal and Regulatory Framework

3.4.1.1 Brief overview

In strategic terms, EU waste policy, according to the Roadmap to a resource efficient Europe, aims to ensure that by 2020 waste is managed as a resource; waste generated per capita is in decline; re-use and recycling of waste are economically attractive options for public and private actors; more materials are recycled according to high quality standards; energy recovery is limited to non-recyclable materials; landfilling is virtually eliminated; and illegal shipments are eradicated. The revised Waste Framework Directive introduced a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy[34].

On a national level, the general national policy directions on waste management were outlined in the First and Second National Environmental Action Plan, in 1996 and 2006 respectively. The Law on Waste Management, which was established in 2004[35], constitutes a cover regulation act and provides general rules applying to main issues on non-hazardous and hazardous waste and on special waste streams. It also represents the legal basis for a variety of secondary legislation as rulebooks or guidelines.

The core strategic documents that shape the future vision of the FYR Macedonian waste management, on the national level, are the National Waste Management Strategy for the period 2008-2020 (Official Gazette no. 39/08) and the National Waste Management Plan for the period 2009-2015 (Official Gazette no. 77/09). The former aims at defining the long-term needs in the area of waste management, as well as the necessary legislative measures for enforcement. The latter makes an assessment of current conditions and outlines activities as well as resources and financial mechanisms in the waste management process for the period of its validity. The National Waste Management Strategy of the Republic of Macedonia (2008-2020) defined the directions and principles of waste management, whereas the National Waste Management Plan 2009-2015, based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European Union. During the period 2007-2011 there was an intensive effort from the Government to harmonise its waste legislation with the EU guidelines and directives, in which the majority of new regulations emerged. These regulations covered issues for landfilling, incineration, biodegradable municipal waste, packaging waste, WEEE etc.[36]

[34] European Environment Agency (EEA) (2013). *EEA Report, N.8/2013 - Towards a green economy in Europe - EU environmental policy targets and objectives* [pdf]. Retrieved from http://www.eea.europa.eu/publications/towards-a-green-economy-in-europe

[35] Amended in 2004, 2007, 2008, 2010, 2012

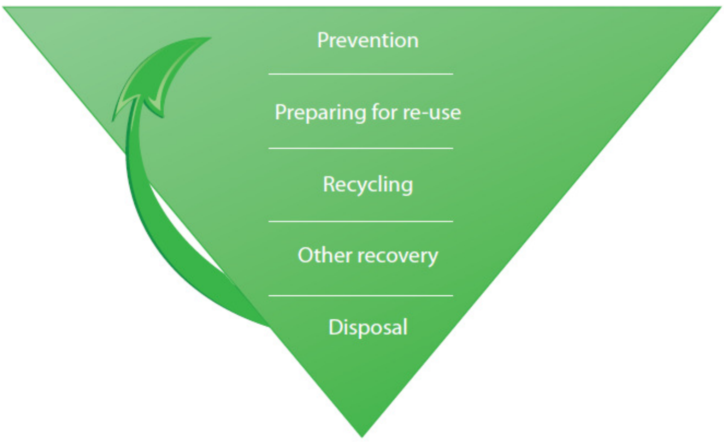
[36] EEA (2013). Municipal *Waste Management in the former Yugoslav Republic of Macedonia* [pdf]. Retrieved from http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.eea.europa.eu%2Fpublications%2Fmanaging-municipal-solid-waste%2Fmacedonia-fyr-municipal-waste-management&ei=YGL4UrfQAoeS0QX21YHIBQ&usg=AFQjCNFqABALaJnInndJ6h7kYbRyQBb7rg&sig2=0RZmZC76__06MuYHIKqyPw&bvm=bv.60983673,d.d2k

In the planning documents mentioned above, for each objective there are targets established. The targets, especially those afferent to the technical objectives are quantifiable indicators. In the National Waste Management Plan, a set of comprehensive and ambitious targets is presented. These demonstrate the keen interest of the country for the swift improvement of its MSW management performance in the future years[36].

A multitude of regulations, incorporating elements of the Landfill Directive (1999/31/EC), have been adopted into the national legislative framework during the years 2007-2009. Furthermore, in 2009, a set of targets was introduced quantifying the percentages of biodegradable municipal waste (BMW) that should be diverted from landfills. There are three milestones which need to be met by 2017, 2020 and 2027, by achieving a certain percentage reduction of BMW landfilled within a period of time starting from the year 2011[36]. Moreover, separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets.

An overview of the requirements and targets set by legal and regulatory framework is presented in paragraph 3.4.1.8 In strategic terms, EU waste policy, according to the Roadmap to a resource efficient Europe, aims to ensure that by 2020 waste is managed as a resource; waste generated per capita is in decline; re-use and recycling of waste are economically attractive options for public and private actors; more materials are recycled according to high quality standards; energy recovery is limited to non-recyclable materials; landfilling is virtually eliminated; and illegal shipments are eradicated. The revised Waste Framework Directive introduced a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy, , as presented in the following figure [37].

Figure 3-35: Moving up the waste hierarchy



On a national level, the general national policy directions on waste management were outlined in the First and Second National Environmental Action Plan, in 1996 and 2006 respectively. The Law on Waste Management, which was established in 2004[38], constitutes a cover regulation act and provides general rules applying to main issues on non-hazardous and hazardous waste and on special waste streams. It also represents the legal basis for a variety of secondary legislation as rulebooks or guidelines.

[37] European Environment Agency (EEA) (2013). *EEA Report, N.8/2013 - Towards a green economy in Europe - EU environmental policy targets and objectives* [pdf]. Retrieved from http://www.eea.europa.eu/publications/towards-a-green-economy-in-europe

[38] Amended in 2004, 2007, 2008, 2010, 2012

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In the planning documents mentioned above, for each objective there are targets established. The targets, especially those afferent to the technical objectives are quantifiable indicators. In the National Waste Management Plan, a set of comprehensive and ambitious targets is presented. They demonstrate the keen interest of the country for the swift improvement of its MSW management performance in the future years[36].

A multitude of regulations, incorporating elements of the Landfill Directive (1999/31/EC), have been adopted into the national legislative framework during the years 2007-2009. Furthermore, in 2009, a set of targets was introduced quantifying the percentages of biodegradable municipal waste (BMW) that should be diverted from landfills. There are three milestones which need to be met by 2017, 2020 and 2027, by achieving a certain percentage reduction of BMW landfilled within a period of time starting from the year 2011[36]. Moreover, separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets.

An overview of the requirements and targets set by legal and regulatory framework is presented in paragraph 3.4.1.8.

3.4.1.2 EU Policy and legislation

Collection, recycling and recovery targets to be reached between 2011 and 2020 have been introduced by binding legislation for various waste streams. Directive 2006/66/EC addresses batteries, Directive 2008/98/EC addresses non-hazardous construction and demolition waste, as well as paper, plastic, glass and metal from households, and Directive 2000/53/EC addresses end-of-life vehicles. Similar targets were previously established for the period 2001–2008 for other waste streams. For example Directive 2002/96/EC addresses waste electrical and electronic equipment and was followed recently by Directive 2012/19/EU. Similarly, Directive 94/62/EC, as amended by Directive 2004/12/EC, addresses packaging waste.

[39] EEA (2013). Municipal *Waste Management in the former Yugoslav Republic of Macedonia* [pdf]. Retrieved from http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.eea.europa.eu%2Fpublications%2Fmanaging-municipal-solid-waste%2Fmacedonia-fyr-municipal-waste-management&ei=YGL4UrfQAoeS0QX21YHIBQ&usg=AFQjCNFqABALaJnInndJ6h7kYbRyQBb7rg&sig2=0RZmZC76 06MuYHIKqyPw&bvm=bv.60983673,d.d2k

Directive 1999/31/EC, known as the Landfill Directive, sets other compulsory targets concerning biodegradable municipal waste (BMW). It provides that Member States shall ensure, through national strategies, that the disposal of BMW is progressively reduced to 35 % of the total amount (by weight) of BMW produced in 1995 by 2016, with a preliminary target of 75 % by 2006 and an intermediate target of 50 % by 2009.

With regard to hazardous substances, Directive 96/59/EC provides that equipment with polychlorinated biphenyls (PCBs) volumes higher than 5 dm^3 be decontaminated or disposed of by 2010. Directive 2011/65/EU, which repeals Directive 2002/95/EC with effect from 2013, prohibits heavy metals in all new electrical and electronic equipment (EEE) by 2019.

At the international level, the Basel Convention, ratified by the EU and all EU-27 countries, addresses transboundary movements of hazardous wastes and their disposal. The Convention is implemented within the EU through Regulation (EC) No.1013/2006, known as the Waste Shipments Regulation, which also gives effect to the OECD system for the control of transfrontier movements of wastes destined for recovery operations (OECD Decision C/92/39 final, as amended by OECD Decision C/2001/107 final).

The waste sector objectives and binding targets are summarized in the following table.

Table 3-61: Timeline for waste sector targets (2010–2050)34

Sub-sectors and objectives	Sources	Deadline for implementation
Reuse, recycling and recovery targets		
Recycling targets for batteries (by average weight): - 65 % of lead acid batteries, - 75 % of nickel cadmium batteries - 50 % of other batteries	Directive 2006/66/EC	⇨ 2011
WEEE, with reference to Annex I categories: - cat. 1 or 10: 80 % recovery and 75 % recycling - cat. 3 or 4: 75 % recovery and 65 % recycling - cat. 2, 5, 6, 7, 8 or 9: 70 % recovery and 50 % recycling Gas discharge lamps: 80 % recycling *(These targets, established by Annex V to Directive 2012/19/EU, are applicable from 13 August 2012 until 14 August 2015, i.e. before the date of transposition of the Directive (14 February 2014)*	Directive 2012/19/EU	⇨ 2012-2015
Targets for end-of-life vehicles (by average weight per vehicle per year): reuse and recovery: 95 % - reuse and recycling: 85 %	Directive 2000/53/EC	⇨ 2015
WEEE, with reference to Annex I categories: cat. 1 or 10: 85 % recovery and 80 % preparation for reuse and recycling cat. 3 or 4: 80 % recovery and 70 % preparation for reuse and recycling cat. 2, 5, 6, 7, 8 or 9: 75 % recovery and 55 % preparation for reuse and recycling Gas discharge lamps: 80 % recycling	Directive 2012/19/EU	⇨ 2015-2018
WEEE, with reference to Annex IIII categories: cat. 1 or 4: 85 % recovery and 80 % preparation for reuse and recycling	Directive 2012/19/EU	⇨ 2018

Sub-sectors and objectives	Sources	Deadline for implementation
cat. 2: 80 % recovery and 70 % preparation for reuse and recycling cat. 5 or 6: 75 % recovery and 55 % preparation for reuse and recycling cat. 3: 80 % recycling		
Preparation for reuse, recycling and any other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste, excluding naturally occurring material (cat. 17 05 04), shall be increased to a minimum of 70 % by weight	Directive 2008/98/EC	➪ 2020
Preparation for reuse and recycling of 50 % by weight of materials such as at least paper, plastic, glass and metal from households and possibly from other origins as far as their waste streams are similar to waste from households	Directive 2008/98/EC	➪ 2020
Collection and disposal		
Decontamination or disposal of equipment with PBC volumes > 5 dm3	Directive 96/59/EC	➪ 2011
Collection target for batteries: 25 %	Directive 2006/66/EC	➪ 2012
Separate collection for at least glass, plastic, metal, paper	Directive 2008/98/EC	➪ 2015
Collection target for batteries: 45 %	Directive 2006/66/EC	➪ 2016
Disposal of biodegradable municipal waste: reduction to 35 % of total 1995 biodegradable municipal waste	Directive 1999/31/EC	➪ 2016
Collection target for WEEE: 45 % of the average weight of EEE placed on the market in the three preceding years in the Member State concerned	Directive 2012/19/EU	➪ 2016
Collection target for WEEE: - 65 % of the average weight of EEE placed on the market in the Member State in the three preceding years or - 85 % of WEEE generated in the Member State.	Directive 2012/19/EU	➪ 2019
Product making		
No heavy metals (Pb, Hg, Cd, hexavalent Cr, PBB and PBDE) in new electrical and electronic equipment	Directive 2011/65/EU	➪ 2019

3.4.1.3 National Waste Management Legislation

Law on Environment (2005, as amended) (LoE)

The national LoE is the framework legal act setting out the main requirements for environmental protection in the country and regulates the SEA, EIA and Integrated permits being horizontal issues for all sectors. It contains the fundamental environmental protection principles, which provide a basis for determining procedures for management of the environment and which are common to all laws regulating specific environmental media. It also defines the roles and responsibilities of the state administrative bodies, municipal authorities and legal and physical persons in the implementation of the legal provisions.

The LoE, which owing to its extension and scope can be almost considered as a Code for the Environment, replaces the previous Law of 1996 with a completely new approach. The new Law contains provisions on all sectors covered by EU legislation on the environment transposing it into national legislation, namely, access to environmental information, public participation in environmental decision-making, environmental monitoring, procedures for environmental assessment, integrated pollution, prevention and control, prevention and control of accidents involving hazardous substances and environmental liability. In addition, the Law contains provisions with regard to monitoring the work of the local self-government units (LSGU) from the aspects of LSGU jurisdiction and organizational set-up, particularly that of the inspection authorities. Finally, the Law also contains the legal basis for adoption of the subsidiary legislation needed to implement the Law's provisions and thus necessary for the direct harmonization and implementation of EU environmental legislation.

Including several aspects of environmental protection in a single Law is definitely a valid approach, as it helps ensure coherence within the system and facilitate access to legislation for citizen who do not have to read several documents but can find most of the information in one. The Law is complemented by and further specified in several thematic rulebooks and by-laws relating to the different topics covered[40].

According to the LoE:

- The waste management plans at national and regional level are subject to obligatory SEA;
- The construction of the elements of the integrated waste management infrastructure requires following EIA procedures.
    - The waste management facilities require 'A' - integrated environmental permits (A-IEP) or 'B' - integrated environmental permits (B – IEP).

The installations subject to A-IEP and B-IEP are determined by a Decree of the Council of Ministers of 13 October 2005.

Regarding waste management the activities requiring A-IEP are:

- Installations for the disposal, recovery and/or co-incineration of hazardous waste with a capacity exceeding 10 tonnes per day
- Installations for the incineration of communal waste with a capacity exceeding 3 tonnes per hour
- Installations for disposal of non-hazardous waste a capacity exceeding 50 tonnes per day
- Landfills receiving more than 10 tonnes per day or with a total capacity exceeding 25 000 tonnes, excluding landfills of inert waste
- Installations for incineration of animal carcases
- Installations for managing mining waste

All other waste management installations with the capacity bellow the thresholds set out above as requiring A – IEP are subject to B-IEP.

[40] United Nations Economic Commission for Europe (2011) "2nd Environmental performance review of the former Yugoslav republic of Macedonia" Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

Strategic Environmental Assessments (SEAs)

The implementation of the Strategic Environmental Assessment (SEA) procedure for strategies plans and programmes (hereinafter: planning documents) is regulated in Chapter X of the Law on Environment as amended and relevant bylaws based on the Law[41].

With regard to SEAs, the Law on Environment contains general stipulations that each strategic, planning and programme documents of the State administrative bodies or LSGUs (hereinafter: planning documentation) should be subject to SEAs.

The Law emphasizes that the details for SEAs have to be developed in secondary legislation. In 2007, the Government adopted the list of criteria for determining whether a given planning document is likely to have a significant impact on the environment. Also in 2007, two subsidiary acts were adopted for determining the procedure for performing SEAs. The Government determined the planning documentation, which is subject to SEA, via the Decree on the strategies, plans and programmes, and their amendments for which the SEA procedure must be carried out. Changes in the secondary legislations were made at the beginning of 2011. The general obligation for the performance of SEAs is the responsibility of MoEPP (Sector for Sustainable Development and Investments), and all other State administrative bodies and LSGU entities are obliged to perform the SEA procedure if they are competent for the adoption of some of the plans stipulated in the above-mentioned Decree[40].

A special web page was created for the SEA process and is available at www.sea-info.mk. This may be singled out as a very good approach for popularization and for the provision of adequate information to the public and concerned parties.

The practical implementation of the SEA procedure began in mid-2009. The procedure starts with a request for an opinion on whether or not SEA is necessary. The intermediate steps follow general practice – screening, scoping, preparation of the report and quality assessment and public participation. After the insertion of the remarks provided from the MoEPP and other parties, the final SEA report is approved.

The Protocol on Strategic Environmental Assessment (2003) to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context was ratified in 2013. The requirements of the Protocol have been incorporated into the Law on Environment.

The number of SEA submissions depends on the activity of State structures and the business climate in the country. The relevant Ministries whose plans or programmes are likely to have an impact on the environment have been identified as the Ministry of Agriculture, Forestry and Water Economy, the Ministry of Transport and Communication, the Ministry of Economy, the Ministry of Health, and the Ministry of Local Self Government. The plans and programmes which are expected to be prepared within 14 different sectors (energy, mining, water and waste management, transport, local and regional development, agriculture, forestry, fishing, industry, telecommunication, tourism and land planning and land use) are already identified and will require the SEA procedure if they have an environmental impact[40].

Environmental Impact Assessments (EIAs)

The legal framework for EIA is well along. The Law on Environment gives detailed instructions for the steps and conditions involved in carrying out the procedure, including notification, screening, scoping, content of the study for EIA, and requirements for the expert preparing and assessing the

[41] www.sea-info.mk

quality of the documentation. The public's access to EIA documents and information is described in a different article, and covers all steps as well as the public hearing. The procedure is finalized with the issuing of a decision on whether to grant or reject the application for the project implementation. The legal effect of the decision is also determined by the Law. Practice shows that implementation is consistent with all these legal requirements.

Following the Law on Environment, two pieces of secondary legislation have been adopted. The Decree for Determining the Projects for which an Environmental Impact Assessment Shall Be Carried Out also includes an Annex I stipulating the activities for which EIA is mandatory and an Annex II mentioning activities for which screening is necessary, as well as a definition of any change to or extension of projects. The Ordinance for Regulating the Procedure for Carrying out Environmental Impact Assessments regulates the procedure for carrying out EIAs under the Law on Environment. It regulates inter alia the content of the notification of intent to carry out a project, the screening procedure, the content of the EIA study, and the procedure for informing the public as well as public participation. Up until now, the existing framework has been supplemented by the adoption of subsidiary acts and technical guidelines.

Law on Waste Management (2004, as amended) (LoWM)

The legal framework for waste management has been established by the 2004 Law on Waste Management. Relevant EU directives have been transposed in the Law on Waste Management (LpWM), also taking into consideration the local conditions. The Law regulates issues concerning the framework Policy on Waste; on Hazardous Waste; on Landfills; Waste Oils; PCB/ PCT; on Incineration of Non-hazardous Waste; on Incineration of Hazardous Waste; on Hazardous Substances Containing Batteries and Accumulators; on Packaging and Packaging of Waste; on End-of life Vehicles; and on Waste from the Titanium Dioxide Industry. The Law on Waste Management also provides grounds for the adoption of several secondary legislation acts. The LoWM defines in details the responsibilities with regards to waste management planning, waste management activities, permitting and licensing system, rules for specific waste streams, monitoring, data collection and reporting, and financing

The EU recognises seven over-arching principles for waste management, which should be considered in the waste management plan[42]:

- **Waste Management Hierarchy**. Waste management strategies must aim primarily to prevent the generation of waste and to reduce its harmfulness. Where this is not possible, waste materials should be reused, recycled or recovered, or used as a source of energy. As a final resort, waste should be disposed of safely (e.g. by incineration or in landfill sites);
- **Self-Sufficiency** at Community and, if possible, at Member State level. Member States need to establish, in co-operation with other Member States an integrated and adequate network of waste disposal facilities;
- **Best Available Technique Not Entailing Excessive Cost (BATNEEC)**. Emissions from installations to the environment should be reduced as much as possible and in the most economically efficient way;
- **Proximity**. Wastes should be disposed of as close to the source as possible;
- **Precautionary Principle**. The lack of full scientific certainty should not be used as an excuse for failing to act. Where there is a credible risk to the environment or human health of

[42] Regional Environmental Center, Umweltbundesamt GmbH (2008) Handbook on Implementation of EU Environmental Legislation. (http://ec.europa.eu/environment/enlarg/handbook/handbook.pdf).

acting or not acting with regard to waste, a cost-effective response to the risk identified should be pursued;

- **Producer Responsibility**. Economic operators, and particularly manufacturers of products, have to be involved in the objective to close the life cycle of substances, components and products from their production throughout their useful life until they become a waste;
- **Polluter pays**. Those responsible for generating or for the generation of waste, and consequent adverse effects on the environment, should be required to pay the costs of avoiding or alleviating those adverse consequences. A clear example can be seen in the EU Directive 99/31/EC on landfill of waste, Article 10.

Most of the above principles are incorporated in the Macedonian Law on Waste Management, for example Article 7 on priorities in waste management, Article 9 on the precautionary principle, Article 10 on the proximity principle and Article 12 on the polluter-pays. Therefore, the Law incorporates the basic principles of waste management. Waste management, as a public service, is based on the principle of service universality (non-discrimination, sustainability, quality and efficiency, transparency, affordable price and full coverage of the territory).

The Macedonian Law on Waste Management includes the following provisions concerning preparation of waste management strategies and plans under Section II:

Article 15, Planning in waste management

The responsible authorities of the Republic of Macedonia, the Municipalities and the City of Skopje, as well as legal and physical persons dealing with waste management shall adopt and implement strategic, planning and programme documents regarding the waste management in order to:

- protect the environment and human life and health;
- achieve the objectives and guidelines laid down in the National Environmental Action Plan;
- implement the general principles and guidelines regarding the waste management;
- establish an integrated national network of installations and plants for waste processing and disposal;
- fulfil the obligations with regard to the waste management undertaken by the Republic of Macedonia on an international level;

Within the procedure for adoption of strategies, plans and programmes provided for in the LoWM, strategic environmental assessment shall be undertaken in accordance with the Law on Environment.

Article 16, Strategy on Waste Management

The Government of the Republic of Macedonia shall, upon a proposal of the body of the public administration responsible for the affairs of the environment, adopt a Strategy on Waste Management.

The Strategy on Waste Management shall determine:

- basic guidelines for management of all types of waste;
- improvement of the general situation in the area of waste management;

- the necessary legal measures for implementation of the Waste Management Plan;
- the long-term needs of the Republic of Macedonia in the area of waste management;
- strategic approach to the development of the public awareness and education in relation to the waste management;
- other issues of importance for the development of the waste management.

The Strategy shall be valid for a period of twelve years.

Article 17, Waste Management Plan of the Republic of Macedonia

For the purpose of the implementation of the Strategy on Waste Management, the body of the public administration responsible for the affairs of the environment shall adopt a Waste Management Plan of the Republic of Macedonia.

The Plan shall be adopted for a period of ten years, and shall include in particular:

- description and assessment of the existing status of waste management;
- predictions of future trends in the waste management;
- guidelines and objectives related to waste management including the schedule of realisation thereof;
- implementation of measures, activities and manner of accomplishing the objectives of handling specific types of waste, schedule and scope of their realisation;
- incentives for implementation of the activities for avoidance and reduction of waste generation, as well as for re-use, recycling or use of the waste as a source of energy;
- manners of disposal of the waste that cannot be avoided and processed;
- specification of the type and quantity of waste according to which the obligation for the legal and physical persons for preparation of waste management programs is assigned;
- application of the monitoring system during waste management;
- concrete measures and activities for reducing the biodegradable components in the waste intended for disposal and the time schedule and extent for the implementation thereof,
- assessment of the needs of the Republic of Macedonia for construction of facilities and installations for waste processing and disposal, including the measures and deadlines of realisation;
- locations and installations for waste disposal;
- data on the integrated national network for waste disposal and installations for waste processing;
- technical and other conditions to be fulfilled when dealing with waste management;
- measures for remediation of illegal landfills and polluted areas;
- activities undertaken by the local self-government units concerning the waste management;
- educational and public awareness raising measures concerning the waste management;
- identification of waste management regions
- estimation of the costs for the waste processing and disposal operations; and
- financial instruments for the implementation of the Waste Management Plan.

<u>Article 18, Waste Management Plans of the Municipalities and the City of Skopje OK according to the latest amendment, October 2012</u>

For the purpose of the implementation of the Waste Management Plan of the Republic of Macedonia, the Councils of the Municipalities and of the City of Skopje shall adopt a Waste Management Plan for the respective Municipality, i.e. the City of Skopje, upon a proposal of the

Mayor of the Municipality and the City of Skopje. The Plan shall be issued for a period of no less than three and no more than six years.

Article 18-a, Regional Plans

For the purpose of regional waste management, the Councils of the municipalities, the Council of the City of Skopje upon a proposal of the Intermunicipal Waste Management Boards adopt Regional Waste Management Plans, for the regions determined by the Waste Management Plan of the Republic of Macedonia. The Regional Waste Management Plans shall regulate and harmonise joint waste management objectives at regional level, according to the National Waste Management Strategy and the National Waste Management Plan. Regional Waste Management Plans are adopted for a period of 10 years. The Intermunicipal Waste Management Board may propose amendments to the regional plan every two years. The regional plan to be adopted by municipal councils or the City of Skopje Council, shall be submitted for approval to the state government responsible for the environment. The Minister managing the body of the state administration responsible for the environment shall prescribe the content of regional plans.

Article 19, Waste Management Programmes

The implementation of the Waste Management Plan of the Republic of Macedonia shall be carried out through one-year programs on waste management, adopted by:

- The body of the public administration responsible for the affairs of the environment;
- The Councils of the Municipalities and of the City of Skopje, upon a proposal of the Mayors of the Municipalities and of the City of Skopje;
- The legal and physical persons dealing with waste management, determined in accordance with this Law and other regulations.

The Programmes shall be in accordance with the Waste Management Plan of the Republic of Macedonia and with the waste management plans of the Municipalities and of the City of Skopje. The Programmes shall specify the sources of funding of measures and activities, as well as the instruments for the waste management programmes implementation.

Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment (2012) (LoEEEWEEE)

The following targets are set:

Table 3-62: Targets according to the Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment (2012) (LoEEEWEEE)

Target	To be achieved by
Collection: At least **4 kilograms** per capita per year of household waste equipment	2020
Recovery: 1) Waste equipment that falls into the **categories 1 and 10**, at least: a) Treatment/Recovery of 80% of the average weight per equipment b) Rate of reuse and recycling of components, materials and substances of 75% of the average weight per equipment; 2) Waste equipment that falls into the **categories 3 and 4**, at least: a) Treatment/recovery of 75% of the average weight per equipment b) Rate of reuse and recycling of components, materials and substances of 65% of the average weight per equipment; 3) Waste equipment that falls into the **categories 2, 5, 6, 7 and 9**, at least: a) Treatment/recovery of 70% of the average weight per equipment b) Rate of reuse and recycling of components, materials and substances by 50% by average weight per equipment 4) Gas discharge lamps - at least 80% reuse and recycling of components, materials and substances by weight of the product.	2020

Also, according to the Law on WEEE, article 43, par. (2) "*In determining the places and locations of collection centers, the number of residents in the area shall be taken into account, providing at least one collection center at the municipal level, i.e. at least one collection center for 30,000 residents*."

The Law on Packaging and Packaging Waste (2009) (LoPPW)

The national aims for collection and treatment of packaging waste according to the Law on Packaging and Packaging Waste are presented in the next table:

Table 3-63: Targets according to the Law on Packaging and Packaging Waste (2009) (LoPPW)

Activity/Waste Stream	Target	To be achieved by
Packaging waste	Recycling (minimum 55%- maximum 80%)	2020
B Materials from the packaging waste ❖ Glass ❖ Paper and cardboard ❖ Metals ❖ Plastic ❖ Wood	 ❖ 60% ❖ 60% ❖ 50% ❖ 22.5% ❖ 15%	 ❖ 2020 ❖ 2020 ❖ 2020 ❖ 2018 ❖ 2020

Landfilling of biodegradable municipal waste

According to the 'Correction in the Rules on the amount of biodegradable waste allowed to be disposed into landfill (Official Gazette no. 108/2009)', targets for diversion of biodegradable waste from landifilling are set.

Table 3-64: Targets for diversion of Biodegradable Municipal Waste (BMW) from landfill

Year	Quantity of BMW that is allowed to be disposed on Landfill on the whole territory (t)	Quantity of BMW landfilled, expressed as a mass percentage of MSW generated in 1995	Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995
1995 (Reference year)	305,000	62%	
2011-2017	229,000	47%	**25%**
2011-2020	153,000	31%	**50%**
2011-2027	107,000	22%	**65%**

Source: 'Correction in the Rules on the amount of biodegradable waste allowed to be disposed into landfill (Official Gazette no. 108/2009)' [43]

According to the table above, there are three milestones which need to be met by 2017, 2020 and 2027, by achieving a certain percentage reduction of BMW landfilled within a period of time starting from the year 2011.

According to the Law on WEEE, article 43, par. (2) "*In determining the places and locations of collection centers, the number of residents in the area shall be taken into account, providing at least one collection center at the municipal level, i.e. at least one collection center for 30,000 residents*."

3.4.1.4 National Waste Management Strategy (2008-2020)

The National Waste Management Strategy of the Republic of Macedonia (2008 - 2020)[44] defined the directions and principles of waste management in Macedonia, whereas the National Waste Management Plan 2009-2015, based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European Union. The NWMS sets out the following strategic goals and objectives:

- Harmonisation of the policy and legislation on waste management regarding the political agreement in the society and requirements of the co-operating economic environment;
- Establishment of effective institutional and organisational arrangements in all phases of implementation of the new integrated waste management system: planning, permitting, financing, operating and enforcement;
- Strengthening human resources and capacity in the public and private sector involved in the establishment process of the waste management system, as well as encouragement and engagement of knowledge, technical know-how and economic potential available in the country;

[43] EEA (2013). Municipal *Waste Management in the former Yugoslav Republic of Macedonia* [pdf]. Retrieved from http://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.eea.europa.eu%2Fpublications%2Fmanaging-municipal-solid-waste%2Fmacedonia-fyr-municipal-waste-management&ei=YGL4UrfQAoeS0QX21YHIBQ&usg=AFQjCNFqABALaJnInndJ6h7kYbRyQBb7rg&sig2=0RZmZC76__06MuYHIKqyPw&bvm=bv.60983673,d.d2k

[44] http://www.moepp.gov.mk/WBStorage/Files/Waste%20Management%20Strategy%20of%20the%20RM%202008-2020.pdf

- Introduction of stable financial resources and adequate economic mechanisms to assure the full cost recovery of providing for the integrated waste management system according to the "polluter pays" principle and to the maximum effects regarding investment and operational activities;
- Raising public awareness and awareness of all stakeholders in the society from the viewpoint of understanding their roles, responsibilities and obligations in the waste management process and in the protection of the environment in order to accept significant changes of the waste management practice from collection to the final disposal;
- Establishing the data collection/ information system on the sources, nature, quantities and fate of waste streams as well as on the facilities for material/ energy recovery and final disposal of waste and assuring necessary public access;
- Establishing the contemporary technical waste management system which takes into account different technical options regarding waste avoidance, lowering their hazardous potential and reduction at sources, material/ energy recovery and utilisation of waste and safe final disposal of stabilised residues according to "best practicable environmental option" with the aim of preservation of non-renewable natural resources and minimal emissions and adverse effect of the waste treatment/ disposal processes on the living and natural environment as well as on public health;
- Application of efficient and cost-effective techniques for the management of segregated waste streams by means of private sector participation to achieve a 100% waste collection rate and optimal level for material/ energy recovery of waste;
- Introduction of landfills for hazardous and non-hazardous waste and other facilities for final disposal of waste compliant with contemporary standards to prevent the appearance of new environmental burdens;
- Progressive closing down and/ or remediation of existing municipal dumpsites and/or industrial "hot-spots" according to the inventory of environmental burdens and corresponding criteria that particularly take into account adverse effects and risks to the environment, future utilisation of physical space, costs of rehabilitation, and acceptability by the population.

The basic principles for development of Macedonian waste management are defined as follows:

- Solving waste problems at source;
- Separate collection of waste streams:
  - according to their hazardous characteristics;
  - according to their point-source or dispersed-source generation; and
  - according to the intention of further management, which shall be acceptable from an environmental and economic aspect.
- Waste utilisation as substitute of natural resources;
- Rational network of treatment and disposal facilities;
- The rationality of space management and preservation of natural and cultural heritage;
- Landfill of the stabilised and low volume waste residues;
- Remediation of contaminated sites -"hot-spots".

The NWMS introduces the concept of waste management on a regional level. The preparation of the priority policy and planning documents on establishment and operation of the new regional waste collection/treatment/disposal system of municipal and other non-hazardous waste is a central part of actions executed by the waste management unit/department in the first 5 years of the implementation of the waste management strategy (p.20).

According to the NWMS (p.21), the Government, in particular MoEPP shall encourage political decisions and organise the establishment of new regional bodies - enterprises and institutions - to carry out the tasks leading towards a contemporary regional waste management system, and assist in the execution of key political, re-organisation, financial, public relation and other operational activities.

It is stated that in order to achieve adequate economic thresholds for management with the municipal waste and acceptable prices for executed services, the majority of pre-treatment operations and landfill of residues shall be carried out on the regional level with more than 200.000 habitants (p.47). The central complex of the infrastructure facilities for the final disposal of residual municipal waste shall be represented by the network of landfills on the regional level of waste management, which shall be built, equipped and in operation according to the EU standards on landfill of waste. Waste management regions shall represent the obligatory association of communities for the common solving of municipal waste issues; the size of the waste management regions shall be of such a range that enables the installation of financially optimal economy of scale of regional or inter-municipality landfills and of other accompanying waste material & energy recovery and treatment plants (p.52).

Regional municipal waste management systems shall represent a link between the state and local communities and they shall take over the majority of their responsibilities and tasks, like planning, leading investments, public relations and organisation of other activities related to the municipal waste management originally addressed to municipalities, on behalf of the joint municipalities and their inhabitants with the consent or participation of MoEPP. From the administrative/organisational and financial side, such systems shall be managed by the intermunicipal boards as political representative bodies of the joint municipalities and of the managing board of the regional waste management companies (RMWMC) which provide the municipal management operations, collection, recovery and final disposal services; RMWMC may also function as the central regional agency carrying out various expert tasks like planning, investments, local regulation, organisation, cost recovery and financing executed municipal waste management operations and environmental monitoring (p.63).

3.4.1.5 National Waste Management Plan (2009-2015)

In addition to the Strategy, in 2009 MoEPP adopted the National Waste Management Plan for the period 2009 - 2015[45], which represents an amendment and supplement of the National Waste Management Plan for the period 2006-2012 as based on the National Waste Management Strategy. The National Waste Management Plan has been developed to gradually implement the required improvements of the present problematic solid waste management system in the country by setting main goals, objectives and targets in the process of establishing the waste management system, and by defining the main activities and tasks in the legal, institutional, organizational, technical, and economic fields in the over six-year period. The purpose of the National Waste Management Plan is to provide an adequate environmental policy, decision-making framework, economic basis, public participation and gradual establishment of the technical infrastructure for carrying out waste management operations in order to implement the waste management system in compliance with EU legislation and with the EU Sixth Environmental

[45] http://www.moepp.gov.mk/WBStorage/Files/NWMP_2009-2015_%20of%20RM_finaL.pdf

Action Programme (2002-2012), taking into account its priority in waste management, i.e. the thematic strategy on sustainable use of resources and thematic strategy on waste prevention and recycling.

The Plan foresees a complex of measures in order to eliminate or mitigate environmental impacts caused by the existing improper waste management operations, and to carry out the preparation and implementation of an integral, cost-effective and sustainable waste management system, taking into account key EU principles of waste management.

The establishment of regional waste management regions to coordinate waste management activities and operations on behalf of the member municipalities is a key recommendation of the National Waste Management Plan 2009-2015 (NWMP). The organisational concept of regional cooperation in waste management is widely established in the EU although there are many approaches to the specific legal setup, shareholding, decision-making and the division of tasks and responsibilities for waste management between the regional level and the individual member municipalities. The involvement of private companies in such organisations can also be found, although essentially municipal waste management is a public service and public supervision and control is essential[46].

The amendments to the LoWM established that Regional Waste Management Plans could be adopted and implemented jointly for several municipalities for establishing a regional integrated waste management system. The RWMPs have to be approved by MoEPP and adopted by all of the municipal councils of the municipalities involved and.

It must be noted that according to the Law amending the Law on Waste Management (Official Gazette No. 123/12-02.10.12, article 2), the Waste Management Plan shall be issued for a period of ten years, instead of six.

The National Waste Management Plan (2009 - 2015) provides a series of targets for specific activities and waste streams.

Table 3-65: Targets for Some Specific Activities in the National Waste Management Plan

Activity/ Waste Stream	Target	To be achieved by
Improvement of collection and source separation efficiency:		
- Mixed municipal waste	Collection efficiency 90%	2014
- Segregation of hazardous and non-hazardous waste fraction (manufacturing/ service sector)	Segregation efficiency 100%	2010
Landfill of waste:		
- landfill of MSW on temporary facilities (after conditioning)	100% of the collected MSW	2014
- landfill of MSW on facility compliant with EU standards	50% of the total MSW	2014
- reduction of biodegradable waste disposed on landfills (transition period needed)	Reduction to 75%	2014
- reduction of the greenhouse gas emissions (landfills only)	Reduction for approximately 25% of CO_2 equivalent	2014
- diversion of industrial hazardous waste streams from non-hazardous landfills	100% effect	2010

[46] United Nations Economic Commission for Europe (2011) "2nd Environmental performance review of the former Yugoslav republic of Macedonia" Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

Table 3-66: Targets for Some Specific Waste Streams in the National Waste Management Plan

Activity/ Waste Stream	Target	To be achieved by
Special waste streams		
- Packaging waste of all 3 categories (transition period needed)	Recovery: 50% Recycling: 25%	(2018)* (2018)*
- Used tyres	Collection efficiency: 90% Energy recovery: 100%	2014 2014
- Batteries/ accumulators	Ban on import and sale of Hg and Cd batteries and batteries containing too high Pb content	2010
- End of life vehicles	Collection: 90% Recovery or reuse: 70% Recovery or reuse: 85%	2014 (2018)* (2018)*
- Waste electric & electronic equipment	Collection: 90%	2014
- PCB/ PCT waste	Inventory complete Destruction	2009 (2018)*
- C&D waste collection/ recovery/ recycling facilities and landfill	Collected: 30% Recovered/ recycled: 10% Disposal: 90%	2014

* Years of achievement given in brackets means that targets may be achieved beyond the timetable of the current National Waste Management Plan.

Instrumental for implementation of the above policies and targets is the establishment of waste regions. The options for waste regions, according to the NWMP are indicated in the table below.

Table 3-67: Overview of Options for Waste Management Regions Proposed in the National Waste Management Plan

<table>
<tr><th>Planning Region (the Number of Inhabitants)</th><th>Option 1</th><th>Option 2</th></tr>
<tr><td>Skopje (590,455)</td><td>WM Region 1</td><td>WM Region 1</td></tr>
<tr><td>East (180,938)</td><td rowspan="3">WM Region 2</td><td rowspan="2">WM Region 2</td></tr>
<tr><td>Northeast (173,982)</td></tr>
<tr><td>Vardar (154,230)</td><td rowspan="2">WM Region 3</td></tr>
<tr><td>Southeast (171,972)</td><td>WM Region 3</td></tr>
<tr><td>Pelagonian (236,088)</td><td rowspan="2">WM Region 4</td><td rowspan="2">WM Region 4</td></tr>
<tr><td>Southwest (222,385)</td></tr>
<tr><td>Polog (310,178)</td><td>WM Region 5</td><td>WM Region 5</td></tr>
</table>

3.4.1.6 Municipal Waste Management Plans

The municipalities are obliged to elaborate and implement Municipal Waste Management Plans in order to implement the National Waste Management Plan (NWMP) and the future Regional Waste Management Plan (RWMP). The MWMP has to be adopted by the municipal council of the municipality involved and approved by MoEPP. For implementing the Municipal plan there shall be an annual municipal programme.

In accordance with Articles 15 and 18 of the Law on Waste Management, 2004, as amended, municipalities shall adopt and implement strategic, planning and programme documents regarding waste management in order to:

- Protect the environment and human life and health;
- Achieve the objectives and guidelines laid down in the National Environmental Action Plan;

- Implement the general principles and guidelines regarding waste management;
- Establish an integrated national network of installations and plants for waste processing and disposal; and
- Fulfil the obligations with regard to waste management undertaken by the Republic of Macedonia on an international level.

The MWMPs should be prepared in accordance with the provisions of the Law on Waste Management as well as taking into account expected future development of the legislation as a result of the on-going harmonisation of legislation and practices in the former Yugoslav Republic of Macedonia with those of the European Union.

Information was gathered at municipal level, including Municipal Waste Management Plans and Programs. The following table presents the MWMPs and Programs which were submitted to the Project Team.

Table 3-68: Submitted MWMPs and/or Programs in East Region

#	Municipality	Submitted Municipal Plans and/or Programs
1	Cesionovo-Oblesevo	☑ Program 2013
2	Delcevo	☑ Plan 2008-2012
3	Kocani	☑ Plan 2008-2013 & Program 2008
4	Pehcevo	☒ **didn't submit a plan**
5	Berovo	☑ Draft Plan
6	Probistip	☑ Plan 2011-2016
7	Stip	☑ Plan 2009-2014 & Program 2009
8	Vinica	☒ **didn't submit a plan**
9	Zrnovci	☑ Programs (public cleaning) 2010-2013 WM included
10	Karbinci	☒ **didn't submit a plan**
11	Makedonska Kamenica	☑ Plan 2010-2014 & Program 2012

3.4.1.7 Other relevant strategies and policies

i) National Strategy Sustainable Development for the period 2010-2030

Since sustainable development is a fundamental EU goal, the former Yugoslav Republic of Macedonia, after being awarded candidate status for EU membership in December 2005, was obliged to prepare a national strategy for sustainable development. In January 2010, the Government adopted the National Strategy for Sustainable Development for the period 2010-2030, which aims at setting out a vision, mission and objectives for economically, socially and environmentally balanced development for the next 20 years.

Based on this Strategy, the Government established the National Council for Sustainable Development, No. 8/2010, which is chaired by the Deputy Prime Minister of the Government responsible for economic issues and composed of representatives of nine State bodies, the Assembly, Academy of Science and Arts, three faculties, the Economic Chamber and NGO DEM, a network of NGOs in the country. In support of the Council's expert, logistical and technical activities, the establishment of an office for sustainable development has been envisaged, with the Ministry of Environment and Physical Planning to carry out these activities in the meanwhile.

The NSSD respects the strategic directions that have already been set in different sectors, but also provides strong cross-cutting links essential for sustainable development. It analyzes the main constraints for making the former Yugoslav Republic of Macedonia sustainable, which are identified as:

- Limited understanding and awareness of, and commitment to, the concepts and principles of sustainable development (SD);
- Partially developed SD supporting policy framework;
- Partially developed SD supporting legal and regulatory framework;
- Weak capacity for the cross-cutting and integrated working approach that SD implies;
- Weak capacity in public organizations and institutions for SD-based strategic work, planning, administration (including processing of SD-based applications and projects), and enforcement;

Not readily available domestic and foreign fund and investments for SD projects and activities and a weak banking sector in terms of processing SD-based projects;

- Weak engineering and construction capacity for implementing SD-based projects.

Therefore, the Strategy sets two main actions to overcome those constraints:

- Short, medium and long-term objectives, which address the important issue of EU accession in a timely fashion:
- Seven strategic thrusts, which are based on guiding principles and are designed to cover the three main pillars (economic, social and environmental sustainability), namely:

1. Ensuring EU accession, a key issue;
2. Raising awareness and commitment to sustainable development covering all walks of life;
3. Introducing E-government as the key SD implementation tool and the key booster of the commercial process;
4. Streamlining the public sector through organizational development and institutional strengthening based on the concepts and principles of SD, including cross-cutting and integrated strategic and participatory work. This is also to ensure that SD activities and projects can be processed and approved expeditiously;
5. Streamlining the banking, funding and financial infrastructure in the same context, so that investment and running costs are readily available for SD projects and activities;
6. Streamlining the private sector so that the private sector is developing based on SD principles, and that engineering, construction and other supporting private companies have the capacity to plan, design and implement/ construct projects and activities based on the principles of SD;

Identifying a number of demonstration and pilot projects early on during implementation of the NSSD. These should be used as practical demonstration of costs and benefits of SD based development. They will function as integrated and good examples in the awareness-building and commitment-raising activities. Furthermore, they will provide guidance and inspiration in relation to the municipalities and the private sector, which will have the main role and functioning in relation to the operational part of making the country sustainable. [47]

ii) National Strategy for the Clean Development Mechanism for the First Commitment Period under Kyoto Protocol, 2008-2012

The Government adopted the National Strategy for the Clean Development Mechanism for the First Commitment Period under Kyoto Protocol, 2008-2012 in February 2007.

The goal of the National Strategy for the Clean Development Mechanism (CDM) is to facilitate transfer of investment and technologies through CDM for implementation of projects that reduce greenhouse gas (GHG) emissions and contribute to the country's national sustainable development priorities. The Strategy outlines a course of action that the Government, together with its national and international partners, will pursue during the first commitment period of the Kyoto Protocol (2008-2012) to achieve this goal. Inter alia, one of the priority areas identified in the Strategy for implementation of CDM projects in 2008-2012 is the forestry sector.

The former Yugoslav Republic of Macedonia has registered and implemented various CDM projects.

The country, with the necessary support of the international community, has also developed two other documents in the field of climate change:

- Strategy for Climate Change, approved by the Government in 2008;
- National Strategy for Adaptation of Health Sector to Climate Change, which is going through an approval procedure led by the Ministry of Health with the support of WHO.

iii) National Environmental Investments Strategy for the period 2009-2013

In April 2009, the Government adopted the National Environmental Investments Strategy for the period 2009-2013 (NEIS). The Strategy for Environmental Investments identifies the condition and problems in the area of environmental infrastructure, as well as priorities, measures and activities for the realization of environmental investments in the country.

The NEIS comprises three pillars:

- Definition of a funding budget from national and international sources;
- Allocation of these funds to clearly defined and agreed priorities;
- Institutional strengthening and changes to ensure efficient and effective NEIS implementation.

In the Strategy, non-investment measures are also defined as a prerequisite for smooth NEIS implementation, in relation to institutional strengthening.

Despite its adoption in April 2009, at this stage it is not possible to evaluate whether the Strategy will be implemented and the investment made.

iv) National Program for Adoption of the Acquis Communautaire

The National Program for Adoption of the Acquis Communautaire (NPAA) is a key document for the EU integration process. Adopted for the first time in 2001 by the Government, it is revised

[47] United Nations Economic Commission for Europe (2011) "2nd Environmental performance review of the former Yugoslav republic of Macedonia" Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

annually. The Plan reflects the dynamics of harmonization of national legislation with EU legislation as well as the necessary adjustments and strengthening of national institutions and resources.

NPAA is a comprehensive long-term document that defines the dynamics of the adoption of the Acquis Communautaire (EU legislation), strategic guidelines, policies, reforms, structures, resources and deadlines to be realized /implemented by the former Yugoslav Republic of Macedonia in order to fulfil the requirements for EU membership

The core functions of NPAA are to:

- Establish plan and timescale for approximation and for adoption of the EU Acquis and determine the competent institutions and authorities for preparation and implementation thereof;
- Determine the necessary administrative structures for implementation of the EU Acquis into national legislation;
- Determine budget resources and foreign assistance funds necessary for implementation of the anticipated tasks.

The two main features of NPAA are its capability to serve as a basis for:

- Monitoring progress made by the country yearly;
- Formulating the position papers and negotiation positions of the country upon commencing the accession negotiations.

The short-term and medium-term EU priorities with regard to the process of integration are defined in the Accession Partnership, a document produced by the EU. It is a mean of realizing the European perspective of the western Balkan countries within the framework of the stabilization and association process. The concrete activities for achievement of the Accession Partnership's priorities are integrated in NPAA.

NPAA represents a control mechanism in the monitoring of the process of legislation harmonization. Chapter 27 on the Environment refers to the provisions of the Stabilization and Association Agreement (SAA), which establish the basis for obligations concerning the harmonization of national legislation, the implementation deadline, the competent body, the overview of the relevant EU legislation, as well as the overview of the existing national legislation and the planned legal acts to be adopted.

Every year, NPAA contains a list of legislation and policies that the country needs to adopt for improving its approximation to EU standards, and great efforts are made to produce and update as many documents as possible.

v) National Set of Environmental Indicators

In September 2008, the Government adopted the National Set of Environmental Indicators including 40 indicators, which was published in November 2008 in two languages. The set mainly corresponds to EEA indicators data sets, and represents the basis on which the country will assess the state of the environment and the impact of legislation and policies.

vi) 2005 Strategy on Raising Public Awareness

The 2005 Strategy on Raising Public Awareness sets short and medium-term goals as to how to structure and improve the ministries' performance in raising environmental awareness of the relevant target groups, decision-makers in industry and the general public, as well as short-term and medium-term communication goals in order to improve communication between all stakeholders in the field of environmental management with a focus on EU-MoEPP, inter-ministerial communications and communications with the ministry itself.

The strategies for strengthening the communication capacities of the Ministry and for raising awareness have been developed in parallel with the Environmental Communication Strategy. It applies a holistic approach by developing in parallel an internal as well as an external communication strategy, resulting in two different strategy papers.

vii) Vision 2008 Communication Strategy

This is a basic mid-term strategy (Mother Strategy). It has been designed for external and internal MoEPP communication, including definition of mission statement, styles of communication and guidelines for policy marketing. All strategic issues addressed in this document are the basic layer or the fundament of all awareness and promotion activities of the Ministry in a five-year period. A yearly update of this Strategy according to monitoring and implementation progress will be necessary. This Strategy in particular was related to the impacts of designing policies and communicating policies at the same time. The model entails high involvement of stakeholders from NGOs and from the private sector

Vision 2008 enables the Ministry to play a proactive role in national environmental improvement and in the upcoming EU membership negotiations and reduce institutional dependency on donor funding and external technical assistance, while at the same time enabling mobilization of domestic and external funding for environmental investments. In is intended to bring benefits in terms of improved performance of the public administration as well as the development of democracy in the country on the way to full EU membership.

viii) Awareness strategies

There are three topical strategies based on the communication and management styles defined in Strategy. Together, these four strategies constitute a comprehensive and integrated approach towards a sustained improvement in MoEPP communication capacity. The result is an integrated communication model.

ix) Environmental Monitoring Strategy

The objective of the 2006 Environmental Monitoring Strategy is to streamline MoEPP tasks with regard to environmental monitoring. This also includes the design of a monitoring system that would comply with EU monitoring and reporting requirements.

Based on the assessment of current monitoring systems and the evaluation of current data management systems, the Environmental Monitoring Strategy specifies activities which need to be pursued in order to develop effective and cost-efficient environmental monitoring and earmarks investment for environmental monitoring. In addition to the internationally accepted DPSIR model, the Strategy also deals with self-monitoring and reporting requirements, as well as the establishment of the environmental information system that is described in greater detail in the Environmental Data Management Strategy. It highlights the concept of goal-oriented monitoring; and presents planning schemes to develop the monitoring of environmental quality (water, air, biosphere, noise, nature, soil) and the monitoring of emissions, in particular wastewater, exhaust air and waste. It puts monitoring into the respective framework of legal, institutional and technical issues, and provides guidance as to references. However, the core pieces of the present Strategy are modules which specify important environmental goals for all environmental media. The purposes and objectives of monitoring are identified, aiming at the specified goals, and, the required activities are deduced.

x) *Strategy on Environmental Data Management*

The 2005 Strategy on Environmental Data Management provides a step-by-step plan for the implementation of a standardized architecture for software and data structures that can accommodate data from multiple regulatory programs—such as air pollution control, water pollution control, soil and noise control and hazardous waste management— and that can provide integrated (i.e. cross-program) access to data. In parallel with the technical roadmap that guides the implementation of the necessary Environmental Information System (EIS) modules, the Environmental Data Strategy addresses the human factor challenge of how to avoid frictions between the parties concerned and build cooperation while at the same time motivating users. Users will require special training in parallel with the hardware and software installation, but they must also be motivated and informed about the benefits of using EIS in their daily work. EIS sets a data management approach that promotes efficient, well-integrated data management within each environmental program area and also facilitates cross-program data viewing and multi-program retrievals.

The Strategy on Environmental Data Management provides the guiding principles and framework for implementing a national environmental data management program. Future environmental protection depends on modernized and highly unified data services to maintain reliable, secure, and efficient information-sharing in the face of the expected growth in demand for such services. The primary goal of the data management program is to provide reliable information available quickly. The achievement of this primary goal requires the following specific goals:

- The establishment of an environmental information system (EIS);
- An increase in data sharing;
- The improvement of data availability in terms of timeliness, access, and quality;
- The promotion of collaboration on data management activities;
- The provision of maximum benefit with existing data infrastructure.

xi) *Spatial Plan*

The 2004 Spatial Plan incorporates emphasized strategic development connotation and defines and establishes the basis and at the same time feasible goals and directions for development, especially with regard to the necessary qualitative and quantitative structural changes and the relevant and adaptable spatial planning solutions and options. This document constitutes a foundation for the organization, development, use and protection of space in the country, covering a 20-year period. The Study on the Environment and Nature Protection, carried out within the framework of the Plan, specifies the goals and planning guidelines for environment protection, as part of the overall activities in the field of spatial planning.

xii) *Plan for Institutional Development of National and Local Environmental Management Capacity for the Period 2009-2014*

The Plan for Institutional Development of the National and Local Environmental Management Capacity for the Period 2009-2014 aims to determine the relevant functions and to suggest an institutional development plan for central administrative bodies and bodies of local self-government with competences in the area of the environment, within the medium term. The plan sets differentiation and grouping of specific activities into a general framework of functions in competence of certain central or local bodies, so that these bodies could subsequently develop the necessary administrative capacity to carry out individual activities or, based on the workload, carry out activities using existing administrative capacity. It aims to establish a plan for an efficient national environmental management system and for the strengthening of the central administration, ensuring practical implementation of harmonized legislation and of strategic plans and programmes. The plans identifies priorities and measures aiming at facilitating the process of transfer of competences from central to local level, increasing the implementation capacity of local self-government, and developing solid ties between central government and local self-government.

xiii) National Environmental Health Action Plan (NEHAP) (1999)

This 1999 National Environmental Health Action Plan (NEHAP) recognizes the linkage between the environment and health: it formulates guidelines aimed at overcoming environmental health problems, and identifies priorities and actions that treat, among other issues, the institutional set-up, stressing the need for the establishment of inter-sectoral cooperation, reform of environmental health services and capacity-building, information systems strengthening, development of criteria and procedures for the assessment of environmental impacts on human health and their integration in decision-making processes, and establishment of control measures.

xiv) Strategy on Improvement of Energy Efficiency by 2020

The objective of the 2010 Strategy on Improvement of Energy Efficiency by 2020 (SIEE) is to develop a framework for accelerating adoption of energy efficiency practices in a sustainable fashion through implementation of a series of programs and initiatives that are linked to the reduction of import dependence, energy intensity, non-productive use of electricity, establishment of a favourable climate for maximizing the involvement of and opportunities for the private sector complementary advocacy, and training activities. The final result of achieving this objective will be the realization of over nine per cent energy savings till 2018, comparing to average consumption in the observed five-year period (2002-2006), with continued promotion of energy efficiency and monitoring and verification until 2020. This is an important task for the country on the way to sustainable development of the country's economy and fulfilment of commitments on the way to EU accession, and will serve as the first benchmark in the realization of the planned measures. With the Second National Energy Efficiency Action Plan (2018-2020) the Government will develop additional measures to reach 14.5 per cent savings in 2020, which means that the country will approach the EU target in 2020 of achieving savings of 20 per cent. The objective of the elements incorporated into the SIEE is to stimulate a progressive transformation of the market. The development of an adequate policy framework is intended to stimulate the demand for more energy-efficient technologies and services. As this demand grows, it should encourage the formation of energy service companies and companies that provide more efficient equipment and accompanying maintenance.

xv) Second National Environmental Action Plan

The first National Environmental Action Plan, adopted in 1996 as highlighted in the first EPR, was an outdated document for the needs of the country, as a result of which a recommendation was made that a new NEAP should be adopted. Unfortunately, before preparing a new NEAP the country did not carry out an assessment on the implementation status of the first NEAP.

The Government adopted the second National Environmental Action Plan in 2006. The document, prepared by MoEPP in coordination with different ministries, provides general guidelines and directions for the country in the area of environment until 2011. In addition to setting general objectives and goals in different sectors, NEAP also envisages specific order to achieve said goals.

NEAP represents the Government's approach and response to environmental problems in the country. In the area of environment, the process of EU approximation poses significant requirements for the country, in terms of not only financing but also capacity-building, institutional restructuring and strengthening. As confirmation of this, the Government, through MoEPP, has developed a roadmap for approximation of the area of environment to EU legislation.

NEAP also provides a basis for the local environmental action plans (LEAP), which are developed along the lines of NEAP, taking into consideration the local conditions of each municipality.

On the one hand, NEAP sets the principles and priorities for action by MoEPP, and on the other side it provides a solid basis for proving the relevance of proposed projects and actions for donor assistance, especially by NGOs.

Compared to the first NEAP, the one adopted in 2006 is a completely new document rather than a mere update. In particular, this document also stipulates the necessary instruments for implementation and monitoring of its goals. Despite the relevant provisions, and in particular the plan for annual reporting to the Government on NEAP implementation, there is no actual monitoring of NEAP implementation. This is partly due to a lack of human resources in MoEPP, leading to a lack of communication from relevant bodies (such as other ministries, NGOs, donors) which are supporting NEAP implementation mainly through projects. In fact, MoEPP does not have sufficient capacity to properly monitor NEAP implementation and remain abreast of any NEAP-related activity implemented by other bodies.

xvi) Local Environmental Action Plans

As of January 2011, 64 municipalities out 85, including the City of Skopje, had developed local environmental action plans. Most of the four larger municipalities have greater economic and human capacity and have developed their LEAPs, while smaller municipalities are lagging behind in the preparation of this document. There are a number Plans prepared in the last three years, after the adoption of the Methodology for the preparation of LEAPs by MoEPP, based on Article 64 of the Law on Environment, such as LEAP for the municipalities within the City of Skopje, for example Aerodrom, Ilinden, Gjorce Petrov, and other municipalities, such as Novaci, Vasilevo, Brvenica. Twenty LEAPs prepared by 1998 are particularly outdated since they were developed prior to the preparation of the MoEPP Methodology for the Preparation of LEAPs, based on the DPSIR approach.

The Government and in particular MoEPP is financially supporting the municipalities in the preparation of the LEAPs. In addition to these national resources, the international donor community is active in this field. MoEPP has prepared a methodology for LEAP preparation based on the DPSIR approach (Driving forces, Pressures, States, Impacts and, Responses). The methodology is used by municipalities in preparing the LEAP, and it can be seen that in recent years, the quality of LEAPs has improved and they are becoming increasingly relevant.

3.4.1.8 Overview of requirements set by legal and regulatory framework

Current national waste management targets are presented in the following table.

Table 3-69: Current timeline for waste sector objectives and targets in FYR Macedonia

Objectives and targets	Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	…2027
Improvement of collection and source separation efficiency													
- Mixed municipal waste - Collection efficiency: 90%	NWMP				⇨	2014							
- Segregation of hazardous and non-hazardous waste fraction (manufacturing/ service sector) Segregation efficiency: 100%	NWMP												
Landfill of waste/diversion													
- landfill of MSW on temporary facilities (after conditioning) - 100% of the collected MSW	NWMP				⇨	2014							
- landfill of MSW on facility compliant with EU standards - 50% of the collected MSW	NWMP												
- reduction of the greenhouse gas emissions (landfills only) - Reduction for approximately 25% of CO_2 equivalent	NWMP												
- diversion of industrial hazardous waste streams from non-hazardous landfills – 100% effect	NWMP												
- reduction of biodegradable waste disposed on landfills expressed as a percentage reduction of the BMW generated in 1995	NWMP& Rules (OG No.108/2009												
2011-2017: 25%								⇨	2017				
2011-2020: 50%											⇨	2020	
2011-2027: 75%												⇨	2027
Packaging and packaging waste													
Treatment / Recovery: 60% b.w.	LoPPW										⇨	2020	
Recycling: (minimum 55% - maximum 80%)	LoPPW										⇨	2020	
-22.5% plastic	LoPPW								⇨	2018			
- 60% glass, 60% paper and cardboard, 50% metals and 15% wood	LoPPW										⇨	2020	
Batteries/accumulators													
Collection of at least 25 % b.w.	LoBAWBA						⇨	2016					
Collection of at least 45 % b.w.	LoBAWBA										⇨	2020	
Waste electrical and electronic equipment													
Collection: >4kg/capita/year	LoEEEWEEE										⇨	2020	
Cat. 1 and 10: recovery 80% and	LoEEEWEEE												

Objectives and targets	Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	…2027
prep. for reuse/recycling 75%													
Cat. 3 and 4: recovery 75% and prep. for reuse/recycling 65%	LoEEEWEEE												
Cat. 2,5,6,7,9: recovery 70% and prep. for reuse/recycling 50%	LoEEEWEEE												
Gas discharge lamps - at least 80% reuse and recycling	LoEEEWEEE												
Construction and demolition waste													
Collected: 30% Recovered/ recycled: 10% Disposal: 90%	NWMP										⇨	2020	
Used tyres													
Collection efficiency: 90% Energy recovery: 100%	NWMP				⇨	2014							
PCB/ PCT waste													
Inventory complete (2009) Destruction	NWMP								⇨	2018			
End of life vehicles													
Collection: 90%	NWMP				⇨	2014							
Recovery or reuse: 70%									⇨	2018			

As already mentioned in paragraph 3.2.1.2, according to the Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment (2012) (LoEEEWEEE), article 43, par. (2) *"In determining the places and locations of collection centers, the number of residents in the area shall be taken into account, providing at least one collection center at the municipal level, i.e. at least one collection center for 30,000 residents*."

3.4.2 Analysis of weaknessess of waste management system

The current waste management system is based mainly on waste collection and disposal. Most of the population that does not receive any collection service lives in rural areas. Waste is not treated before disposal. Industrial, construction, agricultural, and even hazardous waste often is landfilled together with municipal waste without prior treatment.

The municipal landfills, though organized, do not comply with EU requirements. There are many uncontrolled dumpsites, which pose significant environmental risks. Consequently, the targets set in the NWMP for the year 2014 will probably not be achieved, for example the target for 75% reduction of biodegradable waste disposed on landfills and landfilling of 50% of total MSW in EU-compliant facilities.

The Waste Framework Directive introduced a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. Therefore, a shift away from landfill is crucial. The necessary changes in waste management will require the development of appropriate infrastructure to provide an integrated network or waste collection, transport, recycling, recovery and disposal facilities. Due to waste composition, there is high potential for biological treatment. The proposed changes in the next phase should reduce the amount of waste being landfilled.

An overview of the current waste management system is presented in the following table.

Table 3-70: Overview of current solid waste management system in East Region

Sector	Current situation/ gaps and weal spots
Regulatory framework	**Regulatory and economic policies for various streams / sources** The National Waste Management Strategy of the FYR of Macedonia (2008 - 2020) defined the directions and principles of waste management in the country, whereas the National Waste Management Plan 2009-2015, based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European Union. The NWMP was composed in October 2008 and adopted in 2009. In principle the National Waste Management Plan contains mainly the complete general information needed, but country-specific sometimes are missing to take necessary action. Problems have been identified, but proposals made are very general and should be more concrete. The National Waste Management Plan provides a series of targets for specific activities and waste streams. It was an ambitious program for a 6 year period and the targets set for the year 2014 will likely not be achieved. The waste management hierarchy is almost reflected in the current NWMP, however it is necessary to strengthen the provisions encouraging prevention and preparation for re-use of waste. The waste hierarchy is not implemented, as no waste prevention measures are taken, the waste collection system is not source-separated and there are no formal recycling activities. No measures for diversion of BMW from landfill are taken. The most dominant fraction of the waste composition is other biodegradable waste i.e. kitchen waste, with a share of 36.0%, followed by garden waste with 18.3% and fine fraction with 10.1% of the total waste
Institutional framework	**Institutional framework, resources and jurisdiction to manage various waste stream/sources** The current organogram of MoEPP is under revision with a new "regional" approach relying on decentralization of both types of inspectors (nature protection and environment protection). Moreover, the plan foresees that environmental inspectors will have to specialize in one of the sectors among IPPC, Seveso and waste management. The Inter-municipal Board for Waste Management has been recently established and is fully operational. The Inter-municipal Board for Waste Management shall be seen as a complementary body to the Inter-municipal Waste Management Enterprise creating a clear distinction between planning/ contracting and operations, which will result in greater transparency and potentially higher cost efficiency.

Sector	Current situation/ gaps and weal spots
Financial mechanisms	**Financing provisions, including subsidies, levies, charges and private sector participation** The tariffs for individuals vary from 84 to 200 MKD/month per household or from 1.8 to 2.8 MKD/m2 annually. The tariff of business institutions for large entities is between 3.5 and 5.46 MKD/m2/year or from 300 to 2 000 MKD/month, for small entities - from 4 to 9 MKD/m2/year or from 84 to 500 MKD/month and for schools and kindergartens are from 2.61 to 5 MKD/m2 per year or 300 MKD/month in Cesinovo-Oblesevo. The tariffs in Vinica for large entities and schools and kinder gardens are surprisingly high - 8 MKD/m2/month and 1.5 MKD/m2/month - courtyard. Apart from the municipalities of Berovo, Karbinci, Pehcevo and Vinica, the other municipalities of the East region have not submitted data for their costs for waste management in the questionnaires. In Berovo revenues cover the total waste costs. In Karbinici revenues cover only collection costs. For Vinici there is no data for total waste costs but revenues exceed collection costs over 2.4 times and probably cover the total costs. Revenues per ton collected waste in Vinica are almost 6 times higher than revenue per ton collected waste in Berovo and more than 3 times higher than that in Karbinci. Berovo has the lowest collection costs - 4,6 lower than collection costs in Vinica and 3,5 lower than that in Karbinci. Based on the provided data and a series of assumptions made, Waste fees for households at the region are affordable in Berovo municipality and not affordable at Vinica municipality. The affordable level allows increasing the waste fee in Berovo by 10%. In Vinica Municipality the fees are above the affordability level by 60%.
Technology and infrastructure	The National Waste Management Plan (2009 - 2015) provides a series of targets for specific activities and waste streams. However the targets are not expected to be met on time. The waste management system is based mainly on waste collection and disposal. The waste collection, transportation and disposal service is mainly provided by Public Communal Enterprises (PCEs). However, the insufficient liquidity of PCEs prevents investments in suitable infrastructure for waste segregation and treatment, therefore mainly mixed waste is collected and disposed of at municipal, non-EU compliant landfills, with the exception of Štip settlement, where there are separate bins for PET and paper. According to the received questionnaires, the percentage of the population that receives a regular service ranges from 38% (Cesinovo-Obleshevo) to 100% (Stip& Pehcevo). Most of the population that does not receive any collection service lives in rural areas. This has lead to the proliferation of illegal dumpsites located on the outskirts of settlements. The waste collection frequency varies among municipalities. In order to interpret the results, it must be reminded that the most populated Municipality of the region is Štip Municipality and the least populated municipality is the Zrnovci Municipality. Analytically: **Collection and transportation** The collection system is not source-separated. **Treatment and disposal** The eleven (11) municipal landfills, though organized, do not comply with EU requirements. There are 71 uncontrolled dumpsites which pose significant environmental risks. The target set in the NWMP for landfilling of 50% of total MSW in

Sector	Current situation/ gaps and weal spots
	EU-compliant facilities by the year 2014 will most likely not be achieved. **Recycling and recovery** There are no formal recycling and recovery operations. The informal recycling sector, which involves socially vulnerable groups, handles streams for which demand, and consequently prices, are high (plastics, metals etc.).
Stakeholder participation	**Role of waste generators** In Stip, according to the received questionnaire, 38,8 tons of paper (50% from institutions /commerce) - up to 08.01.2013 were collected and handed over to the Collective scheme "PAKOMAK". Pakomak is a nonprofit company, founded on 3/12/2010, whose main activity is management of packaging waste. **Role of private sector for waste management services and for recycling and recovery** In Stip, the company "MINOL", which purchases industrial waste oils from Stip and other areas in the vincinity, had collected in 2012 4.000 kg waste oil. Also, the company "IVAL TRADE Ltd" purchases old car batteries and WEEE, but no data were available from the municipality. In Cesinovo-Obleshevo, according to the received questionnaire, green waste is sorted by I.E. Zeliniot and the municipality together. Also, hazardous waste is sorted, but no further information is provided. The Municipality of Berovo has established a Public-Private Partnership (PPP) with a local firm for collection of PET bottles in 4 settlements of the municipality. The following are the private companies that operate in the Municipality of Probishtip: 1. “Otpad familija Todevi” which performs transport and disposal, and temporary storage for the Municipality of Probishtip, Company Todevi purchases and stores ELVs. It also performs the following: a. Purchase and processing of used batteries (melting) b. Storage and delivery in a safe place c. Storage and delivery in a safe place d. Public storage dump e. Storage and delivery in a safe place It serves 5000 inhabitants, i.e. 30 % of the municipality population. 2. “TA DAmipak” which produces cardboard packaging. 3. Tab Factory for batteries and accumulators purchases and processes (melts) waste car batteries. 4. Car repair shop Zoki, AR Meche, Gogo trans, Creshovo topche and Boki trans store waste oils and transport them to a safe place. 5. Tire repair Ficho stores used tires and transports them to a safe place Regarding public awareness activities, the majority of events are organized in the context of national public awareness campaigns. Most of the awareness events take place in the City of Skopje and there few at regional/local level.

3.5 WASTE GENERATION FORECAST

The projection is an essential element in the planning process. Based on the municipal waste generation projection, the targets set at regional level are quantified, and implicitly the capacities of the waste management facilities to be installed are determined.

In order to calculate the waste generation forecast (2018-2042) for the Region, the following assumptions have been made:

- The population average rate of change for each Municipality during the period 2002-2012 was calculated. Using the calculated average rate of change, each municipality's population was estimated for the period 2013-2042.
- There were two approaches for the evolution of waste production factor. In the first approach, a total waste production factor was used and in the second approach, a separate waste production factor for each municipality of was used (calculated from collected waste and served population). Finally, the first approach was adopted. The waste production factor increases by 1% during the period 2013-2027 and by 0.5% during the period 2028-2042

Figure 3-36: Population forecast per municipality

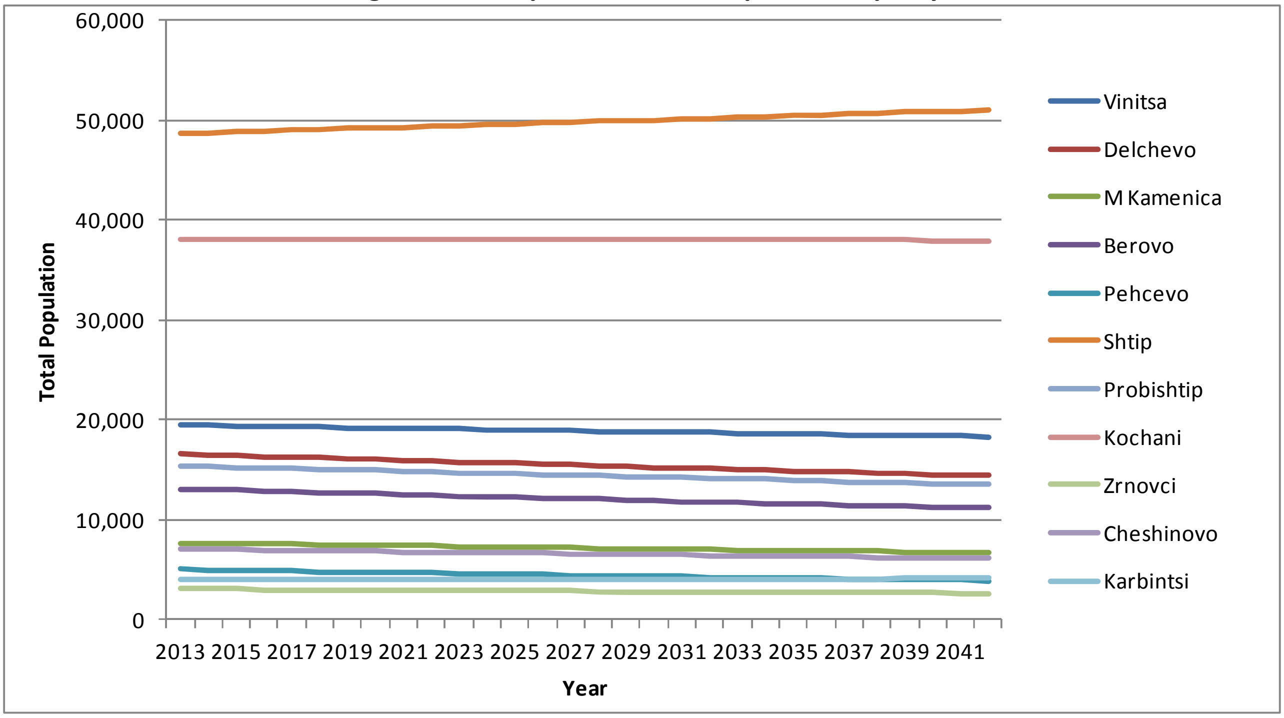


Figure 3-37: Regional population forecast

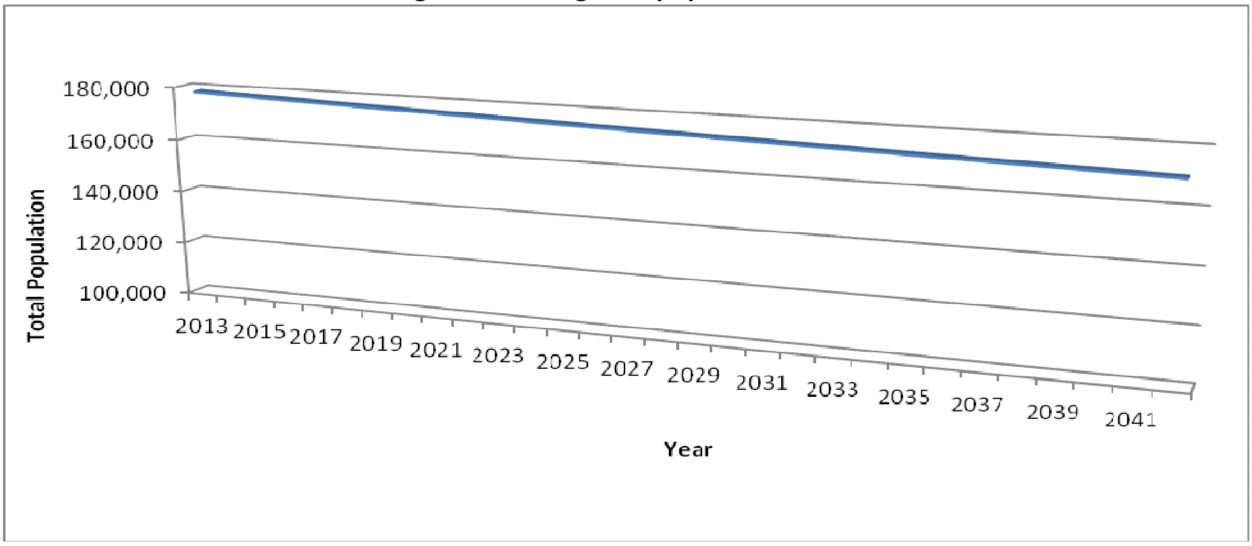
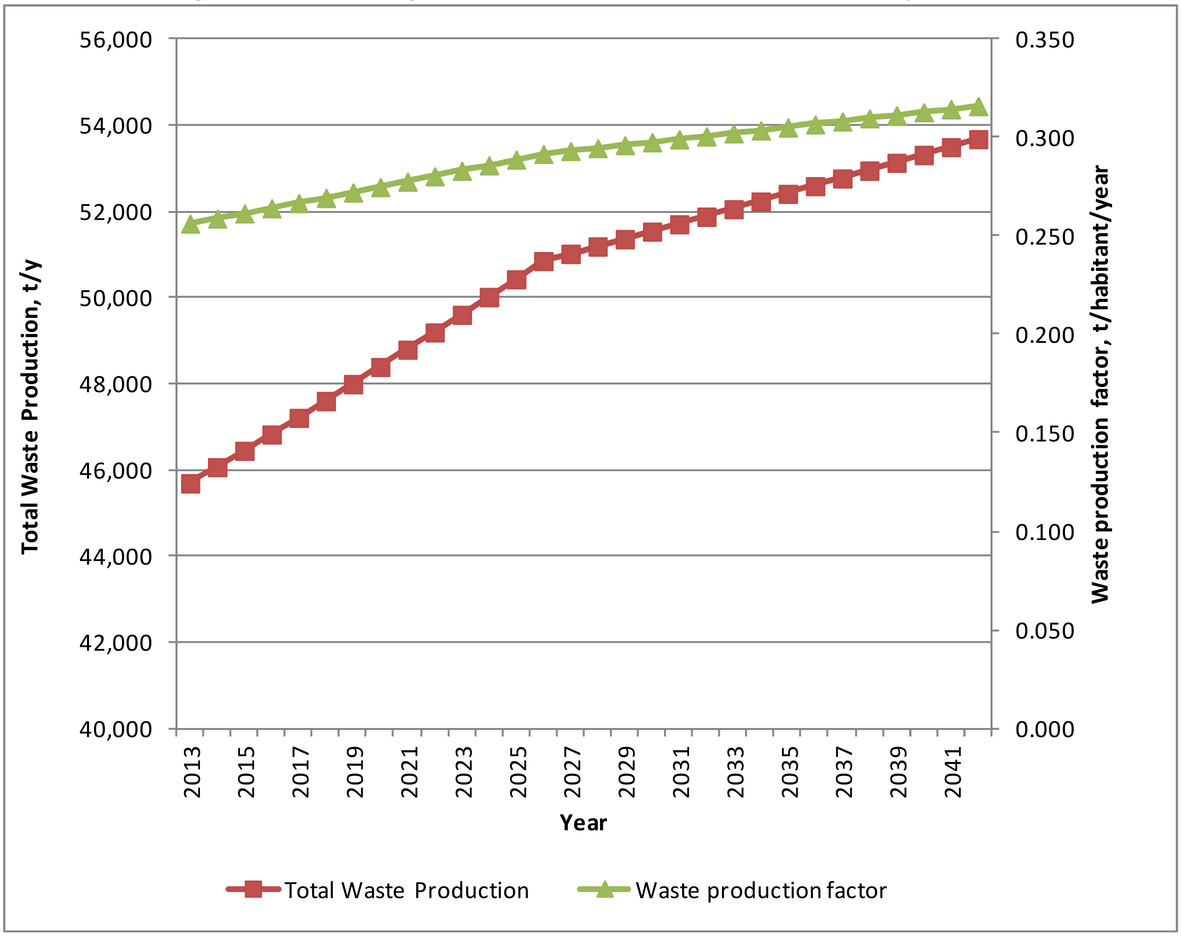


Figure 3-38: Waste generation forecast / evolution of waste production factor



Detailed presentation of the waste generation forecast and its composition is presented in Annex II-Waste generation forecast. A detailed calculation of forecasted waste quantities and the calculation of target achievement per waste management scenario is presented in Annex III-Calculation of targets.

3.6 OBJECTIVES AND TECHNICAL OPTIONS FOR WASTE MANAGEMENT

3.6.1 Introduction

The Regional Waste Management Plan is a key element of Regional Policy, providing a strategic framework which will allow the Region as a whole to rapidly progress to more sustainable ways to produce and consume goods, and then recycle or recover as much value as possible from that waste which is produced. It also has an important role to identify the current capacity of the Region to manage the waste and to set out the waste management infrastructure which will need to be developed to meet future needs.

The aims and objectives of the RWMP must be framed against the numerous statutory and aspirational targets relating to waste management which have been set out in both the National Strategy and Plan. The aim of the Regional Waste Management Plan is to take the principles and priorities set out in the National Waste Strategy and Plan and develop them into a concise, deliverable framework which ensures that the Region moves to sustainable practices in the future.

The Regional Waste Management Plan (RWMP) is elaborated al the regional level and:

- represents the link between the national targets and the possibilities and options for achieving the targets at the regional and local level;
- allows the utilization of the local advantages from the region in order to achieve the national targets for the entire region;
- represents the waste management strategy synchronized at the level of all municipalities belonging to the region;
- allows the compensation for the differences between municipalities in the Region(i.e. low capacity of recycling in a municipality);
- can lead to a strategy for waste management which cannot be administrated or financed by one single municipality;

The RWMP is in line with the provisions of Article 1 WFD (protection of environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use), Article 4 WFD (the waste management hierarchy), Article 13 WFD (protection of human health and environment), and Article 16 WFD (principles of self-sufficiency and proximity).

The Plan fulfills the mandatory elements of a waste management plan listed in Article 28(3) WFD and the additional elements which may be contained in the plan, listed in Article 28(4) WFD.

3.6.2 Vision, aims and objectives

Guided by the European and National policy context, the Regional Waste Management Plan has the following vision and aims:

Vision & Aims of the Regional Waste Management Plan

Vision: To provide a regional planning framework for the sustainable waste management and recovery of resources by developing an integrated waste management system, with the following aims:

Aim A: Minimisation of negative impacts on the environment and human health caused by the generation and management of waste.

Aim B: Minimisation of negative social and economic impacts and maximisation of social and economic opportunities.

Aim C: Conformity with the legislative requirements, targets, principles and policies set by the European and National legal and regulatory framework.

To meet these aims, the following objectives have been set. The objectives will be reviewed during the Strategic Environmental Assessment (SEA) process.

Objectives of the RWMP

Environmental and Human Health Objectives (Aim A)

Sustainable use of land and other resources
Minimization of greenhouse gas emissions
Minimization of negative impacts on air quality and public health
Minimization of negative impacts on water quality and water resources
Land and cultural heritage conservation
Biodiversity protection
Protection and improvement of living conditions of the population
Protection and promotion of biological diversity and natural heritage
Protection and improvement of the water quality
Protection and improvement of the soil quality, quantity and function
Improvement of the quality of air and reduction of greenhouse gas emissions
Protection of material assetsProtection and promotion of cultural heritage
Preservation of landscape characteristics and protection of landscape everywhere and especially in the designated area

Socio-Economic Objectives (Aim B)

Provision of public awareness campaigns, enhancement of public involvement
Optimization of waste collection system and minimization of local transport impacts
Employment opportunities
Waste Management system in balance with economic resources of the society

Legal and Regulatory Framework Objectives (Aim C)

Conformity with EU and National waste legislation, policy and principles – achievement of waste management targets regarding waste generation, collection, recycling infrastructure, efficiency in relation to waste diversion from landfill targets, energy recovery, cost recovery, remediation of existing dumpsites and environmental awareness. The plan takes into consideration:

- The waste management hierarchy
- The Best Practical Environmental Option for each waste stream
- The principle of regional self-sufficiency
- The proximity principle

The Regional Waste Management Plan will be based on the Waste Management Hierarchy. The hierarchy highlights the need to move practices away from landfill disposal and to promote prevention, preparing for reuse, recycling and other recovery. Fundamental to achieving these policy objectives are recognition and acceptance by all target groups of society, as producers of waste, of their responsibility to support and adopt more sustainable waste management practices, both at home and at work. It is implicit therefore that the perception of waste as an unwanted but necessary by-product will need to change, with recognition of its potential as a resource.

The perspectives for regional waste management system are the following:

Environmental

The waste management system will be based on an integrated approach of self-regulation, regulation and control. Problem shifting across environmental media – air, soil, and water - must be avoided. Acceptance of user charges should be seen in connection with the application of the polluter pays principle.

Economic

The waste management system shall be developed in such a manner that it does not put an undue strain on the population. The waste system shall be worked out in such a manner that it is in balance with the economic resources of the society. The system should facilitate and assure waste collection, treatment, and disposal to attain desirable levels of hygiene and aesthetics, within the capacity of different economic actors to pay.

Institutional

Duties and responsibilities of the municipal and private institutions and companies involved in waste activities must be clearly defined and coordinated. Regional waste management planning is a pre-requisite for effective management and must be periodically evaluated and revised. Information collection and exchange between various institutions of waste management must be improved in order to facilitate the decision-making process.

Social

All stakeholders of the waste management system should accept the chosen strategy and all of its components in its institutional, legal and financial framework. This includes the willingness to adopt direct user charges and enhance waste regulations that have an impact on the stakeholders' attitudes.

3.6.3 Waste Prevention and Minimization

Reducing the amount of waste generated at source and reducing the hazardous content of that waste is regarded as the highest priority according to the Waste Hierarchy established in the revised Waste Framework Directive (Article 4). Waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging[48]. The objectives are:

- Breaking the link between economic growth and the environmental impacts associated with the generation of waste.
- Reduction of environmentally harmful impacts

[48] EC. (n.d.). Retrieved February 14, 2014, from http://ec.europa.eu/environment/waste/prevention/

- Reduction and substitution of hazardous substances
- Optimising the quantity of packaging per packaged product
- Promotion of reuse
- Raising awareness, dissemination of best practices. Integration of the principles of sustainable consumption and dematerialization into the daily behaviour behaviour of the consumers

Waste prevention is linked to the introduction of economic instruments and raising awareness among the population and waste generators. Relevant economic instruments are usually introduced on a national scale, whereas awareness-raising will be oriented and implemented at the regional and local level.

Any such initiatives at a regional and local level usually require support from a national programme, before an effective and integrated programme of actions can be delivered for the Region.
A Regional Waste Prevention Program may be elaborated separately. Awareness campaigns can start from 2015 onwards and they will be promoted to meet the long-term challenge of waste prevention and minimisation at the household and business level. Waste prevention measures shall be clearly identified and appropriate qualitative or quantitative targets and indicators must be adopted in order to monitor and assess the progress of the measures.

3.6.4 Collection of municipal waste (services and level of coverage)

Objectives:

- Providing collection and transport services to as many waste generators as possible–setting up systems covering the entire area of waste generators
- Increasing the quantity of packaging waste collected. Implementation of separate collection system for recyclable materials to assure achievement of legal targets regarding packaging waste

Currently, collection coverage in the region is variable and incomplete, especially in the rural areas. Future realization of works will be taken into account when planning collection services and provisions for further expansion of service coverage in the urban and rural areas will be made. The best options available for waste collection and transport will be selected, in order to allow effective recovery through an optimal technical and economical configuration.

According to the NWMP 2009-2015, 90% of mixed waste should be collected by 2014. However, the target was not achieved. In East Region, the percentage of the population that receives a regular service ranges from 38% (Cesinovo-Obleshevo) to 100% (Stip& Pehcevo). Most of the population that does not receive any collection service lives in rural areas. Therefore, gradual targets will be adapted.

- *For the period 2014-2017, 80% coverage of the population in* Cesinovo-Obleshevo and Vinica.
- *2016-2018: 90% coverage in all areas,* after the provision of the necessary collection equipment.

The collection and coverage targets are set up to ensure that collection capacities are adapted to the number of inhabitants and to the quantity of generated waste. In the long run, full collection coverage must be achieved by the region, as it is a crucial element in overall management.
Furthermore, according to the NWMP 2009-2015, "*the separate collection of recyclables under the given financing patterns within the municipalities is not yet recommended, except some pilot scale recycling for selected material for which a market already exists is proposed. However, on the other hand, separate collection of selected fractions of commercial waste shall be encouraged because relatively big amounts of clean recyclable material may be collected; recovery and partly recycling may be carried out by Macedonian companies or recovered waste fractions may be exported to foreign recycling facilities*."
Green waste and WEEE will be collected separately. The separate collection of recyclables will be examined during option analysis.

Clear contractual relations and split of responsibilities between Public Communal Enterprises, private entities (licensed to collect, transport and treat the waste), collective schemes and recycling companies are required for successful operation of the system.

In case certain municipalities are too small to organize separate collection, two alternative options can be proposed: i) collection is undertaken once a week or once a fortnight with the same ordinary waste truck and transported to the nearest treatment facility, and ii) delegate this service to the municipality responsible for operating the MRF.

3.6.5 Recycling and recovery of waste

Objectives:

- Exploiting all the technical and economic possibilities for waste recovery
- Developing materials and energy recovery activities
- Improving the level of packaging reuse and recyclability
- Optimising the quantity of packaging per packaged product
- Optimising the materials recovery schemes
- Setting up and optimising energy recovery schemes for packaging waste (where materials recovery would not be "feasible")
- Promoting waste treatment in order to ensure rational environmental management

Separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets. The proposed timeframe is the same with the timeframe set in the laws. It will be guaranteed that the targets at regional level will be achieved without imposing "*unbearably*" high investment and operation costs for the regional population. The targets can be differentiated, where applicable.

3.6.6 Waste disposal, including minimization of biodegradable waste

Objectives:

- Reducing the quantity of biodegradable waste to be landfilled
- Construction of final disposal facilities fully compliant with EU standards.

The WFD also highlights the significance of the bio-waste stream in Article 22, which states:

"Member States shall take measures, as appropriate, and in accordance with Articles 4 and 13, to encourage:

a) the separate collection of bio-waste with a view to the composting and digestion of bio-waste;

b) the treatment of bio-waste in a way that fulfils a high level of environmental protection;

c) the use of environmentally safe materials produced from bio-waste.

In 2009, a set of targets was introduced quantifying the percentages of biodegradable municipal waste (BMW) that should be diverted from landfills. There are three milestones which need to be met by 2017, 2020 and 2027, by achieving a certain percentage reduction of BMW landfilled within a period of time starting from the year 2011. The proposed timeframe is the same with the timeframe set in the Rules[49].

According to the NWMP 2009-2015, 50% of collected waste should be landfilled in EU compliant landfills by 2014. However, taking into account the target was not achieved and the future realization of works, the target can be modified to landfilling 100% of residual waste in EU compliant landfills by 2018.

3.6.7 Special waste streams

Objectives:

- Separate collection and establishment of management infrastructure for special waste streams

According to NWMP 2009-2015, "*activation of the licensed private sector and investments in the collection, storage and process equipment for management of special waste streams and end-of - life products shall be by the setting up of (voluntary) "compliant" schemes and by earmarked taxation of selected products like used tyres, used oils and lubricants, packaging and packaging waste, waste electro-and electronic equipment, etc which assure the payment of services executed through the entire collection/recovery and disposal chain.*" "*Projects related to the collection and recovery/recycling system for other special waste streams and end-of-life products shall be initiated by preparation of the necessary preliminary studies, technical, environmental and investment documentation."*

Although those streams are not part of MSW they are indicative concerning the waste management performance of the region. Separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets. The proposed timeframe is the same with the timeframe set in the laws (please see table 2).

3.6.8 Closure, remediation and after-care of municipal landfills and unregulated dumpsites

Objective:

- Closure and remediation of unregulated dumpsites. A timeframe will be developed to address the management or remediation of remaining sites

The closure of non-compliant landfills and dumpsites is essential for minimising the environmental impacts. The risks from the uncontrolled disposal of waste regard:

[49] FYR Macedonia. (2009). *Correction in the Rules on the amount of biodegradable waste allowed to be disposed into landfill (Official Gazette no. 108/2009)*

- air pollution by landfill biogas and odour releases into the air
- contamination of surface water and ground water bodies by landfill leachate
- health and safety risks to humans from pathogen dispersion

According to the EC and national legislation, all non – compliant landfills and dumpsites should be closed and rehabilitated. The selection of the appropriate solution will be site specific, according to the risk assessment of site. The focus will be on addressing those sites that pose the greatest risk to the environment and human health.

3.6.9 Cost recovery

Objective:

- o Enhance cost recovery, promote cost effectiveness and ensure economic sustainability and affordability. "*Assuring revenue flows to cover full cost for executed services provided by the gradually developing waste management system (NWMP 2009-2015)*"

According to the polluter-pays principle, the costs of waste management are borne by the original waste producer or by the current or previous waste holders (Article 14 of WFD)

The NWMP 2009-2015 stipulates that „*it will be necessary in the future to move the payment system progressively towards full cost recovery for the use of public waste management services and facilities so as to ensure their long-term financial viability and sustainability, and to provide an increasing incentive for waste producers to reduce and recover wastes.*
An Economic / Financial Measures policy will be phased in over appropriate transitional periods and takes into account the ability of waste producers to respond to higher costs for managing their wastes. Specific recommendations are made to suggest, with priority, the introduction
of the following instruments:
- improvement of the cost recovery for executed services by reorganisation of the payment and control system;
- establishment of the uniform charging system for the executed MSW services (landfill and collection/transport fees) on the base of the unified methodology for setting fees and tariffs standardisation of the accounting system."

It is essential to achieve cost recovery from the operation of waste management facilities. The application of the polluter pays principle is important so as to link the creation of waste with the environmental costs.

3.6.10 Training and public awareness

Objectives:

- o The objective is education, behavioural change and promotion of best practice. Reducing the amount of waste generated, both by householders or businesses, is the highest priority. This will require that the people change the way they behave in relation to the waste materials that they produce. This will be achieved through the development and delivery of a regional behavioural change plan.

According to the NWMP 2009-2015, „*raising public awareness, awareness of all stakeholders and the establishment of a communication system regarding municipal, other non-hazardous and*

hazardous waste management in the country shall be one of the unavoidable and important conditions in building up citizens understanding, acceptance and their involvement in a successful waste management system. Implementation of the NWMP needs public relation activities in three main fields:
- general informative communications to raise general awareness on waste issues
- communication to production sector
- public awareness on importance and consequences of implementation of waste management projects to achieve constructive public participation."

The primary function of all such campaigns will be in accordance with the waste managemnet hierarchy.

3.6.11 Overview of Regional Waste Management Objectives and Targets

The regional objectives and targets regarding waste management are the basis for the setting up of a regional integrated waste management system.

When establishing the targets, the following have been taken into consideration:

- each objective may have one or more targets;
- the targets at regional level must be at least equal to the targets set at national level;
- the National Waste Management Plan (2009-2015) and the National Waste Management Strategy (2008-2020) in force have been approved in 2009 and 2008 respectively.

Table 3-71: Proposed timeline for regional waste sector objectives and targets

Objectives and targets	Source	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	...2027
Improvement of collection and source separation efficiency													
- Mixed municipal waste - Collection efficiency: 90%	Modif/tion from NWMP			⇨	2017								
- Segregation of hazardous and non-hazardous waste fraction (manufacturing/ service sector) Segregation efficiency: 100%	Modif/tion from NWMP	⇨	2015										
Landfill of waste/diversion													
- landfill of MSW on temporary facilities (after conditioning) - 100% of the collected MSW	NWMP	N/A											
- landfill of MSW on facility compliant with EU standards - 50% of the collected MSW 100% of residual waste to be landfilled					⇨	2018							
- reduction of the greenhouse gas emissions (landfills only) - Reduction for approximately 25% of CO_2 equivalent	Modif/tion from NWMP												
- diversion of industrial hazardous waste streams from non-hazardous landfills – 100% effect	Modif/tion from NWMP	⇨	2015										

Objectives and targets	Source	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	...2027
- reduction of biodegradable waste disposed on landfills expressed as a percentage reduction of the BMW generated in 1995	Rules (OG No.108/2009												
2011-2017: 25%				⇨	2017								
2011-2020: 50%							⇨	2020					
2011-2027: 75%												⇨	2027
Closing, remediation and after-care of existing municipal landfills and unregulated dumpsites													
Remediation of high risk unregulated dumpsites.	N/A			⇨	2017								
Gradual remediation of remaining sites	N/A						⇨	2020					
Packaging and packaging waste													
Treatment / Recovery: 60% b.w.	LoPPW						⇨	2020					
Recycling: (minimum 55% - maximum 80%)	LoPPW						⇨	2020					
-22.5% plastic	LoPPW				⇨	2018							
- 60% glass, 60% paper and cardboard, 50% metals and 15% wood	LoPPW						⇨	2020					
Batteries/accumulators													
Collection of at least 25 % b.w.	LoBAWBA						⇨	2016					
Collection of at least 45 % b.w.	LoBAWBA										⇨	2020	
Waste electrical and electronic equipment													
Collection: >4kg/capita/year	LoEEEWEEE						⇨	2020					
Cat. 1 and 10: recovery 80% and prep. for reuse/recycling 75%	LoEEEWEEE												
Cat. 3 and 4: recovery 75% and prep. for reuse/recycling 65%	LoEEEWEEE												
Cat. 2,5,6,7,9: recovery 70% and prep. for reuse/recycling 50%	LoEEEWEEE												
Gas discharge lamps - at least 80% reuse and recycling	LoEEEWEEE												
Construction and demolition waste													
Collected: 30% Recovered/ recycled: 10% Disposal: 90%	NWMP						⇨	2020					
Used tyres													
Collection efficiency: 90% Energy recovery: 100%	NWMP		⇨	2016									
PCB/ PCT waste													
Inventory complete (2009) Destruction	NWMP				⇨	2018							
End of life vehicles													

Objectives and targets	Source	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	…2027
Collection: 90%	Modif/tion from NWMP		⇨	2016									
Recovery or reuse: 70%	NWMP				⇨	2018							
Stakeholders and public awareness and participation													
Carrying out public awareness campaigns	N/A												
Elaboration of communication programs to individual waste generators	N/A												

3.7 TECHNICAL OPTIONS FOR INTEGRATED WASTE MANAGEMENT

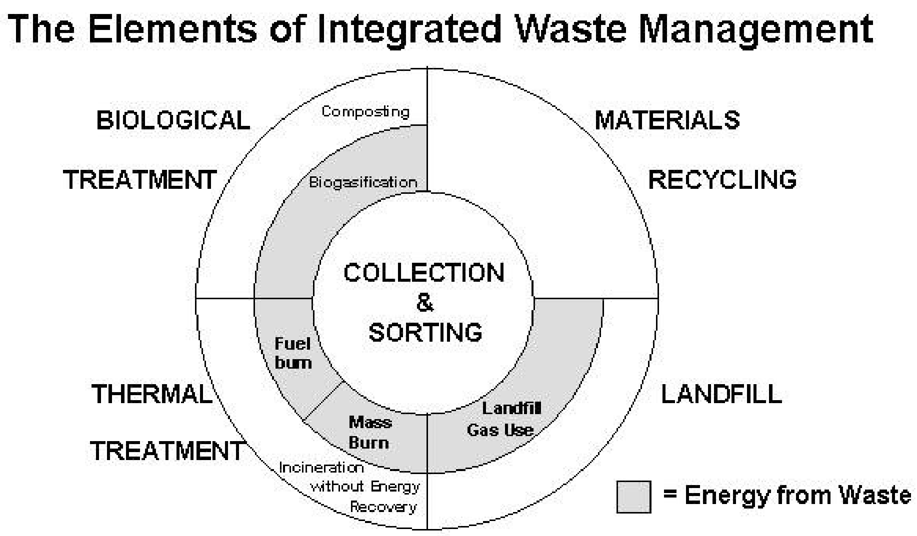
3.7.1 Introduction in Option Analysis

An integrated waste management system needs to be a sustainable system which is economically affordable, socially acceptable and environmentally effective.

- **Economic affordability** requires that the costs of waste management systems are acceptable to all sectors of the community served, including householders, commerce, industry, institutions, and government.
- **Social acceptability** requires that the waste management system meets the needs of the local community, and reflects the values and priorities of that society.
- **Environmental effectiveness** requires that the overall environmental burdens of managing waste are reduced, both in terms of consumption of resources (including energy) and the production of emissions to air, water and land.

Integrated Waste Management (IWM) takes an overall approach to this, involves the use of a range of different treatment options, and deals with the entire solid waste stream.
The following figure represents the concept of Integrated Waste Management (IWM). The IWM “doughnut” demonstrates that collection and sorting are at the centre of any successful waste management system. The four main waste management technologies surrounding the collection and sorting system are shown as equal sized quadrants to illustrate that they must be considered equally when developing a waste management strategy for any location. Flexibility in technology application for a specific location is also an essential component of the IWM concept. Data based decision support using Life Cycle Assessment tools facilitates the selection of the most appropriate waste management technologies (not necessarily all four) needed to deliver an environmentally optimized IWM system for a specific location. In combination with economic and social considerations, this approach helps for the design of a more sustainable solid waste management system.

Figure 3-39: The Elements of Integrated Waste Management



Along with the overall need for sustainable waste management, it is clear that no one single treatment method can manage all materials in Municipal Solid Waste (MSW) in an environmentally effective way. Following a suitable collection system, a range of treatment options will be required. These include materials recovery, biological treatment (composting/biogasification), thermal treatment (mass-burn incineration with energy recovery and/or burning of Refuse Derived Fuel - RDF) and land filling. Together these form an Integrated Waste Management (IWM) system.

Effective management schemes need the flexibility to design, adapt, and operate systems in ways which best meet current social, economic, and environmental conditions. These are likely to change over time and vary by location. The need for consistency in quality and quantity of recycled materials, compost or energy, the need to support a range of disposal options, and the benefit of economies of scale, all suggest that IWM systems should be organized on a large-scale, regional basis. Any scheme incorporating recycling, composting or energy from waste technologies must be market-orientated.

Whilst it uses a combination of options, the defining feature of an IWM system is that it takes an *overall* approach to manage all materials in the waste stream in an environmentally effective, economically affordable, and socially acceptable way.
An integrated waste management system consists of the following stages, which are deeper analyzed in the following chapters:

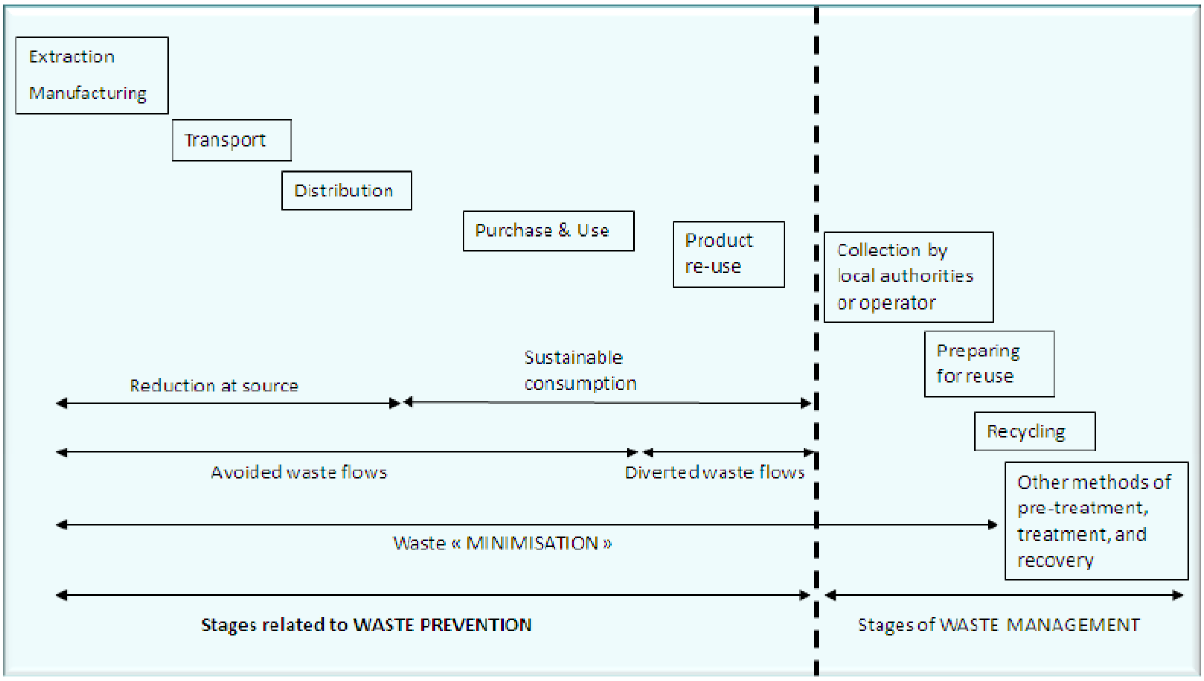
- Waste Prevention and Reuse
- Waste collection (mixed, source separated)
- Waste transportation and transfer (to transfer station, recovery and recycling facility, treatment plant or landfill)
- Waste mechanical separation (material recovery and recycling facility)
- Waste treatment (thermal, physical, chemical or biological treatment)
- Waste disposal to landfill

3.7.2 Waste prevention

Waste prevention and minimization lies at the top of the hierarchy as it preserves energy and natural resources and it is the key to sustainable development. Other than where life-cycle thinking suggests otherwise, prevention and preparing for re-use should be considered priority areas for waste management policy in future. This suggests that it is no longer sufficient for Member States to simply ‘encourage’ through voluntaristic measures and aspirations, pursuit of the hierarchy. Rather, the hierarchy needs to be given some force through policy and law. Indeed, the WFD sets out a requirement for Member States to develop Waste Prevention Programmes under Articles 29 to 31.

The hierarchy makes a clear distinction between ‘preparation for re-use’ and ‘re-use’ (see Art. 2 (4)). One of the previous debates within the context of waste prevention related to how one should consider measures which reduce the hazardousness of waste through increasing the quantity of waste (for example, using vitrification, or stabilisation in cement). The Commission's definition appears to address this by including the clause '*measures taken before a substance, material or product has become waste*' In other words, measures which reduce hazardousness after a waste has been generated would not be considered 'waste prevention'. The definition of waste prevention is illustrated in the following Figure:

Figure 3-40: Definition of waste prevention



The revised Waste Framework Directive requires the Member States to create national waste prevention programmes by 12 December 2013. The objective of these programmes is to present a coordinated national approach to waste prevention, delineating targets and policies, and aiming to decouple economic growth from the environmental impacts of waste generation. National waste prevention programmes should support Member States in decoupling economic growth from the environmental impacts of waste generation. The guidance document "Preparing a Waste Prevention Programme" - October 2012, has been published by EU, designed to support EU Member States and other interested parties to take advantage of the many opportunities in waste prevention and resource efficiency.

The waste prevention measures shall be clearly identified and appropriate qualitative or quantitative targets and indicators must be adopted in order to monitor and assess the progress of the measures. This task is by no means easy, as practical difficulties occur in how to measure 'something which is no longer there'.

Specific measures can be implemented on a national/ regional level. The measures can target different group of stakeholders or specific waste streams, as outlined in the next paragraphs:

A. Responsible consumer behaviour and informational programs

Waste production is typically associated to everyday consumption patterns and it is difficult to be regulated. In the past, efforts have been made by EC to stabilise waste generation per capita which were afterwards abandoned. In a flourishing consuming society, people tend to replace regularly electrical equipment long before they are out of use (cellular phones, TVs, video machines, etc) as the technology changes quickly, or simply because there is so great availability and older electrical items have no more place and become naturally “waste”. A considerable amount of food waste is rejected from households. On average, preventing 1 t of food waste avoids over 4 t CO_2 equivalent[50]. Potential for waste minimisation in mass terms is probably low, however savings in terms of material/energy/fuel in the overall cycle of a product are significant; for example electrical goods contain rare constituents and multiple amounts of mining waste are “hidden” during their production.

Excessive waste generation is a symptom of inefficient production processes, low durability of goods and unsustainable consumption patterns. Authorities can motivate public to change the consumption pattern of citizens, prolong the life of goods (keep products for longer) and encourage reuse of products. People should be made aware of the measures they can take in their daily lives to reduce, reuse and recycle. Environmental advantages (better use of materials and reduction of the need for landfills) of reused products and products containing reused components and recycled material need to be emphasized so that a cleaner environment can be left for future generations.

A novel campaign was launched in UK by the WRAP (Waste and Resources Action Programme) organisation with title “Love food hate waste”[51]. A unique study into waste composition preceded, providing evidence that around one third of all food bought is thrown away, while most of this could have been eaten. It regards astonishing quantities of spoiled food and most consumers are unaware of it. The objective was to provide tips, advice and recipes for leftover food to help everyone waste less. Necessity for food waste reduction was not just attributed to the environmental implications; focus was put to the “ethic” side of good food going to waste, as well as cost for the average family as high as £420 a year. The embedded energy used to produce, package, transport and deliver the food to our homes produces the equivalent of 15 million tonnes of carbon dioxide every year. The campaign resulted in a fall of more than one million tn of food waste in 2011 and has gathered attraction outside UK as well.

Increased awareness for sustainable living resulted in a slow uprise in interest in second-hand items. Potential exists especially for textiles and clothes, WEEE and furniture. Re-use is mostly promoted by charities or NGO organisations, such as Freecycle[52] or ReuseIt Network [53]. People can pass their unwanted goods, free, to others who can make use of them. What started as a fundamental idea to keep items away from landfills, has become an increasing popular environmental web community, with members in 85 countries. All kind of items change hands through the network, most of these being furniture, books, garden equipment, white goods, toys and TVs.

[50] http://www.defra.gov.uk/publications/2011/06/15/pb13529-waste-hierarchy-summary/
[51] http://www.lovefoodhatewaste.com
[52] www.freecycle.org
[53] www.reuseitnetwork.org

Relative actions are promoted by RReuse[54], that regards an European umbrella for social enterprises with activities in reuse, repair and recycling. RREUSE's members are national and regional social economy networks that combine both social and environmental objectives and give them equal emphasis.

B. Responsible business behaviour

In the business sector, product design and manufacture should be promoted that enables easier upgrades, repair and recycling at end of life. This will prevent waste and improve sustainability by reducing the need for primary production of resources. These efforts will be targeted at products with high carbon and environmental impacts, such as food, metals, plastics, textiles and wood.

Companies that are committed to their environmental profile strive to make packaging lighter, remove unnecessary packaging and making recycling easier for consumers. Large but also smaller retailers promote multi-use bags and non packaged loose vegetables and other goods. Savings from the Super market sector are appreciable.

One key tool to encourage waste prevention is eco-design, focusing on the conception and design phase of a product. Eco-friendly products are manufactured in a resource-efficient process, made using recycled raw materials and avoid the use of hazardous substances. They are designed to consume less energy during the usage phase and should be able to be recycled once they have been discarded. Waste prevention is closely linked to improving manufacturing methods and influencing consumers so that they demand greener goods. Eco-design has especially attracted interest in the automotive and EEE sector aiming to enhanced recyclability of the whole product or particular parts of it, as well as incorporating recycled material into new cars/appliances.

Additionally, innovation techniques are developed by both producers and the recycling sector to improve the separation process and yield secondary materials with greater efficiency, per polymer type for example.

C. Second-hand centers

As mentioned, a potential exists for re-use or exchange especially for materials such as textiles and clothes, WEEE and furniture. These activities take place in second-hand centers, either private or owned by charities. In local communities with low incomes, very little is wasted and a number of shops function that sell or give for free second hand items including old books and CDs. Such shops also serve as places that “exchange concerns and ideas” and may help to battle poverty and long term exclusion from work.

Larger charity shops redirect materials from landfills working with a network of channels worldwide. Collected textiles are hand sorted and graded by skilled workers who are able to recognise the variety of fibre types. Once graded the clothes are weighed and press packed into

[54] http://www.rreuse.org/t3/public-area/about-rreuse/our-network/

bales. Bales are then sent to various destinations including developing countries where it is reused as second hand clothing and wearable shoes. Only a part of it is recycled or rejected as waste[55].

D. Home Composting

Home composting is considered as a waste prevention action since it is applicable on a home basis, prior to waste collection. Home composting can be practiced in most backyards in a variety of manufactured composting bins, which differ in complexity and price. The user gradually adds organic matter to the vessel and over a period of time this naturally decomposes to form compost. The high temperature will kill most weed seeds and speed up the decomposition process so that the compost may be ready in about 3 months.

Shopping centers, schools, restaurants and other institutions can also easily compost in pilot size, more engineered units. Some preparation of material such as cutting and mixing is desirable; the end product normally satisfies the Animal By-products regulations.

Figure 3-41: Example of i) home composting bin and ii) pilot composting plant

Source: www. http://massenv.com/A900-rocket.php)

Bins are commercially available from a number of manufacturers in a variety of sizes from 75 to 400 lt, whereas residence time amounts to 12 weeks. Home composting requires households to separate and compost their own kitchen and green waste and handle compost produced in their own garden. As a strategic tool, home composting is addressed to people living in rural areas; it is not particularly feasible for those living in flats. Individuals participating are mostly “keen recyclers” as effort and commitment is required, and on a second level gardeners.

[55] E. Salamone, Material Gains, CIWM Journal, July 2012

3.7.3 Options for Waste Collection

3.7.3.1 Options for mixed waste collection

Waste collection is an integral part of waste management and precondition for environmental sound management of waste. If waste is not collected properly, and no 100% collection coverage is reached, such waste will most likely be disposed of without environmental controls, illegally buried, dumped, burned or stored. Deficits in collection of waste would result in uncontrolled abandoning of waste, unused resources and severe impacts on the environment.

Waste collection in East Region is currently less than 100%, as indicated in the previous chapter. The present and following chapters provide guidelines towards the future system for collection of municipal waste streams such as residual, recyclable and biodegradable waste.

The waste collection and transportation system generally consists of the following elements, which are closely interlinked and a final recommendation can be made only for complete collection and transportation systems:

- The pre-collection system, the container placement and the provided container volume; most important, the type of collection system, kerbside (door-to-door) and bring system
- The collection frequency
- The types of trucks used for the collection and transportation
- Collection shifts

The above elements are analysed and discussed in the following sections. In regard to the types of pre-collection systems, there exist:

1) Door to door collection of
   i) plastic bags, or
   ii) individual bins (120l or 240l)
2) Bring system (street collection point system) with
   a. wheeled standard Euro-containers 0.66 or 1.1 m³ containers or
   b. fixed containers of sizes 1.8, 2.4 m³ and 3.6 m³ (Italian-Spanish system),
   c. Large collection points equipped with skips
   d. Underground container system

Systems c and are d relatively expensive and are not considered further for the region.

In bring systems, local authorities or third parties provide containers ("banks") on certain street points and residents deposit household waste. The bring system is simple to use, faster and less expensive. The same trucks can be used to collect different waste streams on different days. This system would be more suitable in urban areas (blocks of flats) where space is scarce. In high density population areas the distance to the nearest container is 50-100 m.

Kerbside collection is common method for collection of waste from single houses in rural and semi-urban areas. Residents are provided with a bin, where waste is placed for subsequent collection on particular day(s). The kerbside system may be inappropriate in narrow streets and areas with traffic congestion problems. For this reason, this system may not be suitable for urban areas. The collection in kerbside systems is labour intensive and may require more collection time. Finally, kerbside collection is related with higher investment and operational cost (more bins per household). On the other hand, it leads to greater satisfaction and greater capture rate for recyclables.

Currently, the collection system in the various municipalities is mixed, based on individual bins and street collection points with wheeled 1.1 m^3 Euro-containers.

Regarding the collection frequency, there are several parameters to consider:

- In Southern European countries, the warmer climate and collection frequencies of more than once a week would cause big odour and hygienic problems. Thus usually in urban areas the collection frequency is more often than once per week. The collection frequency shall not be less than twice per month as a general rule.

- Furthermore the optimal collection frequency is also dependent on the population density. The more MW is produced in a certain area per person and day, the more economic it is to maintain high collection frequencies.

- Another possibility to obtain high MW quantities in a small area is to let the MW accumulate several days and only then to collect. However, if a container system is applied, this requires that more containers have to be placed in the area to receive the accumulated waste quantity. In this sense the frequency also becomes a cost optimisation and area requirement issue.

- No collection during Sunday or during weekend takes place. This means, that the placed container capacities are designed to cater for more than two or three days.

- For the purpose of the needs assessment, a frequency of collection of twice per week on average can be assumed. In any case the logistics and the collection frequency have to be optimized by a subsequent feasibility study or by the operator as soon as the system begins to operate.

Regarding compaction trucks, there has been a trend throughout Europe over the last 30 years that waste collection vehicles to become larger in size. That trend has been coupled with an increase in complexity and higher compaction ratios. However that increase in size has raised issues of manoeuvrability in congested streets, road safety issues, noise, and environment impact of such large trucks.

Over the last years collection trucks with greater compaction technologies, better chassis and with 6x2 or 6x4 wheelbase become largely used. Wherever the conditions allow, there is a general trend for implementing large capacity vehicles, being able to collect a payload of 8 - 10 t/trip. In the rural areas due to the longer distance between collection points it is not quite appropriate using bigger trucks as the time for collection and transportation to the new landfill is limited to 8 hours/shift.

Figure 3-42: Example of a collection truck with compaction

Given the higher payload of trucks, more time can be spent for collection and less time lost for travelling to the disposal site. This increases collection economy but only for bigger settlements where collection points are near to each other and a truck could be relatively quickly loaded. It is therefore expected, smaller trucks to operate in areas, where the large trucks cannot enter, or in family housing areas, where the pay-load capacity of the small truck is even difficult to be filled within a working shift.

The RCVs normally operate with a driver and one or two loaders. One-shift operation is proposed, whereas the implementation of two shifts can be implemented only when the existing trucks are not sufficient.

Taking into account that no big cities are present in the region, the low density of population and that majority of residents are living in individual houses, a cost-effective compromise is a 16 m3 truck with about 8t payload. Waste collection and transportation to the regional landfill or Transfer station is under the responsibility of the municipalities. It can be recommended a transfer of collection service responsibility to the Regional Association or a delegation of the service to a private operator; this would result in reduced costs due to economies of scale, as well as better coordination of collection and usage of bins/trucks. This can be advantageous especially in the smaller municipalities where the respective technical means are limited.

3.7.3.2 Options for dry recyclables collection

Source separation is a critical precondition for generating high-quality secondary raw material from waste and to facilitate re-use of material. The separation of specific fractions of municipal waste at the source provides for best results in recycling certain materials.

The Waste Framework Directive sets out the obligation to provide for separate collection at least of paper, glass, metal and plastic. The Packaging Directive requires specific provisions for the separate collection of packaging waste. There are different systems for separate collection applied throughout the EU. Same as in previous chapter, source separation can be done in various places at households via provision of special bags, containers etc. or at local collection points. The main infrastructural systems include kerbside collection (door-to-door) and bring systems (containers, recycling centres etc.).

Capture rates for the different materials depend on whether the systems provided are door to door services (high captures) or bring site (lower). The capture rate values shown in the following Table are typical for the two systems, but they may still be contingent on factors such as service quality, collection frequencies, residual waste charging policies etc.

Table 3-72: Dry Recycling Capture Rates for various materials

	Bring Collection	**Door-to-Door**
Paper & Cardboard	50%	85%
Glass	60%	85%
Metal	40%	65%
Plastic	25%	55%
Wood	15%	30%

Also, the reject rates in the MRFs are lower in door to door collection.

Figure 3-43: Examples of a) door to door collection, where car parking may cause obstruction to the vehicle route, b) collection point for multiple materials and c) multiple bin system

a)

b)

c)

For both systems, a further decision on the number of individual streams for collection must be taken and several approaches have been applied:

- Collection of paper, glass, plastic and metal fractions in separate bins or bags
- Commingled collection of recyclables in the same bin
- Commingled collection of recyclables in the same bin with separate collection of glass
- Commingled collection of recyclables in the same bin with separate collection of paper

Separate collection of paper has been justified by the need to reduce the potential to bind together with other materials, satisfy the high fibre quality requested by industry standards and finally to maximise profits. Glass has been also collected on itself, in order to avoid breaking and making reprocessing less complicated. A recent UK study (WYG Environment, Review of Kerbside Recycling Collection Schemes in the UK in 2010/11) indicated that collection of recyclables in a commingled fashion yielded the highest rates in kg/household/y compared with other multiple stream collection types in 30 municipalities. This result was justified by the greater simplicity and convenience offered to the citizens.

The key issue for the successful implementation of a separate collection scheme is double-fold: one, is the highest possible participation of citizens to increase the recycling quotas; two, it regards avoiding contamination by non-recyclable materials that reduce the output quality, lower its value and damage sorting machinery at MRF. Industrial reprocessors may even reject lower quality material altogether. Decision about the collected fractions depends also greatly on the MRF. For example, certain MRFs may not accept all kind of plastic waste but HDPE bottles only.

There are several reasons why a citizen throws mixed waste to recycling bins, i.e. ignorance, negligence, lack of information, laziness and occasionally deliberately misuse. An awareness campaign must take place prior to the implementation of the incurred changes in the system, highlighting the environmental benefits they will bring. As public in the East region is not familiar with recycling, it is important to make participation convenient by placing sufficient number of bins, making bins more attractive and selecting strategic positions. In this respect, a range of containers can been developed with “clever” messaging, incorporating adverse graphics, shapes and colours, thus motivating and encouraging public.

In regard to the transportation option, double compartment vehicles (at a ratio for example of 30:70) have been developed in the last years. The merit of these vehicles lies in the ability to collect both mixed and recyclable waste in different chambers and within the same route, thus allowing for greater flexibility. The lifting mechanism is capable to lift both 120 l as well as 1,1 m^3 bins. In order to optimize transport routes, MRF and landfill must be situated in the same area. One of the problems is that one of the compartments on the vehicle may fill before the other and the vehicle would have to return to be emptied before the end of its normal round; as a result collection efficiencies may be reduced.

The suitable collection system with the associated elements must be selected depending on the local conditions, preferences, municipality needs and cost affordability.

In regard to organisation of packaging waste collection and recycling, a number of competitive Recovery Organisations have been formed in EU countries that undertake the responsibility to achieve the targets on behalf of the producers. In certain cases, one single RO is formed as opposed to multiple, with the aim to avoid inefficiency and increase traceability and transparency. Separate collection may or may not be organised by the packaging recovery organisation(s). In the former case, ROs have formal approval to organise and operate a separate collection system in the specified districts, whereas municipalities are not involved in operational issues. In the latter case, separate collection is organised by the municipality. The financing of separate collection and sorting activities is guaranteed through contracts with Recovery Organisations.

3.7.3.3 Options for biowaste collection

The main fractions of BMW which can be separately collected are paper, food waste, garden waste, textiles and wood. All aforementioned systems can be used to separately collect biodegradable municipal waste, as well as the delivery directly to civic amenity sites. There have been reports of increased public cooperation, successful diversion of organics and cost-effectiveness in the long run. There is also evidence that citizens gain a visible insight of how much food they are producing and discarding and as a result they take measures to reduce it.

Home Composting Bins

Composting is the most practical and convenient way to handle organic wastes in rural areas. Composting, nature's own way of recycling, is the controlled decomposition of organic material such as leaves, twigs, grass clippings, and vegetable food waste. Compost is the soil amendment product that results from proper composting. It can be easier and cheaper than bagging these wastes or taking them to a transfer station or to the bins of centralized waste collection system. Compost also improves the soil and the plants growing in it. In rural areas usually there are gardens, lawns, trees, shrubs, or even planter boxes and the home made compost is very useful. Anything organic can be composted. All Green wastes – yard wastes, such as fallen leaves, grass clippings, weeds and the remains of garden plants, also food waste, make excellent compost. Woody yard wastes can be clipped and sawed down to a size useful for the wood stove or fireplace or they can be run through a shredder for mulching and path-making. Used as mulch or for paths, they will eventually decompose and become compost.

Whether the composting is done on site, at the point of waste generation or in a large-scale, centralized facility, it helps to keep the high volume of organic material out of landfills and turns it into a useful product. On-site or home composting reduces the cost of hauling materials and is generally exempted from solid waste regulations.

Composting can be practiced in most backyards in a homemade or manufactured composting bin or simply an open pile (some cities do require enclosed bins). Businesses, schools, and other facilities can also easily compost. Homemade bins can be constructed out of scrap wood, chicken wire, snow fencing or even old garbage cans (with holes punched in the sides and bottom). Manufactured bins include turning units, hoops, cones, and stacking bins. There are several types of composting bins, which differ in complexity and price.

- Portable Wood and Wire Composting Bin
- Single Compartment Wood Bin
- Urban All-Wood Bin

- Wire Mesh Composting Bin
- Lath Snow Fence Composting Bin
- Wood and Wire Three Compartment Bin
- Rotating Barrel Composting Bin
- Compost Screen
- Homemade Food Waste Composting Bin
- Worm Bins
- Worm Composting Bin
- Pallet Worm Bin

Composting can be done in a style requiring more effort, with quick results – or can be done more casually. Both ways will have a positive effect on the environment and produce usable compost. It just depends on how the time needed to be spent for compost production.

Figure 3-44: Simple Compost Bin

Figure 3-45: Rotating Composting Bin

Figure 3-46: Mega Composter Home Composting Bin

Figure 3-47: Kitchen Compost Bin with Filter Lid

Figure 3-48: Urban Compost Tumbler

Figure 3-49: Pyramid Composting Bin

The complicated compost piles that have the right blend of nitrogen (greens) and carbon (browns) and are kept moist and fluffed regularly, will heat up to temperatures of 48o C to 60 o C . The high temperature will kill most weed seeds and speed up the decomposition process so that the compost may be ready in 2 to 3 months or less.

"Casual" compost piles are also quite workable since compost will "happen" even if you just pile on yard and food waste, water sporadically, and wait. The pile won't get as hot, so it won't decompose as quickly and may not kill weed seeds. Casual composting can take several months.

An open pile is not preferred, because of the odours and development of microorganisms, so the best way doing home composting is using any kind of composting bin.

Separate Collection of Bio Waste at the Source

Three different collection receptacles are used for the collection of the biodegradable fraction of municipal waste from households; bio bins, paper bags and to a limited extent biodegradable bags. Bio bins are generally made from plastic and are usually stored along with the collection receptacle used for storing the mixed waste fraction. The size of these bins range in general from

40 to 120 litres. Paper bags are often used for the storage of biodegradable municipal waste because the paper bag does not have to be removed prior to composting, as it will degrade during the composting process. This is usually facilitated by passing the bags through a shredder prior to the composting process. The use of biodegradable bags for the collection of BMW is gaining popularity as, like with paper bags, they can be placed directly into the composting process. An additional advantage is that they are more durable than paper bags, which tend to disintegrate when they get wet. However, biodegradable bags tend to be more expensive than plastic or paper bags.

The frequency of collection varies between municipalities but is generally weekly or alternative weeks. During the summer, the food and garden waste fraction may need to be collected at greater frequencies in order to prevent nuisances and odours. A key advantage of collection direct from households is that high participation rates are generally achieved.

Separate Collection of Bio Waste in Organic Bin

This consists of large containers which are located in close proximity to households in strategically located positions such as beside supermarkets, where householders can bring their separated waste fractions for collection. There is usually a colour-coded container designated to each waste fraction. Food waste, garden waste and textiles can all be collected in this way. In relation to food waste, householders are usually provided with bags in which they place their food waste, which they then deliver to these collection points. The frequency at which these containers are emptied varies between municipalities and depends upon the fraction of waste that they contain, for example, greater frequencies for food waste. In some countries and regions, e.g. Catalonia, the food waste containers are emptied either on a daily basis or every second day. This frequency may be increased during the summer months to minimise potential nuisances. The receptacles are cleaned at least once in every two week period. This type of collection method is particularly suitable for areas with high residential densities with limited space available for larger containers.

Collection of Bio Waste at specific points

Some guidelines are further provided in the National Strategy for reducing biodegradable waste, such as positioning the organic-bin in the last, most distanced position, providing information for the inhabitants on the acceptable material and exercising a basic control system to identify impurities.

Separate collection of bio-waste should be encouraged by the Member States (Article 22 of Waste Directive). There have been initiatives by EC on a Directive regarding the management of biowaste, however these were abandoned later (to dissatisfaction of some MS) and officially it is unknown when they will be repeated. In the mean time, requirements for separate collection were proposed in the Second Draft of the Biowaste Directive (DG ENV, 2001), for:

- food waste from households
- food waste from restaurants, canteens, schools and public buildings
- biowaste from markets, commercial, industrial and institutional sources
- Green waste from private/public parks, gardens and cemeteries.

Separate collection schemes must at least cover urban agglomerations of:

- > 100,000 inhabitants within 3 years;
- > 2,000 inhabitants within 5 years.

The separate collection of biowaste can be waived in inner cities where low level contamination of biowaste is difficult to ensure and in rural areas with a population density of <10 inhabitants/km2. No specific date for mandatory separate collection was set in the Second Draft.

In a number of EU reports (for example "Preliminary Impact Assessment for an Initiative on the Biological Treatment of Biodegradable Waste, COWI A/S, 2004), a realistic target of 55% food and green waste separate collection is proposed. This 55% collection rate target was justified as a reasonable balance between the need to ensure a significant level of biological treatment while at the same time respecting the benefits of maintaining a certain level of flexibility for the countries in defining their unique path towards compliance with the landfill directive.

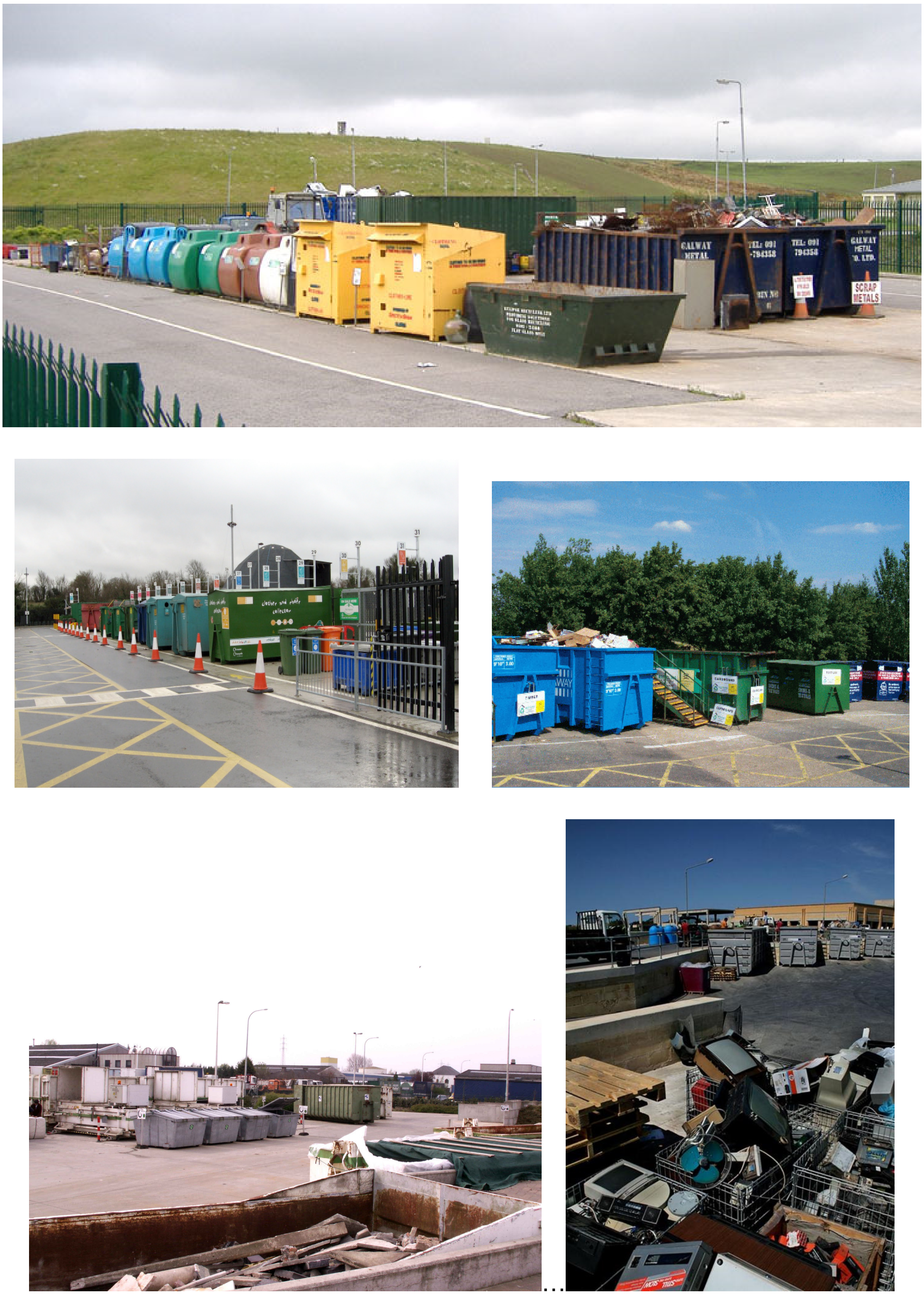
3.7.3.4 Civic amenity centres or Green Points

In order to achieve mandatory recycling targets and a raft of European Directives civic amenity centres up to community sector involvement are developed and implanted. Faced with mandatory recycling targets it has been recognized that the cheapest and easiest way to increase recycling is to improve facilities like Household Waste Recycling Centres, e.g. Civic Amenity Centres, which are also called "bring centres", "drop-off centres" or even "Green Points" Growing legal requirements to separate and treat biodegradables, recyclables and all specific types of hazardous and difficult wastes such as fridges, oil, tyres, batteries and waste electrical equipment present a great opportunity for local re-use schemes. The Civic Amenity Centres offer quality low-cost service for waste collection, while reducing final landfill disposal. CAC provide householders with an outlet for the disposal of a wide range of materials and in this way maximizing the recyclable rates.

The civic amenity centres (also recycling yards or green points) are designed to work as complementary facilities of other measures for collection and recycling. These centers will receive separated waste streams, which are suitable for recycling or for further suitable management. Apart from recyclables, a range of waste can be delivered such as batteries, electrical goods, bulky waste, C&D waste and biodegradable waste.

The main benefits from recycling yards is the diversion and recovery of special waste streams such as household hazardous waste, batteries, bulky items, etc., which otherwise would be disposed in ordinary landfill sites. At the same time, the recycling yards can contribute to the education of the citizens for managing the aforementioned streams.

Figure 3-50: Civic amenity centres offering an extended number of containers



In civic amenity sites, reuse centers can also be established. Citizens may bring items, especially WEEE but also furniture and textiles, normally because they are not functioning or torn, but also because they do not want it anymore or they have replaced it with a newer one. The condition of these items is afterwards checked, being fully reusable, needing slight or significant repair, or needing disposal. In the latter case, some spare parts may be in working condition. The citizens may collect the electrical appliance after repair. If it is unwanted or for furniture/ textiles, the reuse centers function as second-hand shops.

For the region, it is interesting to note that schemes which involve preparation for re-use can be sources of employment and can provide re-training opportunities for those who have been out of work for some time. It can also target youth unemployment that can give young people practical skills and hands on experience, to be utilised at a later stage.

At present, no recycling yard exists in the region. The location of CAC that will serve the 6 municipalities must be decided and a suitable public land must be selected, inside or not far from the city's borders.

3.7.4 Technical Options for Transportation and Transfer

3.7.4.1 Collection Vehicles

Numerous types of collection vehicles and optional features are available. Manufacturers are continually refining and redesigning collection equipment to meet changing needs and to apply advances in technology. Trends in the collection vehicle industry include increased use of computer-aided equipment and electronic controls. Now, some trucks even have onboard computers for monitoring truck performance and collection operations.

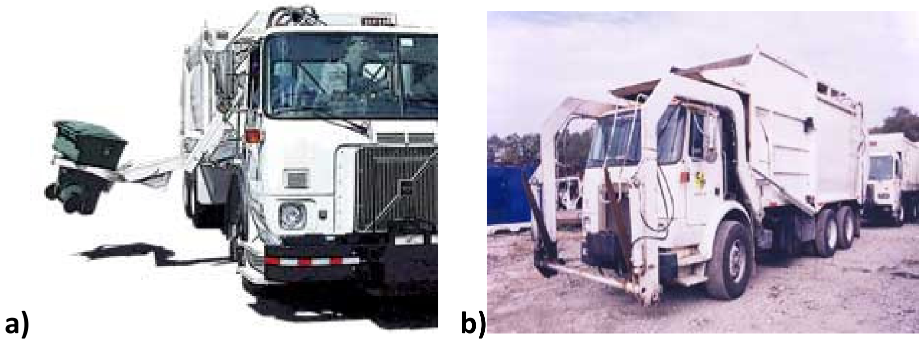
Truck chassis and bodies are usually purchased separately and can be combined in a variety of ways. When selecting truck chassis and bodies, municipalities must consider regulations regarding truck size and weight. An important objective in truck selection is to maximize the amount of wastes that can be collected while remaining within legal weights for the overall vehicle and as distributed over individual axles. Also, because they are familiar with equipment, collection crews and drivers should be consulted when selecting equipment that they will be using.

Compactor trucks are by far the most prevalent refuse collection vehicles in use. Widely used for residential collection service, they are equipped with hydraulically powered rams that compact wastes to increase payload and then push the wastes out of the truck at the disposal or transfer facility. These trucks vary in size from 7,5 to 35 cubic meters, depending on the service application. Depending on where containers are emptied into the truck, compactor trucks are commonly classified as:

- front-loading
- side-loading
- rear-loading

Figure 3-51: Rear-loading truck

Figure 3-52: (a) Side-loading truck and (b) Front-loading truck



Before compactor trucks were developed, open and closed noncompacting trucks were used to collect solid waste. Although these trucks are relatively inexpensive to purchase and maintain, they are inefficient for most collection application because they carry a relatively small amount of waste, and workers must lift waste containers high to dump the contents into the truck. Noncompacting trucks are still used for collecting bulky items like furniture and appliances or other materials that are collected separately, such as yard trimmings and recyclable materials.

Noncompacting trucks can also be appropriate for small communities or in rural areas. Recently, many new types of noncompacting trucks have been designed specifically for collecting recyclable materials.

Waste set-out requirements, waste quantities, and the physical characteristics of the collection routes are likely to be key considerations in the selection of collection vehicles. For example, suburban areas with wide streets and little on-street parking may be ideally suited to side-loading automatic collection systems. Conversely, urban areas with narrow alleys and tight corners may require rear loaders and shorter wheelbases.

For large apartment buildings and complexes, and for commercial and industrial applications, hauled-container systems are often used. The roll-off containers used with these systems have capacities of up to 40 cubic meters. They are placed on the waste generator's property, and when full, are transported directly to the transfer/disposal site. Special hoisting trucks and a cable winch or hydraulic arm are required to load the containers.

To determine specific equipment design information, hauling companies or departments should contact vendors and review existing equipment records. The following Text Boxes provide criteria that should be used to determine the most appropriate collection equipment.

Municipalities can use these criteria to outline the requirements that equipment must meet and select general equipment types that will be considered. In addition to the technical requirements listed in the above Text Boxes, the following cost data should be compared for each truck being considered:

- Initial capital cost
- annual maintenance and operation costs
- expected service life.

Life-cycle costs should be computed using this information to compare total ownership costs over the expected life of the required vehicles.

Table 3-73: Factors to consider in selecting/specifying solid waste collection equipment

<u>Loading Location</u> Compactor trucks are loaded in either the side, back, or front. Front-loading compactors are often used with self-loading mechanisms and dumpsters. Rear loaders are often used for both self and manual loading. Side loaders are more likely to be used for manual loading and are often considered more efficient than back-loaders when the driver does some or all of the loading.
<u>Loading Height</u> The lower the loading height, the more easily solid waste can be loaded into the truck. If the truck loading height is too high, the time required for loading and the potential of injuries to crew members will increase because of strain and fatigue. Design Considerations: • *Weight of full solid waste containers.* • *If higher loading height is being considered, consider an automatic loading mechanism.* **<u>Chassis Selection</u>** Chassis are similar for all collection bodies and materials collected. Design Considerations: • *Size of truck body. Important for chassis to be large enough to hold truck body filled with solid waste.* • *Road width and weight limitations (also need to consider waste and truck body*

weight). *• Air emissions control regulations.* *• Desired design features to address harsh treatment (e.g. driving slowly, frequent starting and stopping, heavy traffic and heavy loads) include the following: high torque engine, balanced weight distribution, good brakes, good visibility, heavy duty transmission, and power brakes and steering.*
Truck Body or Container Capacity Compactor capacities range from 7,5 to 35 cubic meters. Containers associated with hauled systems generally have a capacity range of 3,5 to 30 cubic meters. To select the optimum capacity for a particular community, the best tradeoff between labor and equipment costs should be determined. Larger capacity bodies may have higher capital, operating, and maintenance costs. Heavier trucks may increase wear and tear, and corresponding maintenance costs for residential streets and alleys. Design Considerations: *• The loading speed of the crew and collection method used.* *• Road width and weight limits (consider weight of both waste and vehicle).* *• Capacity should be related to the quantity of wastes collected on each route. Ideally, capacity should be an integral number of full loads.* *• Travel time to transfer station or disposal site, and the probable life of that facility.* *• Relative costs of labor and capital.*
Loading and Unloading Mechanisms Loading mechanisms should be considered for commercial and industrial applications, and for residences when municipalities wish to minimize labor costs over capital costs. A variety of unloading mechanisms are available. Design Considerations—Loading: *• Labor costs of collection crew.* *• Time required for loading.* *• Interference from overhead obstructions such as telephone and power lines.* *• Weight of waste containers.* *Design Considerations—Unloading:* *• Height of truck in unloading position. Especially important when trucks will be unloaded in a building.* *• Reliability and maintenance requirements of hydraulic unloading system device.*
Truck Turning Radius Radius should be as short as possible, especially when part of route includes cul-de-sacs or alleys. Short wheelbase chassis are available when tight turning areas will be encountered.
Water tightness Truck body must be watertight so that liquids from waste do not escape.
Safety and Comfort Vehicles should be designed to minimize the danger to solid waste collection crews. Design Considerations: *• Carefully designed safety devices associated with compactor should include quick-stop buttons. In addition, they should be easy to operate and convenient.* *• Truck should have platforms and good handholds so that crew members can ride safely on the vehicle.*

• *Cabs should have room for crew members and their belongings.* • *Racks for tools and other equipment should be supplied.* • *Safety equipment requirements should be met.* • *Trucks should include audible back-up warning device.* • *Larger trucks with impeded back view should have video camera and cab-mounted monitor screen.*
Speed Vehicles should perform well at a wide range of speeds. Design Considerations: • Distance to disposal site. • Population and traffic density of area. • Road conditions and speed limits of routes that will be used.
Adaptability to Other Uses Municipalities may wish to use solid waste collection equipment for other purposes such as snow removal.

3.7.4.2 Waste Transfer Stations

The primary reason for using a transfer station is to reduce the cost of transporting waste to disposal facilities. Consolidating smaller loads from collection vehicles into larger transfer vehicles reduces hauling costs by enabling collection crews to spend less time traveling to and from distant disposal sites and more time collecting waste. This also reduces fuel consumption and collection vehicle maintenance costs, plus produces less overall traffic, air emissions, and road wear. In addition, a transfer station also provides an opportunity to screen waste prior to disposal, flexibility in selecting waste disposal options, as well as an opportunity to serve as a convenience center for public use.

Waste transfer stations also offer more flexibility in terms of disposal options. Decision makers have the opportunity to select the most cost-effective and/or environmentally protective disposal sites, even if they are more distant. They can consider multiple disposal facilities, secure competitive disposal fees, and choose a desired method of treatment and disposal.

Finally, transfer stations often include convenience centers (Civic Amenity Centers) open to public use. These centers enable individual citizens to deliver waste directly to the transfer station facility for recycling and/or ultimate disposal. Some convenience centers offer programs to manage yard waste, bulky items, household hazardous waste, and recyclables. These multipurpose convenience centers are assets to the community because they assist in achieving recycling goals, increase the public’s knowledge of proper materials management, and divert materials that would otherwise burden existing disposal capacity.

Types of Transfer Stations
The type of station that will be feasible for a community depends on the following design variables:

- Required capacity and amount of waste storage desired
- Types of wastes received
- Processes required recovering material from wastes or preparing it (e.g. shred or bale) for shipment
- Types of collection vehicles using the facility
- Types of transfer vehicles that can be accommodated at the disposal facilities
- Site topography and access.

Following is a brief description of the types of stations typically used for three size ranges:

- Small capacity (less than 50 tons/day)
- Medium capacity (50 to 150 tons/day)
- Large capacity (more than 150 tons/day).

Small to Medium Transfer Stations

Typically, small to medium transfer stations are direct-discharge stations that provide no intermediate waste storage area. These stations usually have drop-off areas for use by the general public to accompany the principal operating areas dedicated to municipal and private refuse collection trucks. Depending on weather, site aesthetics, and environmental concerns, transfer operations of this size may be located either indoors or outdoors.

More complex small transfer stations are usually attended during hours of operation and may include some simple waste and materials processing facilities. For example, the station might include a recyclable materials separation and processing center. Usually, direct-discharge stations have two operating floors. On the lower level, a compactor or open-top container is located. Station users dump wastes into hoppers connected to these containers from the top level.

Smaller transfer stations used in rural areas often have a simple design and are often left unattended. These stations, used with the drop-off collection method, consist of a series of open-top containers that are filled by station users. These containers are then emptied into a larger vehicle at the station or hauled to the disposal site and emptied. The required overall station capacity (i.e., number and size of containers) depends on the size and population density of the area served and the frequency of collection. For ease of loading, a simple retaining wall will allow containers to be at a lower level so that the tops of the containers are at or slightly above ground level in the loading area.

Large Transfer Stations

Larger transfer stations are designed for heavy commercial use by private and municipal collection vehicles. In some cases, the public has access to part of the station. If the public will have access, the necessary facilities should be included in the design. The typical operational procedure for a larger station is as follows:

1. When collection vehicles arrive at the site, they are checked in for billing, weighed, and directed to the appropriate dumping area. The check-in and weighing procedures are often automated for regular users.

2. Collection vehicles travel to the dumping area and empty wastes into a waiting trailer, a pit, or onto a platform.

3. After unloading, the collection vehicle leaves the site. There is no need to weigh the departing vehicle if its tare (empty) weight is known.

4. Transfer vehicles are weighed either during or after loading. If weighed during loading, trailers can be more consistently loaded to just under maximum legal weights; this maximizes payloads and minimizes weight violations.

Several different designs for larger transfer operations are common, depending on the transfer distance and vehicle type. Most designs fall into one of the following three categories:

(1) direct - discharge non compaction stations,

(2) platform /pit noncompaction stations

(3) compaction stations.

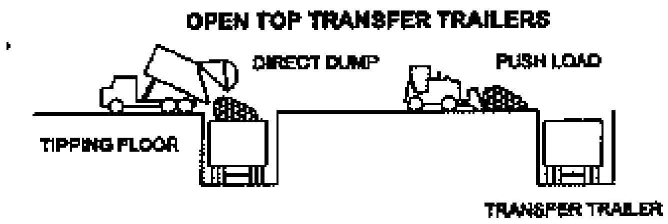
The following paragraphs provide information about each type, and the relevant boxes present the advantages and disadvantages of each.

Direct-Discharge Non-compaction Stations

Direct-discharge non-compaction stations are generally designed with two main operating floors. In the transfer operation, wastes are dumped directly from collection vehicles (on the top floor), through a hopper, and into open top trailers on the lower floor. The trailers are often positioned on scales so that dumping can be stopped when the maximum payload is reached. A stationary knuckle boom crane with a clamshell bucket is often used to distribute the waste in the trailer. After loading, a cover or tarpaulin is placed over the trailer top.

These stations are efficient because waste is handled only once. However, some provision for waste storage during peak time or system interruptions should be developed. For example, excess waste may be emptied and temporarily stored on part of the tipping floor. Facility permits often restrict how long wastes may be stored on the tipping floor (usually 24 hours or less).

Figure 3-53: Transfer Options in a transfer station

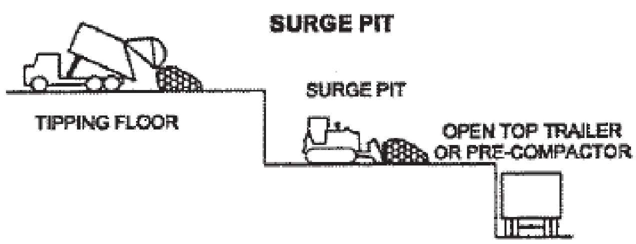


Platform / Pit Non compaction Stations

In platform or pit stations, collection vehicles dump their wastes onto a floor or area where wastes can be temporarily stored, and, if desired, picked through for recyclables or unacceptable materials. The waste is then pushed into open-top trailers, usually by front-end loaders. Like direct discharge stations, platform stations have two levels. If a pit is used, the station has three levels.

A major advantage of these stations is that they provide temporary storage, which allows peak inflow of wastes to be leveled out over a longer period. Although construction costs for this type of facility are usually higher because of the increased floor space, the ability to temporarily store wastes allows the purchase of fewer trucks and trailers, and can also enable facility operators to haul at night or other slow traffic periods. These stations are usually designed to have a storage capacity of one-half to two days' inflow.

Figure 3-54: Surge Pit in a transfer station

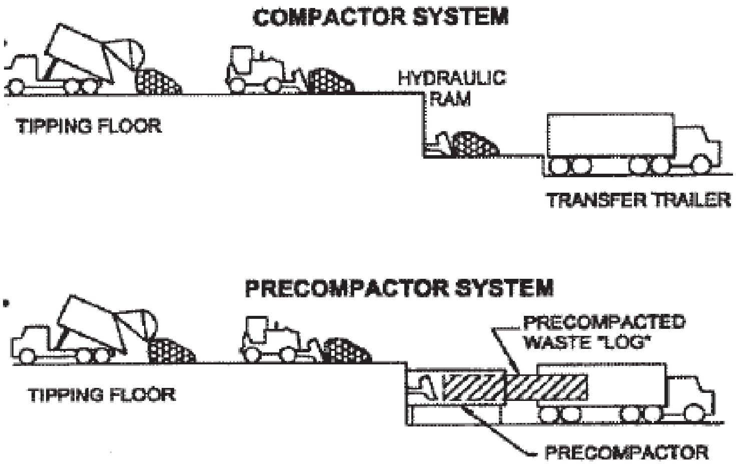


Compaction Stations

Compaction transfer stations use mechanical equipment to dense wastes before they are transferred. The most common type of compaction station uses a hydraulically powered compactor to compress wastes. Wastes are fed into the compactor through a chute, either directly from collection trucks or after intermediate use of a pit. The hydraulically powered ram of the compactor pushes waste into the transfer trailer, which is usually mechanically linked to the compactor.

Other types of equipment can be used to compact wastes. For example, wastes can be baled for shipment to a bale fill or other disposal facility. Baling is occasionally used for long-distance rail or truck hauling. Alternatively, some newer compactors produce an extruded, continuous "log" of wastes, which can be cut to any length. Bales or extruded wastes can be hauled with a flat-bed truck or a trailer of lighter construction because, unlike with a traditional compactor, the side walls of the trailer do not need to restrain the wastes as the hydraulic ram pushes them.

Figure 3-55: Compaction System in a transfer station



Compaction stations are used when (1) wastes must be baled for shipment (e.g., rail haul) or for delivery to a bale fill, (2) open-top trailers cannot be used because of size restrictions such as viaduct clearances, and (3) site topography or layout does not accommodate a multi-level building conducive to loading open-top trailers.

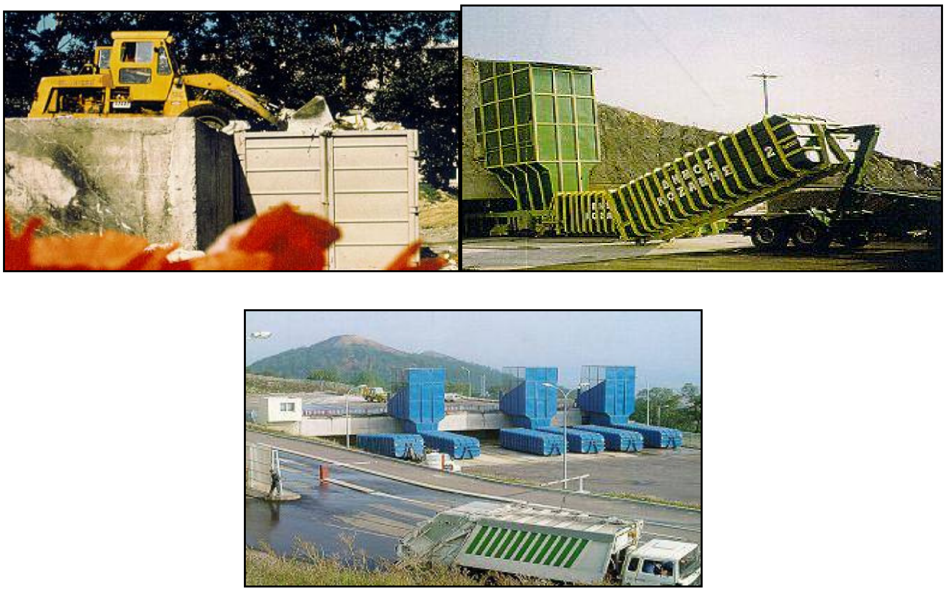
The main disadvantage to a compaction facility is that the facility's ability to process wastes is directly dependent on the operability of the compactor. Selection of a quality compactor, regular preventive maintenance of the equipment, and prompt availability of service personnel and parts are essential to reliable operation.

Table 3-74: Advantages and disadvantages of transfer stations types

<u>**Direct Dump Stations**</u> Waste is dumped directly from collection vehicles into waiting transfer trailers. Advantages: • *Because little hydraulic equipment is used, a shutdown is unlikely.* • *Minimizes handling of wastes.* • *Relatively inexpensive construction costs.* • *Drive-through arrangement of transfer vehicles can be easily provided.* • *Higher payloads than compactor trailers.* Disadvantages: • *Requires larger trailers than compaction station.* • *Dropping bulky items directly into trailers can damage trailers.* • *Minimizes opportunity to recover materials.* • *Number and availability of stalls may not be adequate to allow direct dumping during*

peak periods. • *Requires bi-level construction.*
<u>Pit or Platform Noncompaction Stations</u> Waste is dumped into a pit or onto a platform and then loaded into trailers using waste handling equipment. Advantages: • *Convenient and efficient waste storage area is provided.* • *Uncompacted waste can be crushed by bulldozer in pit or on platform.* • *Top-loading trailers are less expensive than compaction trailers.* • *Peak loads can be handled easily.* • *Drive-through arrangement of transfer vehicles can be easily provided.* • *Simplicity of operation and equipment minimizes potential for station shutdown.* • *Can allow recovery of materials.* Disadvantages: • *Higher capital cost, compared to other alternatives, for structure and equipment.* • *Increased floor area to maintain.* • *Requires larger trailers than compaction station.*
<u>Hopper Compaction Station</u> Waste is unloaded from the collection truck, through a hopper, and loaded into an enclosed trailer through a compactor. Advantages: • *Uses smaller trailers than non-compaction stations uncompacted.* • *Extrusion/"log" compactors can maximize payloads in lighter trailers.* • *Some compactors can be installed in a manner that eliminates the need for a separate, lower level for trailers.* Disadvantages: • *If compactor fails, there is no other way to load trailers.* • *Weight of ejection system and reinforced trailer reduces legal payload.* • *Capital costs are higher for compaction trailers.* • *Compactor capacity may not be adequate for peak inflow.* • *Cost to operate and maintain compactors may be high.*
<u>Push Pit Compaction Station</u> Waste is unloaded from the collection truck into a push pit, and then loaded into an enclosed trailer through a compactor. Advantages: • *Pit provides waste storage during peak periods.* • *Increased opportunity for recovery of materials.* • *All advantages of hopper compaction stations.* Disadvantages: • *Capital costs for pit equipment are significant.* • *All other disadvantages of hopper compaction stations.*

Figure 3-56: Waste disposal in container with no compaction, hopper compaction and automated transfer station



3.7.4.3 Transfer Vehicles

Introduction

Although most transfer systems use tractor trailers for hauling wastes, other types of vehicles are sometimes used. For example, in collection systems that use small satellite vehicles for residential waste collection, the transfer (or “mother”) vehicle could simply be a large compactor truck. At the other extreme, some communities transport large quantities of wastes using piggyback trailers, rail cars, or barges. The following discussion presents information on truck and rail transfer vehicles. Although smaller vehicles may also be used for transfer, their use is more typically limited to collection.

Trucks and Semi trailers

Trucks and semi trailers are often used to carry wastes from transfer stations to disposal sites. They are flexible and effective waste transport vehicles because they can be adapted to serve the needs of individual communities. Truck and trailer systems should be designed to meet the following requirements:

- Wastes should be transported at minimum cost.
- Wastes must be covered during transport.
- The vehicles should be designed to operate effectively and safely in the traffic conditions encountered on the hauling routes.
- Truck capacity should be designed so that road weight limits are not exceeded.

- Unloading methods should be simple and dependable, not subject to frequent breakdown.
- Truck design should prevent leakage of liquids during hauling.
- The materials used to make the trailers and the design of sidewalls, floor systems, and suspension systems should be able to withstand the abusive loads innate to the handling and hauling of municipal solid wastes.

  The number of required tractors and trailers depends on peak inflow, storage at the facility, trailer capacity, and number of hauling hours. Most direct-discharge stations have more trailers than tractors because empty trailers must be available to continue loading, but loaded trailers can, if necessary, be temporarily parked and hauled later.

It is important to select vehicles that are compatible with the transfer station. There are two types of trailers used to haul wastes:

- compaction trailers
- non-compaction trailers.

Non-compaction trailers are used with pit or direct dump station, and compaction trailers are used with compaction stations. Non-compaction trailers can usually haul higher payloads than compaction trailers because the former do not require an ejection blade for unloading. Transfer vehicles should be able to negotiate the rough and muddy conditions of landfill access roads and should not conflict with vertical clearance restrictions on the hauling route. The following Table discusses additional factors to consider when selecting a transfer trailer.

Figure 3-57: Roll-on vehicle transferring full container onto trainer

Table 3-75: Design Considerations for Transfer Truck and Trailer Systems

Trailer Type Trailers are classified as either compaction or non-compaction. Typically, compaction trailers are rear-loading, enclosed and equipped with a push-out blade for unloading. In non-compaction trailers, the entire top is usually open for loading. After loading, top doors or tarps cover waste. Design Considerations: • *Transfer station design usually determines whether to use a compaction or non-compaction trailer.* • *Compaction trailers must endure the pressure of the compaction process; therefore they are usually enclosed and reinforced. As a result, they are often heavier than non-compaction trailers.* • *Non-compaction trailers are larger and lighter than compaction trailers. They are usually made of steel or aluminum. These trailers usually have a walking floor or a conveyor floor, or they are tipped by a hydraulic platform at the disposal facility.*
Trailer Capacity Typically, capacities range 50 cubic meters for compaction trailers to 95 cubic meters for non-compaction trailers. Design Considerations: • *Waste densities are usually 0.24 to 0.36 tn/cubic meter for compacted wastes, and 0.17 to 0.24 tn/cubic meter for non-compacted wastes.* • *Trailers are typically sized to meet legal payload and dimension requirements. Specific requirements vary depending on local regulations.* • *Weight depends on degree of compaction and composition of the material.* • *Trailers are often sized to be higher than legal height requirements when empty, but lower when full.*
Unloading Mechanisms Some trailers are self-emptying, and others require additional equipment to help with the unloading process. The most common mechanisms are the following: Push-Out Blade • *Push-out blades are usually used in compaction trailers and sometimes used in noncompaction trailers.* • *In compaction trailers, the same blade that is used to compact wastes is used to eject them.* • *The blade is relatively simple to operate and can be powered by tractor hydraulic system or by a separate engine. However, items such as tree limbs can wedge under the blade, causing it to jam.* Moving Floor • *Moving floors are common in non-compaction trailers.* • *Floor usually has two or more movable sections that extend across the entire width of the trailer; therefore, even if one section breaks, another can empty wastes.* • *Floor can typically empty wastes in 6 to 10 minutes.* • *Rear of trailer may be larger to expedite unloading.* Hydraulic Lift • *A lift located at the disposal site tips the trailer to an angle that allows discharge of the wastes.* • *Time required for unloading operation is about 6 minutes.*

• *One disadvantage is a possible wait for use of lift. Breakdown of lift seriously impedes ability to receive wastes.*
Pull-Off System
• *A movable blade or cable slings are placed in front of the load. To empty load, auxiliary equipment (e.g., landfill dozer) pulls the waste out of the trailer.*
• *The system may require more time than self-unloading trailers because there may be a wait for auxiliary equipment.*

Rail Cars

As the distance between sanitary landfills and urban areas increases, the importance of railroads in transporting wastes to distant sites also grows. Rail transfer is an option that should be considered, especially when a rail service is available for both the transfer station and the disposal facility, and when fairly long hauling distances are required (80 km or more).

It is of high importance when evaluating a potential rail transfer system, decision makers should consider environmental impacts and potential opposition from towns between the transfer facility and the disposal facility. Rail cars should be covered and kept clean, and shipment should be scheduled to minimize en-route delays.

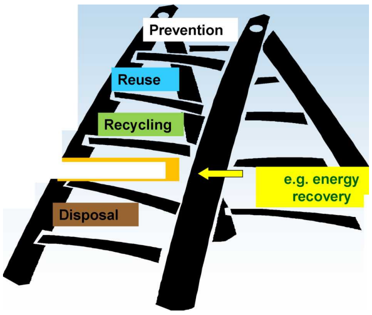
Figure 3-58: Roll-on vehicle transferring full container onto trainer

3.7.5 Options for Waste Treatment

It is estimated that from the total quantities of municipal waste generated in the Country each year a proportion of those is recycled through recovery organizations collection schemes. The remaining waste is disposed to landfills. One of the main reasons for reliance on landfill disposal has been the relative abundance of cheap landfill capacity, which has made alternative treatments uneconomic.

Changes such as the introduction of more stringent waste disposal regulations and publication of the waste strategy in recent years have improved the prospects of alternative waste treatments. These changes are supportive of the generally accepted European Community Strategy for dealing with waste where the waste minimization is the most preferred and landfill of untreated waste the least preferred option.

Figure 3-59: Most preferred options in solid waste management



Other changes, which are likely to support the introduction of alternative waste treatment options, are:

- the rising cost of landfill disposal,
- a generic move towards environmentally sustainable waste management options which also consider factors such as transport and public nuisance impacts;
- the Governments commitment to recycling domestic waste;
- the obligations imposed by Law on Waste Management.

The implementation of the Rulebook Law on Waste Management is going to have significant impacts on all waste management operations, but most significantly on wastes sent to landfill for disposal. The aim of the Law is to reduce the negative environmental impacts of wastes deposited in landfills particularly on surface and groundwater, soils and air as well as global effects such as greenhouse gas emissions.In particular, the Law is going to impact on previous practices on waste management due to the requirement for reductions in biodegradable municipal solid waste sent to landfills.

To meet the requirements of the Law, local authorities will need to implement major systems for reducing the biodegradable content of the wastes that they dispose of and it is expected that recycling, composting, and treatment of municipal waste will increase markedly. Thus, waste will require some form of treatment to reduce its negative environmental impacts.

There are many technologies that can be applied both to treat waste but local authorities and the waste management industry will need to know which technologies are available and how effective they are. Each technology will have to be assessed in terms of meeting Best Practicable Environmental Option (BPEO) requirements so that the most appropriate technology will be employed to reduce environmental impacts at an acceptable cost.

This chapter identifies all the technology options currently available in European Countries and provides a brief technical description of each. The technologies considered are physical, biological or thermal processes and for each technology, a number of issues are considered such as state of the technology and its current deployment, implementation of the technology and how use of the technology can contribute to targets and policy objectives.

The technologies under discussion are:

- Materials recovery facilities
- Aerobic Composting
- Anaerobic digestion
- Mechanical Biological Treatment (MBT)
- Incineration
- Pyrolysis and gasification

An Integrated Waste Management Plant usually employs a combination of these technologies in order to achieve a sustainable facility which is environmental and economical accepted on local level.

3.7.6 Materials Recovery Facilities and Recycling

3.7.6.1 Introduction

Material Recovery Facilities (MRFs) are places where wastes are deposited and then sorted and separated. The main purpose of a MRF is to sort and separate materials to produce products that meet defined specifications and so can be marketed. This is achieved, particularly in a clean MRF, by sorting the collected material into various products and removing contaminant materials.

MRFs can be classified either as clean MRFs, which treat source separated material and recover recyclables, or dirty MRFs which recover recyclable materials and/or a biodegradable fraction directly from unsorted dustbin waste. The size of a MRF is clearly related to the amount of material it is designed to process, and this can typically range from 10,000 tonnes per year to 50,000 tonnes per year or even higher.

3.7.6.2 Clean MRFs

Clean MRFs can handle material collected through civic amenity centers, as well as from kerbside collection schemes. As a clean MRF can only treat source separated material, it is important that it is able to process all the material that is collected. A clean MRF can be designed to either handle a single stream of materials, i.e. paper is mixed with other materials during collection, or can be designed to process paper separately from other materials.

The design of a clean MRF is usually based on one of two approaches:

- A low-technology MRF where virtually all sorting is done by hand (plants may have a magnet extraction unit to remove steel cans). This approach has a low capital cost, but high labour costs.

- A high-technology MRF, which makes as much use as possible of mechanical sorting equipment, e.g. equipment to separate glass bottles from plastic containers. This results in a higher capital cost, and although labour costs are lower, some hand-pickers are still required to meet quality requirements.

The potential advantage of the low technology approach is that it is much easier to respond to changes in market conditions. For example, hand pickers can be instructed to sort alternative materials, whereas equipment designed for one purpose cannot easily be modified (and will still incur costs even if there is no market for the material it is designed to separate). The method of collection of the recyclables will also affect the design of the MRF.

The number of products that a clean MRF can produce is based on the number of materials collected and the level of sorting undertaken at the MRF.

3.7.6.3 Dirty MRFs

A dirty MRF treats 100% of the collected waste stream and as with clean MRFs, the design of dirty MRFs can be either simple or complicated. The main advantage of a dirty MRF is that there are no additional collection costs, and the recovery/recycling rate is determined by the efforts of the sorters at the plant, rather than by the willingness of the public to participate in a source separation scheme.

However, the main disadvantage is that the recovered materials are not as clean as those recovered from source separated wastes because they have been in contact with other materials, particularly food scraps, in the dustbin. A number of dirty MRFs have been built in the USA, but this is because dustbin waste in the USA has a low proportion of food scraps due to the extensive use of kitchen waste disposal units. The higher organic content of dustbin waste in Europe means that it is unlikely that a dirty MRF will be a suitable approach for recovering clean recyclables in Europe.

Dirty MRFs can also be used in order to recover biodegradables and produce compost. However the compost is of low quality which limits the potential market for the product. An alternative form of dirty MRF which could be considered is a plant which produces refuse derived fuel (RDF), as this is able to recover metals and still produce a reject stream which could be composted. These kinds of plants are also called MBT (Mechanical –biological Treatment Plants) and are also discussed on the following paragraphs.

Figure 3-60: Typical layout of MRF plant

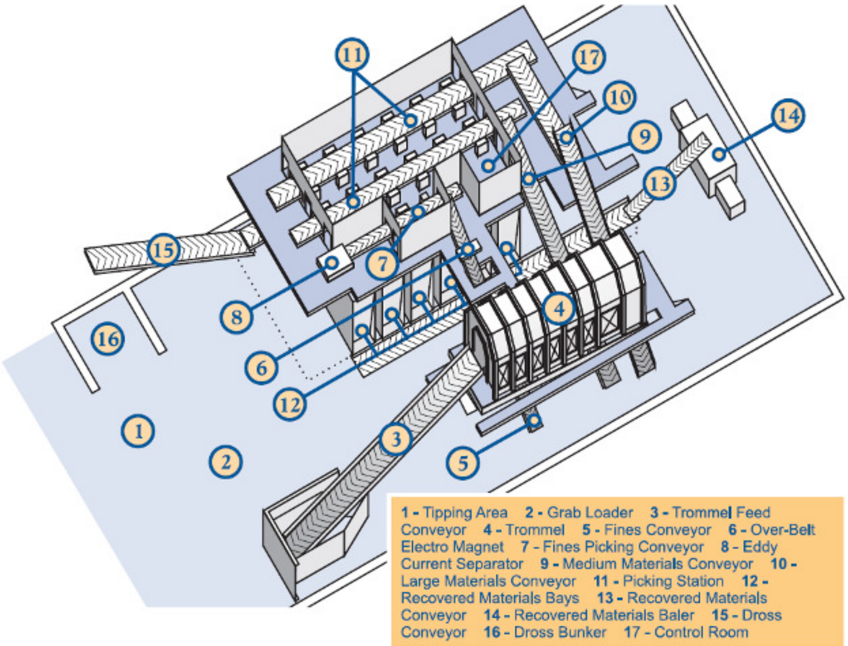
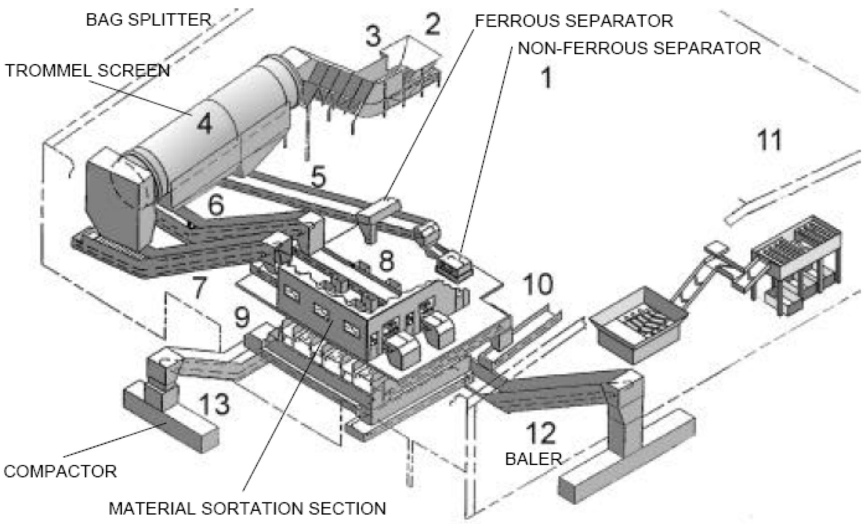


Figure 3-61: Typical layout of MRF plant



1. Tipping Area 2. Grad loading into hopper **3. Receiving hopper and feed conveyor** 4. Trommel **5. Fines conveyor with electro magnet and eddy current separator** 6/7. Feed conveyors **8. Picking station** 9. Multi directional cross conveyors **10. Fines waste conveyor** 11. Removal point for waste fines **12. Baler for recovered material** 13. Back up compactor **14. Existing high density waste baler**

Figure 3-62: Tipping area

Figure 3-63: Tipping area in Dirty MRF

Figure 3-64: Recycling vehicle emptying in Clean MRF

Figure 3-65: Feed conveyor

Figure 3-66: Trommel

Figure 3-67: Tripping area, feed conveyer, trammel, picking line

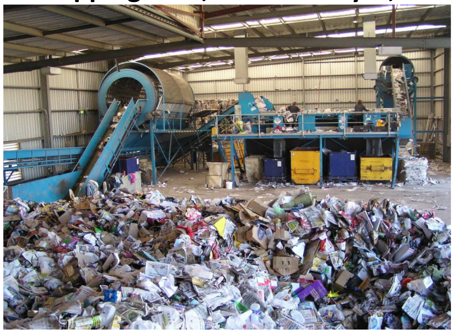


Figure 3-68: Picking Line

Figure 3-69: Picking Line

3.7.6.4 Technology Status

A. Development

The technology for separating materials by material type for clean MRFs is well developed. Recently optical systems (NIR detection) have been developed for sorting plastics by polymer type and this has increased the sorting capabilities in several. Consequently clean MRFs that have identified suitable markets for the materials they recover, have a high degree of commercial success.

Although technologies for dirty MRFs which recover recyclable materials have been developed, and a number of dirty MRFs appear to be operating satisfactorily but problems are still existing in identifying markets for the produced materials at least with commercial prices.

B. Deployment

Clean MRFs operate successfully in many countries. A number of dirty MRFs have been constructed in the USA and in Southern European Countries, as Spain, France, Italy, Greece, Cyprus, e.t.c. Dirty MRFs, which separate a fine fraction, which is then composted, are also operating satisfactory in a number of countries.

C. Costs

It is difficult to give a good estimate of either the capital or operating cost of a "typical" MRF, as every MRF is different in design and the way it operates. A MRF, particularly a clean MRF can range from a simple low-technology (hand-picking) system constructed in an existing building to a high technology (mainly mechanical sorting) system constructed in a new building which may well include other facilities, education centres, etc. The size of the MRF (in terms of the tonnes of waste processed per day) will influence the amount of sorting equipment required and hence the capital costs. Operating costs will be affected by the numbers of different waste materials to be processed. Investment in a MRF, even the largest is unlikely to exceed €5-6 million but it is quite possible to equip a low-technology MRF for €500,000.

D. Performance - Availability and Experience

Both clean and dirty MRFs have a high availability (estimated at 85%) but MRFs can and do suffer breakdowns, which reduce their availability. Spare parts are generally readily available for dirty MRFs and on-site maintenance staff are able to quickly complete repairs.

Where a MRF has automated sorting equipment (such as equipment to sort plastic by polymer type) repairs may well take longer because of the need for specialized repair staff from off-site.

Although the availability of specialized sorting equipment will be lower than that for the simpler equipment such as conveyors and screens, the design of the MRF must allow it to process the bulk of material if the specialized sorting equipment is not operational.

3.7.6.5 Implementation Issues

There are a number of implementation issues that should be considered prior to opting for a MRF. Some of these will depend on the waste management strategy adopted but others depend on the risks associated with financing and the operation of the MRF and the markets for the MRF products. The main risk issues for a MRF are the quality of the products, the stability of markets for the products it produces, and the prices that can be obtained for those products.

A. Financing

Financing the capital cost of a MRF is likely to be undertaken by a private sector company and the financial risks will be assessed within usual commercial constraints. The main advantage to a Local Authority of private sector financing is that they do not have to provide any funding for the MRF, or for any further development that might be required.

The sale of sufficient product and the revenue obtained from these sales clearly helps to reduce the net operating cost of the MRF. Consequently, the financial risk can be reduced if the MRF is able to produce good quality products and achieve a satisfactory income from them.

B. Quality of products

It is important that the MRF produces high quality material to maintain its markets for the recovered products. For a clean MRF, this will require good quality control during collection to minimise the amount of contaminants that need to be removed from the recovered products. There are also well established standards and specifications for recovered paper and metals, which help to ensure a consistent quality of product.

Materials recovered from a clean MRF will be of high quality and easy to sell provided there are sufficient markets for the recovered products. Markets are readily available for paper and metal recovered through clean MRFs although the revenues obtained may be low.

Materials recovered from a dirty MRF will be of lower quality and more variable because of the level of contaminants which can not easily be separated when the material is recovered.

C. Stability of markets for recyclate/products

The main materials which MRFs recover are paper, metals and plastics, although glass and textiles are recovered to a lesser extent There are numerous markets for metal and paper and so consequently the stability of these markets is generally very high. The stability of markets for plastics is low, whilst those for glass and textiles are highly variable.

Figure 3-70: Bales of paper and cardboard

Figure 3-71: Bales of recyclables

3.7.6.6 Planning issues

The main areas of concern in planning applications are visual intrusion and planning permission for the MRF and for the associated storage facilities. MRFs built in industrial areas should be similar in appearance to other buildings in the area to minimise problems of visual intrusion. However, a MRF built in a landfill site is also a good solution and can minimize the problems with gaining planning permission. It is difficult to make more precise comments because of different approaches to planning by different Local Authorities.

A. Land requirements

The amount of land required by the MRF would depend on the type of MFR, the size of the building, the wastes collected and the storage area required. For a typical plan of 30.000-40.000 tn/year a building of 2.000 – 3.000m^2 is generally required.

B. Employment opportunities

The main area for job creation is in the low technology MRF where hand sorting predominates. Table 4.1 shows the numbers of people employed at typical UK MRFs.

Table 3-76: Staff employed in MRFs

MRF	Capacity	Staff employed
Lowestoft	40,000 tonnes per year	5 staff in total (developing plant)
Adur	14,500 tonnes per year	10 workers and 2 management
Ipswich	30,000 tonnes per year	30 workers (operating in 2 shifts) + management and maintenance
Portsmouth	42,000 tonnes per year	64 people (reduced from 80 people)

C. Public participation

Clean MRFs require the public to participate by separating out materials that the clean MRF can process. Source separation schemes will only be successful if the public participates fully. The main factor affecting the amount of material recovered is the number of participating households. The results from a number of studies where participation rates have been measured (for voluntary schemes) show that;

- 20% are highly unlikely to participate
- 20% are highly likely to participate
- publicity material should target the remaining 60%, who are more likely to participate if they receive clear instructions (with regular reminders), and regular information on how well the scheme is performing.

A dirty MRF does not require public participation to be successful as whole bin wastes are treated. However, contamination of potentially recoverable materials reduces the quality of the recovered products and may lead to a lower level of income from sales of the products. Organic wastes contaminate recoverable products, particularly paper, and so initiatives to reduce the organic waste in dustbins could be beneficial to the operation and to the amount of material recovered by a dirty MRF.

D. Education needs

Educating the public to separate out the materials to be collected reduces the amount of sorting required at the kerbside. It also reduces the amount of reject material produced from the MRF when processing mixed recyclables.

The public has accepted recycling schemes for dry recyclables although there are still concerns about the locations of some MRFs. Good education has, for example, allowed the public to accept fortnightly collection of organic waste.

3.7.6.7 Environmental Impacts Issues

The principal emission to air from MRF operation will be through odour and dust.

A. Odours

Odours should not be an issue for a clean MRF that only accepts particular waste streams and especially if the amount of reject material is low. There may be more of an odour problem for a dirty MRF which accepts unsorted waste material, but this can be overcome by careful siting of the MRF and control measures to minimise odour impacts.

B. Dust

Dust can be controlled through ensuring effective ventilation of the MRF both to protect workers and the general public. One aspect of dust that is starting to be of concern is the generation of biologically active dusts, bioaerosols, which pose a potential hazard to workers, but may be dispersed to affect neighbours of the plant.

C. Water/leachates

Clean MRFs processing source-segregated, dry recyclable materials should not have problems with leachate run-off from the processing. Where dirty MRFs are processing mixed wastes containing a high level of organic contaminants, there may be potential problems from leachate generated by the decomposing organic wastes. This can be collected and treated prior to discharge from the MFR.

D. Solid residues/hazard

Upto 15% of input material going to a MRF may be rejected and require disposal at a landfill. Reject material consists of material which either can not be separated by, for example, a MRF or which is too contaminated to recover in a dirty MRF. Better education of the public could reduce the amount of material rejected by the MRF.

Handling of rejects and solid residues requires health and safety issues to be considered. If unwanted materials such as glass are found in the waste streams coming into a clean MRF that is not designed to separate glass, then there may be problems handling the glass. The hazards associated with handling and disposing of items such as needles must be considered for dirty MRFs.

E. Noise

Noise complaints from the public are not likely to be a problem if the MRF is situated at a landfill, or in an industrial area where other activities in the area also create noise, provided the MRF is operating within acceptable noise levels. There may be problems with complaints about traffic noise, even if the MRF is in an industrial area. Traffic movements to and from the MRF are likely to be higher than for a typical factory due to the number of vehicles arriving with waste for sorting.

3.7.7 Options forTreatment of Biodegradables – Aerobic Composting Technology

3.7.7.1 Introduction

Biological treatment of the organic fraction of municipal wastes can be performed by composting. Composting is the **aerobic** decomposition of biodegradable material to produce a residue termed compost with the emission of predominantly water and carbon dioxide.

In technical terms, modern composting is a thermophilic, bio-oxidative degradation process. This means that the process operates at temperatures in the thermophilic range (45-60°C) and is a biological process that oxidises the organic matter to break it down to a more simple form.

The organisms that carry out composting are ubiquitous in the environment and seldom require introduction to the process. In practical terms, the composting operations must ensure that the microorganisms are kept supplied with moisture, oxygen, food and nutrients and that the conditions such as temperature remain in the optimum range. A large number of procedures and engineered solutions have been developed to achieve these objectives for the treatment of organic wastes.

The use of composting in waste management is carried out either by the householder on their premises as home composting or in a centralised system, where collected materials are processed at a purpose built facility.

3.7.7.2 Home composting

Home composting requires householders to separate and compost their own kitchen and garden wastes and to process these in their gardens to produce compost that they can use on their own garden or allotment. This can be achieved using traditional compost heaps or increasingly popular, home composting units.

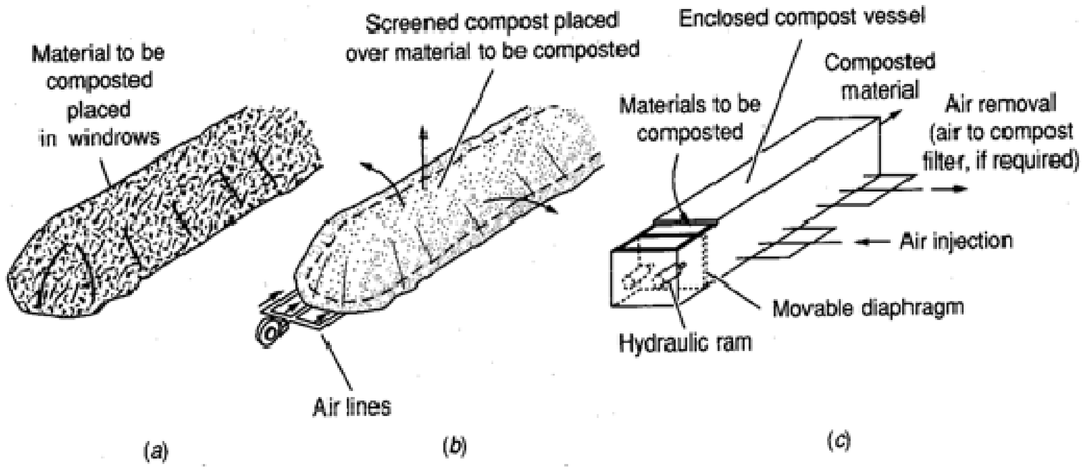
The individuals who are willing to carry out this activity are often those who are keen gardeners and have a requirement for the compost. Local authorities may be able to encourage more households to compost their kitchen and garden wastes through education and subsidising the distribution of compost bins. However, diversion of wastes that would have otherwise been sent for landfill disposal will be limited due to the level of effort and commitment required by the householder and the fact that only a small proportion of households will actively participate. In addition, home composting will not be feasible for the people living in flats or householders with very small gardens.

More details for application of home composting are available in paragraph 3.7.3.3.

3.7.7.3 Centralized composting plants

Centralized composting can be performed in a un-contained/open system or contained within a vessel or building. A brief description of each type is following.

Figure 3-72: Simplified illustration of the 3 basic composting systems: (a) agitated windrows, (b) aerated static piles, (c) closed systems



A.Open (non-reactor) composting systems

Open composting has been practiced for many years and relies on placing the organic waste in piles exposed to the air. The waste is commonly formed into elongated triangular piles that are called windrows, which allow optimum exposure to the atmosphere whilst minimizing the land area taken up. Once the waste is prepared for composting the principal control mechanism for the process is the air requirement of the microorganisms and the dissipation of the heat generated. Introduction of air into the waste can be achieved either though active pumping of air into the waste or through the mechanical lifting and mixing of the waste to introduce air into the pile. These two approaches are called static aerated pile and turned windrow.

B.Turned windrow composting

The turning of the compost in a turned windrow system is achieved either by a specialized turning machine or by use of general-purpose front-end loaders or 360° excavators. These machines lift and mix the composting waste and introduce air into the pile and release the heat and moisture as water vapor. The turning operation is often characterized by a large cloud of "steam".

The turning operation has to be performed many times during composting and the timing will be determined by the progress of the composting process. In the early stages when composting is very active turning several times per week may be required but at the end of the process during the stabilisation phase turning may only be required every few weeks.

There are many varieties of specialised turning machines which either aerate the pile whilst leaving the pile in the same location or pick up the pile and move it a short distance to one side and thus progress the pile on successive turnings. The choice of machine type is dependent on the design of the site and material flow requirements.

The operation of turned windrow systems can be improved by protecting the composting waste from the rain. Rain will cause the generation of leachate that may pollute surface or ground water if released and introduces variability into the process that affects the final product quality. Protection can be provided through either semi-permeable textile layers placed over the windrows or through the construction of a roofed area where composting is undertaken. The textile approach has a low capital cost but does introduce an additional operational workload and hence increases operational costs whilst the roof option has a higher capital cost. The provision of cover also reduces wind blown litter and provides a degree of odour control.

Figure 3-73: Turned windrows compacting system (Open Area)

Figure 3-74: Turned windrow compost (Indoors)

C. Aerated static pile composting

Static aerated pile systems, as their name suggests, are not turned during processing and the air is forced through the composting material by means of a fan and perforated pipes or floors. The windrows are formed over the aeration system and then remain there for the composting period of between 12 and 20 weeks, depending of the feedstock, until the active phase of composting is complete. The air is typically blown upwards through the composting mass and the expelled air, moisture, carbon dioxide and heat is allowed to disperse to atmosphere. Alternatively, the air can be sucked downwards so that the air from the composting material is taken through the fan. The advantage of this downwards flow is that any malodorous air can be treated, but there can be problems with compaction of the pile leading to poor air flow and potential for the material to go anaerobic.

Figure 3-75: Aerated covered heaps (indoors)

Figure 3-76: Aerated covered heaps (open air area)

D. Reactor composting systems

Reactor or enclosed composting is a relatively new composting development that provides a faster active biodegradation process, reducing the area required. The use of a vessel allows much greater control over the process and this helps both with the speed of the process but also the consistency (hence quality) of the compost product.

The reactors come in a variety of forms and have varying degrees of automation. However, the basis of reactor composting is that materials are enclosed in a drum, silo, or similar structure and air is injected into the composting material to maintain the optimum conditions for composting. The simplest systems currently used are the batch tunnel systems. These are essentially large insulated boxes that are filled with a mechanical shovel. Once sealed a computer using temperature, oxygen levels and moisture as control inputs controls the airflow. At the end of the cycle, the material is dug out with a front-end loader or a crane. Often the material will require several cycles in the tunnel as the loading and unloading provide a turning function with in the process. The more complex systems provide a complete process, which will manage the aeration and flow of material through the process automatically and thus require a minimum of intervention from the operators. These self-contained systems are obviously more expensive than the batch tunnels. Any air emissions from the reactors are passed through biofilters to prevent odour problems.

The overall scale and complexity of the systems are reflected in the plant scale and appearance and thus very simple systems such as the batch tunnels are not major facilities whilst the more complex systems generally include buildings that enclose the machinery and thus become more imposing facilities.

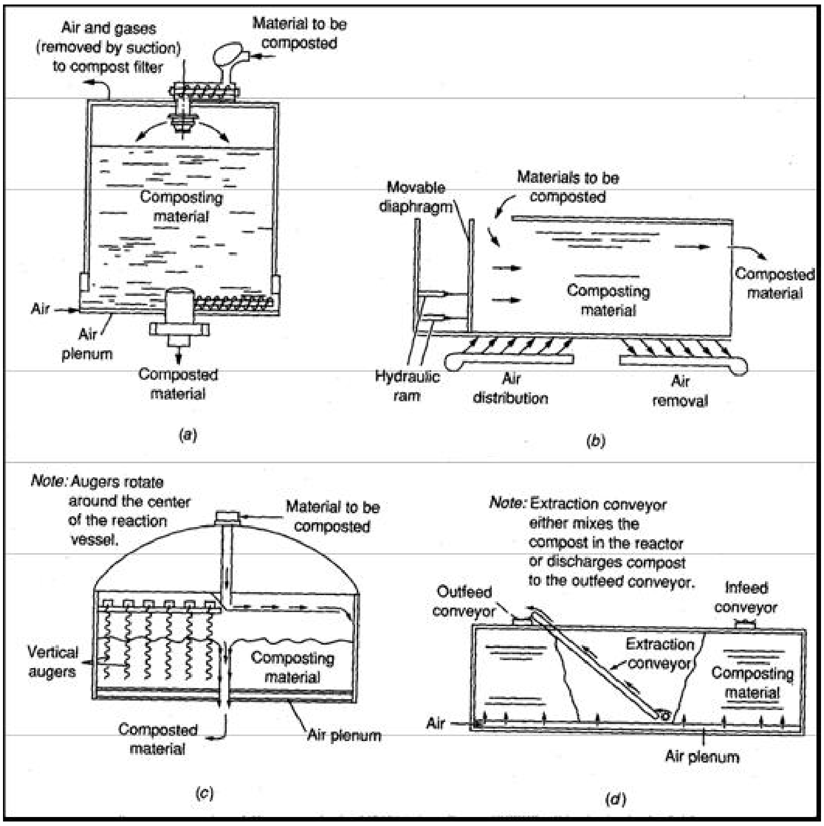
Figure 3-77: a)Composting in boxes, b)Composting bays

a)  b) 

Figure 3-78: a)Composting Beds, b)Rotating drum system

a)  b) 

Figure 3-79: Basic closed composting systems (A&C: vertical reactors, B&D: horizontal reactors)



3.7.7.4 *Wastes treated by composting*

Only the organic biodegradable fraction of municipal waste can be treated by composting. This is primarily kitchen and garden wastes, but paper and fines fractions can be treated to an extent, although the degree of degradation achieved is very dependant on the system used.

Essentially there are two forms of feedstock for composting, source separated and un-segregated wastes. Source separation systems rely on the waste being collected separately from the other household waste and can be achieved through civic amenity sites or through kerbside collections in a separate container. Un-segregated waste for composting can range from the whole waste stream without any removal of recyclables to the composting of processed materials that have had the majority of the contamination removed by mechanical means. The benefits of these two approaches are complex and can be summarised as follows:

- The quality of the end product is significantly higher when source separated material is composted and this leads to reduced problems in marketing the compost. Contamination is not totally eliminated by this route and some clean up of the material may be required in the process. The use of un-segregated waste leads to a lower quality product with higher amounts of contamination by heavy metals, glass and plastics. Sorting can reduce this to acceptable levels for some applications such as landfill restoration or motorway sound barriers. However, these are limited markets and material may still need to be landfilled.

- The quantity of material that can be collected through source separation schemes is limited due to the number of householders who will not or cannot participate and the collection of only a restricted range of the compostible wastes. Thus, in un-segregated systems, the whole waste stream is targeted which can ensure 100% participation from the public.

There are differences between source separation methodologies that have implications for the composting process. Source separation in the UK is carried out either at civic amenity sites where the green waste is mainly larger prunings, leaves and garden waste, or by kerbside collection schemes, which consist of smaller, fleshier materials rather than the larger woody materials, and kitchen wastes. This results in the kerbside collected materials being generally higher in moisture, nutrients and rapidly degradable materials but low in the woody components. This leads to a greater propensity for rapid degradation and hence odour generation and the lower woody component gives rise to a less open structure unless mixed with woods chips or green waste. The greater amounts of plant matter will give rise to a higher nutrient content and this will have value in some applications.

Feedstock requirements for composting plants are principally governed by the product quality requirements. However, the performance of the composting process and the quality of the resultant compost are also dependant on factors such as carbon to nitrogen ratio, nutrient availability, moisture content, porosity, degradability etc. To achieve the required performance and compost properties may need the mixing in of materials other than household waste such as sewage sludge, commercial waste or woodchips. This is normally the case with source separated materials rather than un-segregated composting due to the more stringent requirements of the compost product.

3.7.7.5 Products and residues

Source separated feedstock

The main product from the composting of waste is compost. This stabilized organic material consists of the refractory and slowly degradable cellulosic materials. The main use of this compost is as a soil improver. The quality of the compost is largely determined by the feedstock provided to the process. Relatively uncontaminated feedstocks will give rise to uncontaminated products and these are generally composted from source separated materials.

The residues from the composting process are those materials that do not readily degrade, such as wood and these can either be returned to the front of the process to be shredded or they can be disposed of. This material can represent up to 25% of green waste feedstock. Contaminants from source separated systems will be relatively low, for example in green waste it will be less than 2% of the feedstock. For kerbside collection schemes contamination can be higher and ranges from 1% to over 10% dependent on a wide range of factors associated with the operation of the collection scheme. The composition of these contaminants will vary with the scheme and will contain almost anything that could be in the mixed waste stream, but will have high concentrations of plastics from plastic sacks used to store/transport the waste and from plastic flowerpots and other plastic garden products.

Mixed waste processing

The primary product from mixed waste processing is the stabilisation of the waste. The composting process will remove the readily biodegradable carbon and the resulting residues will degrade slowly in the environment.

In some circumstances the composted waste can be further sorted to generate a low quality soil improver. The eventual use of this material will be limited to landfill cover or other land restoration projects.

Mixed waste processing will generate a large amount of residues such as the non-organic materials rejected by the sorting process and will mainly consist of metals, glass and plastics. There will be some potential to recycle small proportion of this material, but this will be limited to the ferrous and non-ferrous metals. Materials going into the composting process will consist of paper, kitchen and garden wastes and fines. Sorting after the composting process will remove the materials that have not been decomposed sufficiently and these rejects will contain larger proportions of paper and woody materials but also additional glass and plastics. It would be expected that all of these rejects would be either landfilled or incinerated.

3.7.7.6 Composting plant size

Composting is not a particularly staff intensive operation as the bulk processes occur when the waste is in piles or in the vessel. Estimates of staffing levels vary between different employers, but plants less than 25,000 tonnes per year capacity tend to employ between 2-4 staff, giving staffing rates of between 10 and 1 staff per 10,000 tonne per year capacity. As plants get larger than this the staffing levels can be estimated from a level of 1 staff member per 10,000 tonne per year capacity. There appears to be little evidence from the published data to suggest any differential between the various types of composting plant.

3.7.7.7 Technology Status

Three waste composting options are considered as generic examples of composting technology.

3.7.7.8 Whole waste composting (MBT plant)

The composting of whole waste is carried out to stabilise the solid waste and divert biodegradable material away from landfill as low-grade compost. This technology is also referred to as Mechanical-Biological (pre) Treatment (MBT).

The system operates by sorting the waste prior to composting to remove the non-compostable components. The degradation is assisted by the addition of water. After homogenization, the material is screened to remove the materials that have not broken down. These are principally textiles, plastics and metals, although there are some organic materials mixed with these rejects but the proportion is small and this material is landfilled.

The screened material is then placed in windrows. The windrows are positioned under a covered area to reduce the effects of rainfall on the composting process. The windrows are turned on a programme that initially turns the piles twice a week for the first few weeks and reduces to weekly turning after the initial high-activity phase. The process takes approximately 16 weeks to complete, whereupon the composted waste is screened again to remove more contaminants and may undergo air classification or air tabling to remove glass and plastics depending on the end use of the compost. The reject fractions from these sorting phases will be landfilled.

The compost will then be used in an extensive application such as land restoration or potentially agriculture if the compost quality is sufficient.

Figure 3-80: MBT plant interior

Development

As a technology, this is a system from the past, which is now finding a new niche in the waste management market. Mixed waste composting has a lot of applications in Europe (especially in Mediterranean countries) either producing composts for particular agricultural markets such as vine growing or as a pre-treatment option to landfill, so called mechanical biological pre treatment. The following Table shows the mixed waste composting plants in Europe.

Developing countries have continued to install mixed waste composting plants, which have been more successful due to the different nature of the waste. New plants in Western Europe have been largely aimed at pre-treatment of wastes rather than for compost production.

Cost and Performance

The cost of operation and construction of these plants is highly variable depending on the level of complexity of the sorting plant and the desired quality of the compost product. In addition, the cost information tends to be commercially sensitive and thus difficult to gain accurate estimates of the capital and operating costs of plants.

An EU report suggested that the capital cost for mixed waste composting plants ranging from €180 per tonne of capacity for smaller plants (circa 6,000 tonnes per year) down to €100 per tonne of capacity for plants up to 20,000 tonnes per year. The study suggested that for lower grade composts operational costs of €30,0 to €50 per tonne were typical but could rise as high as €80 per tonne for more refined compost products.

The performance of a mixed waste composting plant can be considered in two ways; the diversion of material away from landfill or the production rate of useable compost. In terms of the use of the process as a pre-treatment of waste before landfill the amount of material that is not landfilled is the most important. Whilst, using the process for optimising recycling, production of a useable product (compost and metals) is the main factor.

According to various reports it is suggested that approximately 50-55% of the waste can be diverted from being deposited in landfill, although approximately half of this diversion may be due to materials used in the restoration or management of the site.

3.7.7.9 Green waste composting turned windrow

Green waste is generally classified as garden waste generated by households and deposited at civic amenity sites. It contains principally pruning, tree branches and grass cuttings but will contain a range of contaminants from the garden, the amount of these depending on the level of control applied to the collection skips.

The composting of this material is a simple process. The first stage is visual inspection to remove larger contaminants such as plastic bags, metal items and unprocessable large items such as tree stumps. Then the waste is shredded. The shredders are of several basic types; screw shredders that use slowly rotating augers to cut the waste, shear shredders that use slowly rotating knives working in a scissors action, tub grinders that are fed from the top and use rapidly rotating hammers and the horizontal shredders that are fed from the side and use a rapidly rotating toothed drum. The benefits and weaknesses of the various shredder types are well covered by the manufacturers. The main point is that the shredding process increases the surface area of the waste to allow microbial attack and hence degradation.

The shredded green waste is then placed in windrows, which are normally between 2 and 4 m in height and 4 to 6m width at the base. The length of the windrows is dependent on the site topography and the quantity of waste to be processed. The temperature in the pile rises rapidly and the piles are turned several times during the process. Turning of the windrows is performed by either normal waste handling equipment such as front end loaders, 360° excavators etc., or specialist turning machines. The choice of the type of turning machine is an economic one and is largely controlled by the scale of operation, larger facilities can effectively use a specialist machine, whilst smaller plant require the flexibility of multi-use vehicles. The overall purpose of the turning process is to introduce oxygen in to the composting mass and thus encourage the composting process. Large amounts of steam and heat are released in the process and this acts as a control on the temperature.

The frequency of turning varies throughout the process, in the early stages when degradation is rapid the windrows should be turned frequently, 2-3 times a week. Later in the process after 2-3 months, the turning frequency is reduced. After about 16-20 weeks, the composting is completed and the compost is normally screened to remove the larger woody materials that have not been degraded and plastic contaminants. The markets for the compost determine the size of the aperture. In some plants, a single -20mm product is sold as a soil improver whilst other plants generate several sized fractions for use as mulches, growing media or soil improver.

The product compost is then sold to the users in bulk or bagged for sale to domestic customers. The oversize reject fraction can be either sent to landfill as a waste or returned to the start of the process for another stage of composting.

Development

Composting of green waste is predominant across Europe. Although source separation at the household is increasing, the quantities collected and composted are currently less than the quantity of green waste composting.

Cost and Performance

The cost of open windrow is one of the least expensive process options for treating waste. Gate fees often quoted range between €20 to €30 per tonne. The costs are heavily influenced by the scale of operation and the marketing opportunities for the compost. The capital costs are made up of:

- land purchase;
- the laying down of the hardstanding that will allow the capture of any leachate and provide a hard surface that the vehicles can work on in all weathers;
- purchase of shredder, screen and loading shovels; and
- for larger plants, dedicated turning machine.

Essential revenue to the plant will be the sale of compost. Prices obtained for the compost can be as high as €50 per tonne for bagged material sold to the public, but bulk sales which comprise the majority of the material sold will rarely achieve an average higher than €50 per tonne.

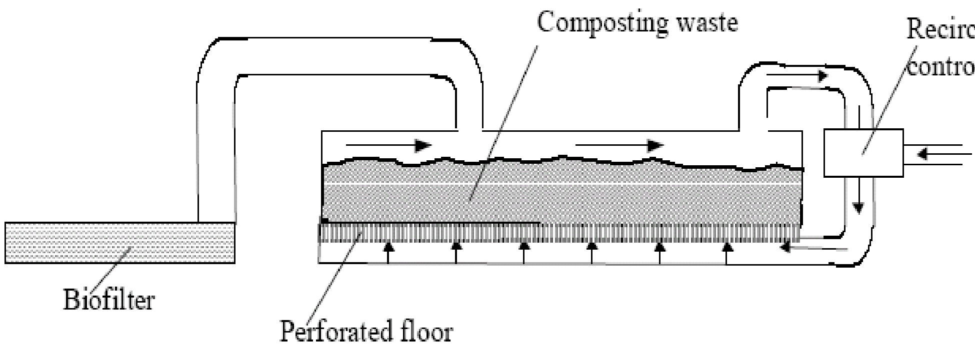
3.7.7.10 Green waste composting in-vessel system

In-vessel composting is the same biological process as describe above but enclosed in a vessel or building. There are many designs but essentially four basic types; batch tunnel, progressive tunnel, sequential bay and vertical units are used. The differences between them are minor and related to the engineering rather than any fundamental differences in processing.

The basic operation of the in-vessel systems is to control the ventilation of the composting material and to agitate or mix the material as required. The air used in the composting process is contained and thus allows the control of any odours or bioaerosols emitted during the main composting process. Obviously, the loading and unloading operations will have the potential to release odours and bioaerosols.

The basic principal of the in-vessel systems can be demonstrated by the batch tunnel system Figure 3.1. Here the waste is placed in a large container with a perforated floor. Air is blown through the waste to facilitate the composting. Air is recirculated or sent to the biofilter for treatment and fresh air introduced depending on the composting temperature and oxygen content of the air. The process is often computer controlled. As the material composts it will compact increasing the resistance to air passage and will require turning to introduce porosity and to open up new surfaces for composting. In continuous systems, this is an aspect of the mechanical system and in batch systems the waste is taken out of the tunnel and turned with a shovel loader before being returned to the tunnel. The turning process may be repeated several times depending on the feedstock. The waste will require windrow composting for several weeks after the initial intense composting phase in the composting unit.

Figure 3-81: Schematic representation of batch tunnel composting



The feedstock to the process will predominantly be green wastes but the inclusion of kerbside collected biowaste can also be incorporated in to the system. The enclosed nature mitigates many of the problems that higher levels of kitchen wastes introduce such as increased potential for odours, leachate generation and attractiveness for vermin.

Development

The development of the technology is limited, comparing to other systems. The following tables show the deployment of in-vessel systems in several countries. Germany, Austria, Belgium and the Netherlands have the large proportion of their plants operating with in-vessel systems, whilst many countries have only a few or no in-vessel composting plant.

3.7.7.11 Implementation

The risks associated with composting can be broken down into financial, technical and environmental.

1. Financial risks

The financial risks of the plant predominantly centre on the gate fee that can be charged and the value or use of the products. The operational costs and capital costs once a project is operational are moderately stable and thus are not "risk" factors. The income from the gate fee is susceptible to competition from alternative disposal options that can either siphon off waste that would have otherwise been processed or result in the gate fee having to be adjusted to remain competitive. In either case, revenue is affected. These risks can be mitigated through design of contracts for the waste supply. The risks to the product revenues/costs are more uncertain.

Source separated waste composting

The largest uncertainties will be the sale value of the finished compost and to a lesser extent the quantity and cost of disposal of the rejects.

The markets for compost are at present limited to existing landscape and horticultural uses. Therefore alternative markets will need to be developed and agriculture is the most likely market with sufficient capacity to deal with the quantities that will be produced.

Mixed waste composting

The financial risks for MBT will be lower than for source separated composting as the main cost elements will be the landfill of the residue. While prices for landfilling are expected to rise with time, the risk will be predictable to an extent hence, reducing the uncertainty (and hence risk) to plant operation.

2. Operational/technical risks

Source separated waste composting

The principal risk to the green waste compost plant operations also come through break down of plant equipment, shredders, loaders etc. This is a manageable process that is controlled by ensuring sufficient capacity on site, ensuring that adequate maintenance is performed and that suitable back-up arrangements are made for inevitable breakdowns. As with other waste operations, plant is based on an availability of 85%, which ensures that there is sufficient stack in the system to deal with mechanical problems.

The technical risks are reduced by the use of the in-vessel system in that the variability of the product is reduced and susceptibility to weather influences is removed. This has benefits for product marketing as the sanitization can be more easily verified and guaranteed and the product is more consistent, an important parameter for professional users. The potential for mechanical problems is higher due to the use of a mechanical system. However, most plants have several process lines and so mechanical problems are likely to only affect a proportion of the feedstock.

Product quality

Green waste is the least contaminated feedstock, although it will still contain contaminants that will require removal. Levels of contaminants can be kept low through good education and supervision of the deposit points at civic amenity sites. The main problem item is plastic film, in which the public often brings the waste to the site. The only effective removal technique is hand picking prior to shredding and screening after composting. This poses little risk to the process, as the product quality is generally high. There is the potential for garden chemicals to be disposed of with the garden waste, which may pose a threat to the performance of the final soil improver. However, the quantities of domestic garden chemical that could get into the process are unlikely to be large. Given that there is significant mixing in the process, this reduces the concentration to a low level. In addition, the composting process will degrade many chemicals thus reducing the risk to product quality still further.

Mixed waste composting

The operational risks are manageable given that mixed wastes may contain almost anything and hence the plant has to be constructed to withstand the full rigours of waste handling. There are the typical risks due to breakdown and maintenance requirements and it is normal to set plant availability predictions at 85%.

Product quality

Mechanical separation of the contaminants from the compost is never complete and the final compost is contaminated with a glass, plastics and metal fragments that limit the application of the compost from mixed waste. Suitable applications vary depending on the national regulations relating to soil quality and the agricultural needs. In France, Portugal and Italy, compost from mixed waste is used on a number of crops, but particularly in the wine growing areas. In Germany and Austria the use of the compost is limited to landfill cover materials. The range of uses could be expected to be for land restoration purposes, as well as for vine growing.

The presence of heavy metals in compost has been an issue for many years and the setting of appropriate limit levels has been difficult. As a general rule, the greater the degree of segregation of the waste the lower the heavy metal contamination is. Thus, mixed waste processing will have the highest metal levels when compared to either green waste or source separated household organic wastes derived composts.

Figure 3-82: MBT composting tunnel

3. Planning issues

Planning of any waste site is problematical in that public opposition is based on a perception of waste being dirty, causing pollution and affecting house prices. The principal issues are odour, bioaerosols and traffic movements. As with all planning issues they have to be resolved on a case by case basis but the principal method of mitigating the problems is to use sites that are sufficiently distant from housing. It is not possible to guarantee that there will be no odour or bio-aerosol releases, although, good operational practice can minimise these. In-vessel composting significantly reduces these emissions as the emissions are captured and treated. Other planning issues centre on the amount of land required for the composting operations. A typical estimate for open windrow systems is 1 m^2 per 1.5 m^3 per tonne capacity. In-vessel systems have a much lower demand for land and depending on the degree of complexity systems occupy between 0.25 and 0.5m^2 per tonne capacity. Obviously, local conditions and the topography of the site affect this.

3.7.7.12 Environmental Impacts Issues

Emissions from mixed waste composting plants are similar to those from green and bio-waste composting plants. The emissions of concern have been identified as bio-aerosols, VOCs, odours and dust.

Bio-aerosols are emitted by all waste management facilities and composting is no exception. Open windrow systems will provide a larger emissions source during the turning operations. Emissions from turned windrow operations have been reported to reach in excess of 690 x10^6 cfu m^{-3}, of bacteria and 2.7 x 10^6 cfu m^{-3} fungi. Estimates from enclosed systems are currently not available but would be expected to be significantly lower.

The air emission that causes the most complaints is the odour from the composting waste. This can be minimized through good management of the composting process to ensure that the material remains aerobic. However, there are occasions where odour is generated. In open turned windrow systems mitigation is not possible although there are some proprietary spray systems (based on surfactants and oils) that claim to reduce the problem when used in a perimeter spay. Alternatively, the windrows can be covered with geotextiles to reduce the odour problem. In-vessel systems and aerated piles that suck rather than blow the air can treat the odorous air through biofilters or chemical scrubbers to eliminate the odour. Obviously, treatment of the odour will also mitigate the VOC emissions. In relation to other forms of composting, mixed waste composting will have a higher potential to generate odours, but as in most cases the process will be contained this will allow control of the problem that is unavailable to open windrow systems used for green waste composting.

Water

Leachate from composting can be a potential hazard to surface or groundwater if it is accidentally released without treatment. Mixed waste composting has a significant demand for moisture, which is used in the initial pulverisation stage and then evaporated in the composting stage. Thus, any leachate produced can be utilized within the process. Composting of green waste and kitchen wastes has the potential to generate greater amounts of excess liquor especially if conducted in the open. The run off and leachate has the potential to contaminate surface or groundwater. There is a need for all composting processes to be performed on impermeable surface as escape of the run off and leachate could potentially contaminate surface or groundwater.

Soil

The contamination of compost derived from green waste is generally low with inert contaminants (glass, plastics, metals) removed through a combination of visual inspection and screening. Kerbside collected organic waste feedstocks will contain slightly greater proportions of contamination, but will still be within the capabilities of systems to remove them. Mixed waste systems will require extensive sorting to remove the inert contamination and significant amounts will remain. This will result in the composts from mixed waste will only be able to be used in the lowest quality applications such as landfill cover or land restoration.

Heavy metal contamination is an issue with all waste based composts, but green waste is likely to be the least contaminated feedstock and mixed waste the most contaminated.

Noise

There are two main noise sources on compost sites, the shredders and the reversing signal for the loading shovels. The noise made by shredders can be up to 90 dB, which is particularly a problem for open systems. However, the windrows can be used as effective sound barriers and appropriate positioning of the shredding operations and windrows can reduce noise complaints to a minimum.

The choice of reversing warning signal is vitally important on compost sites as the vehicles spend almost half their time going backwards. Removing the signal altogether has implications for health and safety issues but there are "smart" signals that vary the volume depending on proximity of people and verbal warnings, which are not so penetrating as the high frequency signal fitted to many vehicles.

Pathogen kill

Heat released during composting elevates the compost temperature of the compost. If uncontrolled, the temperature can rise to 80°C or more, but it is normal to limit the temperature to about 50-60°C. This represents a compromise between the optimisation of the speed of composting and the sanitisation of the compost product. Guidance on the precise conditions required for adequate sanitisation vary but range between maintaining the temperature above 55°C for three days and five days at over 60°C. These guidelines are based on the operation of turned windrow systems. Mixed waste composting is most likely to be performed in an enclosed system and these systems offer improved sanitization due to the greater confidence that all of the waste is exposed to the time-temperature conditions. Thus, this provides greater confidence that the process kills pathogens (both plant and animal). However, mixed waste will contain a wider range of pathogens and thus this increases the need for security in pathogen kill. Overall, mixed waste compost is unlikely to be exposed to the public and thus health risks will be low.

3.7.7.13 Contribution to Targets and Policies

The key target for municipal waste in the Landfill Directive is the requirement to reduce the amount of biodegradable waste landfilled. The precise targets are to reduce the biodegradable municipal waste landfilled to 25%, 50% and 65% of the 1995 quantities by 2010, 2013, 2020 respectively (old EU Member Stattes).

For mixed waste systems that treat the whole of the waste stream, the compost product can be considered as non-biodegradable and hence the only biodegradable material will be the material in the reject fractions that are sent to landfill. Thus, using this estimate mixed waste composting would provide 90-95% diversion of biodegradable material from landfill. However, the process would only divert approximately 60% of the total weight of waste from landfill, as there is no significant effect on the non-biodegradable materials.

Source separated composting will use the compost product outside of landfill and thus diversion will be, again, limited to the reject fractions. The biodegradable fraction of the rejects from source separated waste will be limited and be less than 5% of the biodegradable content of the supplied waste.

Composting of source separated wastes contributes towards both the recycling and recovery targets. However this will depend on the compost being used in a beneficial way. Under normal circumstances all of the material directed to source separated composting facilities will count towards the recovery and recycling target.

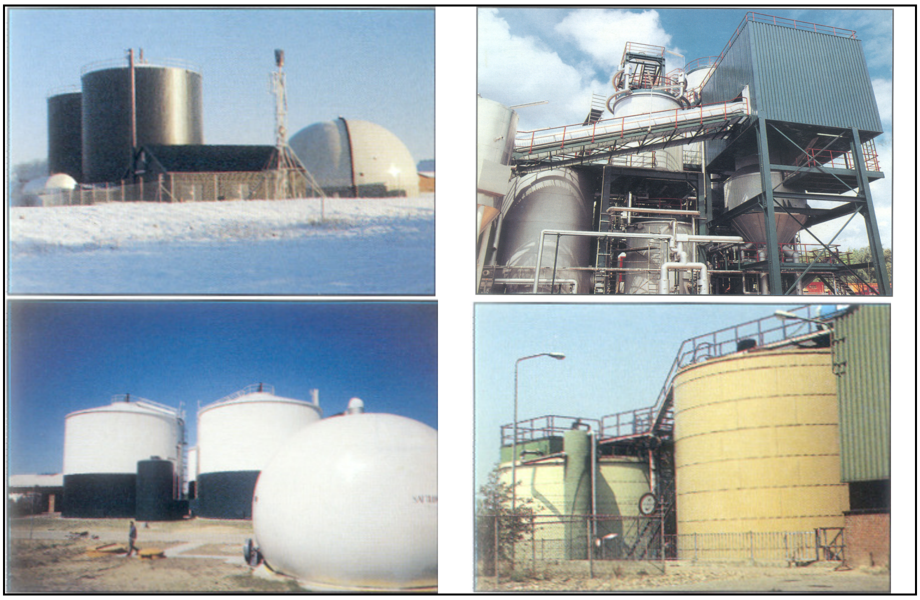
3.7.8 Options for Treatment of Biodegradables – Anaerobic Digestion Technology

3.7.8.1 Introduction

An alternative option to composting for the biological treatment of waste is anaerobic digestion (AD). AD is analogous to composting but is an **anaerobic** decomposition and thus is performed in the absence of air. The main products from this degradation process are a solid residue similar to compost called digestate, biogas a mixture of methane and carbon dioxide and a liquid fraction containing water and nutrients.

Anaerobic digestion will operate over a wide range of temperatures, however there are two temperature ranges where the digestion is most rapid, mesophilic (about 35°C) and thermophilic (about 55°C).

Figure 3-83: Typical anaerobic digestion systems for MSW



3.7.8.2 Technology

To facilitate the digestion of wastes the engineering is required that provides the correct feedstock and maintains the conditions for the biological processes to proceed optimally. The engineering solutions to this problem are many and varied and there are a wide range of process designs, each capable of handling the waste stream in a different way, but with the end result of degrading them anaerobically and recovering biogas. Most of these processes are proprietary designs and thus are only supplied by one manufacture. However, the various designs tend to follow some basic principals, but have advantages and disadvantages in various aspects and there are no single "best" designs.

As a broad guide to the anaerobic digestion systems used for MSW treatment these can be divided into a number of types, depending on four basic parameters, solids concentration, temperature and mixing system and number of stages. Using these parameters can describe most of the systems of the market today, although some systems still fall between these categorisations.

Table 3-77: Operating parameters of anaerobic digestion systems

Temperature	Solids concentrations	Mixing	Stages
Mesophilic (35^0 C)	Low solids<10%DS	Mechanically mixed	Single stage (one vessel)
Thermophillic (55^0 C)	Medium solids<10% - >25%DS	Gas mixed	Multi stage
	High solids >25%DS	Plug flow	
		Batch	

3.7.8.3 Process arrangements

Anaerobic digestion has been practised for many years on organic waste streams, the most notable is the digestion of sewage sludge, which has been a major treatment method for many years. Industrial wastewaters have also been processed by anaerobic digestion including wastes and effluents from dairies, breweries, sugar refineries, soft drinks, starch and paper mill effluents. Solid wastes have been treated by in-vessel anaerobic digestion, although to a much smaller extent. The best examples of this type of technology are agricultural waste digestion processes, which have been operated for several years on farm manures and abattoir wastes.

Anaerobic digestion in waste management can operate in a number of ways. The three main options discussed here are:

- Digestion of "biowaste", source separated organics (kitchen waste and small garden waste) from households,
- Digestion of organic components from mixed municipal solid waste (MSW) to generate low value soil improver or as a pre-treatment to landfill disposal, (as the B part of an MBT plant)
- Centralised anaerobic digestion (CAD) where source separated municipal wastes are digested in combination with other wastes principally agricultural waste but possibly including sewage sludge and industrial organic waste as well.

Biowaste Digestion Systems

Source separated feedstocks are processed by AD in much the same way as biowastes are composted and as such are competing processes. The principal difference is that the process is necessarily enclosed and there is an energy product.

The process proceeds by comminution of the feedstock to reduce the particle size and increase the surface area of the waste. Contaminants, such as metals, plastics and glass, may be removed at this stage through a combination of manual and automated systems. The shredded waste is then mixed with digested material and liquid to inoculate it with the digestion microorganisms. The control of the recirculation of material can be a critical control factor in the process. Once the feedstock is mixed it is introduced to the digestion vessel where the organisms start the degradation and gas production processes.

The digestion normally will take between 14 to 28 days by which time about half of the organic matter will have been degraded. The residue will be the refractory lignocellulosic parts of the organic waste.

The digested waste will be more liquid than when it went in to the process due to the loss of organic matter but effectively no loss of water and thus the waste may require dewatering prior to use of the digestate. The requirement for dewatering is dependant on the market with agricultural markets being able to accept and use slurries whilst most of the uses of the digestate will require the liquid and solids separated.

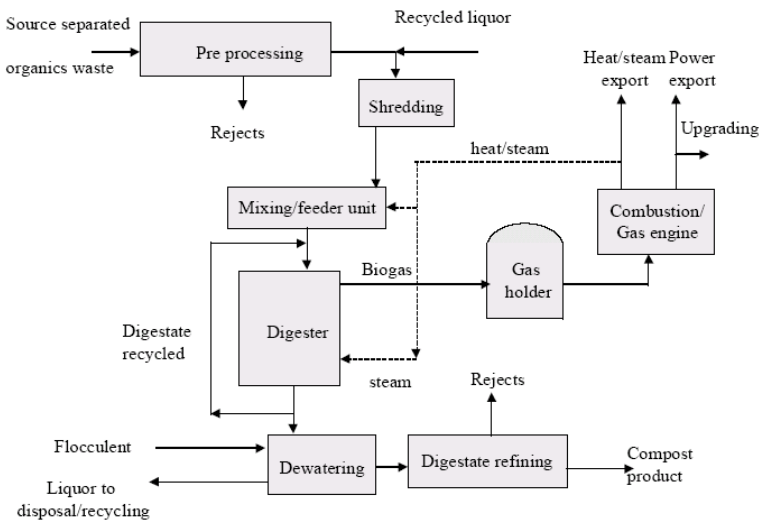
The dewatering will be undertaken through a screw press and in some processes the liquor will go through a centrifuge as well. This can be an expensive part of the process as flocculants are often used to improve the performance.

The liquor contains nutrients and residual organic matter and could be used as a fertiliser. The solid residue requires a short aeration stage (one - two weeks in windrows) before it is screened to remove contaminants and sold as compost.

The biogas product is a valuable energy resource and can be either burnt for heat or electricity or can be upgraded by removal of the carbon dioxide for injection into the natural gas grid or for use in standard CNG (compressed natural gas) vehicles.

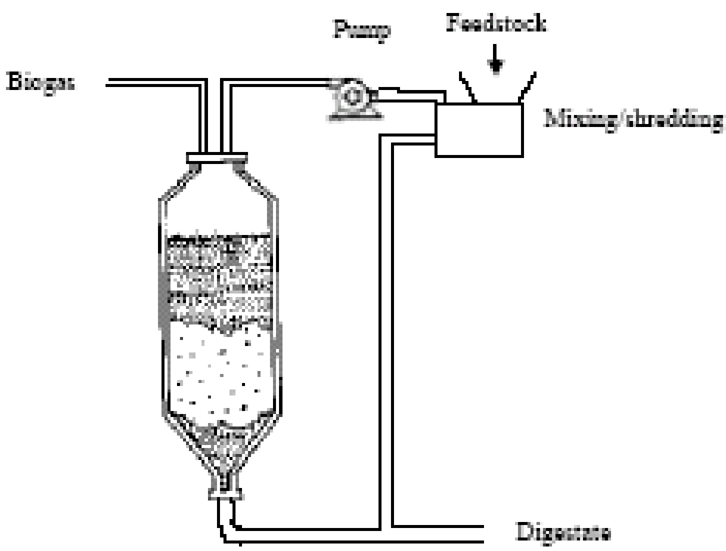
This process is shown graphically in the following Figure

Figure 3-84: Anaerobic digestion process



The processes that are used for biowaste digestion are probably the most varied, with systems using almost all the combinations of process type. There are many suppliers of processes on the market who have built systems but there are a few market leaders who for commercial and technical reasons have started to build larger numbers than other suppliers. However, there is a large number of "home built" digesters on farms (particularly in Germany) processing small amounts of biowaste and whilst they might be more correctly considered as CAD plants they are often similar in many respects to commercial designs.The main processes that are the market leaders for MSW biowaste digestion are Dranco, Steinmuller Valorga, Kompogas and BTA.

Figure 3-85: Schematic representation of thermophilic performance



3.7.8.4 AD feedstock

Raw domestic (unsorted) refuse is generally not a good feedstock for anaerobic digestion plants or any other biological treatment. A more efficient use of anaerobic digestion plant is to feed concentrated feedstocks that contain as few inert components as possible. This ideal situation can be achieved with selected industrial and agricultural wastes but is much more difficult with mixed waste streams such as MSW. Therefore, the refuse has to be sorted to provide concentrated feedstocks to the anaerobic digestion plant. This can be achieved by several strategies.

- Source separation
- Mechanical separation
- Complementary Feedstocks (such as sewage sludge, selected industrial organic wastes and agricultural wastes)

Mixed Waste Digestion - Mechanical Biological Treatment

Wet Anaerobic Digestion of mixed MSW (which is also the traditional application) is not widespread. This technology can be divided in “wet” and “dry” applications, due to economics and technical difficulties from the operation plant so far. The Dry AD method has been developed recently and is considered to deal more effectively with the problems of mixed wastes feedstock.

The AD technology itself is essentially the same as that used for biowaste processing. However, the key difference is the sorting that surrounds the biological processing. The sorting processes will be aimed at removing a high proportion of the non-degradable materials but keeping the organics and paper fractions, which can be degraded. Processing after digestion will include hydro cyclones for removal of the sand and fine glass and floatation for removal of plastics.

Centralised anaerobic digestion (CAD)

Centralised anaerobic digestion plants (CAD) operate where wastes from many different sources are combined in one plant. These are invariably based around an agricultural waste digestion system where several farms co-operate by treating their animal wastes in a single facility. Industrial and municipal wastes are taken in to the plant at upto 10% of the plant feedstock. This provides additional revenue from the gate fee and additional gas generation. The solid residue is distributed back to the participating farms. This approach has been extensively adopted in Denmark where there are many CAD plants in operation. Other examples can be found elsewhere in Europe, but Denmark has been pre-eminent in developing this approach.

The principal technology used for CAD plants is traditional manure based systems which are inherently low solids systems. Here shredded MSW-derived feedstocks are diluted with large volumes of water to provide a 5-10% slurry, which is digested using modified sludge digestion technology from the wastewater industry. The practicality of these CAD plants relies on the organisation arrangements for the supply of waste and the guaranteed market for the digestate provided by the co-operating farms.

Complementary Feedstock

There may be technical and economic benefits in combining the organic wastes from other sources such as sewage sludge, selected industrial organic wastes and agricultural wastes. Sewage sludge in particular has many processing problems in common with MSW in terms of PTE's but is well established in use of the digestate for land application.

There may also be financial benefits from treating industrial organic wastes as these will introduce additional revenues and increase the scale of the plant and thereby spread the overhead costs more widely.

3.7.8.5 Products

Anaerobic digestion of MSW has three products, biogas (a mixture of methane and carbon dioxide), liquid effluent and a solid residue generally termed digestate.

Biogas

Biogas is a mixture of methane 55-65% and carbon dioxide (35-45%) with small quantities of other gases such as hydrogen, hydrogen sulphide or ammonia.

Use of the biogas is normally easy as it can be burnt and therefore has the same potential uses as any other combustible gas, If no suitable user is within a reasonable distance the fuel can be refined for use as a vehicle fuel or for distribution via the natural gas grid, or converted into electricity for distribution via the national grid.

Upgrading the gas for vehicle fuels or pipeline quality is at present an expensive process as the specification required is very high.

Conversion into electricity is generally a simpler task, although not without problems such as emission standards, corrosion and mechanical failure. Although not entirely the same, landfill gas is similar to biogas,

The choice of whether or not the gas is converted on site will be determined by factors such as availability of a local gas user, sale price of produced electricity or pipeline quality gas.

Liquid

The liquid effluent contains a large proportion of the nutrients from the waste and can be used as a fertiliser. The liquid has benefits over compost in that it can be applied at all times of the agricultural cycle. Many countries prohibit the use of this fraction and hence it must be disposed of either by further aerobic treatment or disposal via the sewage system.

Solid digestate - Compost

The solid digestate is the other product of anaerobic digestion and this can be used as a soil amendment in a similar manner to waste derived composts. However if this material is contaminated (particularly with heavy metals), as may be the case with mixed waste feedstocks, the use of this material may be limited. Therefore, some form of refining of this product will be necessary for digestates from mixed waste sources in order to remove inert particles (glass and stones) and PTEs such as heavy metals. Obviously, the extent of contamination will affect the potential end uses of digestate derived compost because of marketing problems even if legislation does not.

3.7.8.6 Technology Status

Anaerobic digestion (AD) has been used to manage wastes and generate energy for centuries. It is widely used in Asian villages, where the climate is suitable for low technology designs, to produce biogas, which is then used for heating and cooking. More recently AD has been developed into an industrial process for large scale waste treatment and energy recovery.

AD of MSW is often described as "emerging and progressing towards full scale commercialisation". For agricultural wastes the technology is more advanced but the economics are such that it still requires some government support.

As discussed there are three main approaches to the digestion of MSW, biowaste, mixed waste, and CAD.

3.7.8.7 Implementation

The risks for AD are essentially similar to those of composting and can be considered as:

- Financial
- Technical and operational
- Environmental.

Financial risk

There is still some apprehension over investing in AD as a result of some poor performance in the past. Operational guarantees will be required and smaller companies may find it difficult to support these. Some countries have introduced mechanisms to aid financing. In Denmark there are special funding schemes with low rate indexed loans for community schemes.

As with any project the key factors in the financial risks are the risks of capital and operating cost variations and the potential for the revenues from the product to alter.

Capital costs

The capital costs of plants are becoming established and plant suppliers are now of a size that guarantees provided can be backed with appropriate financial measures. This obviously reduces the risk element for the construction of AD plants. The rise of modular plant will also help to reduce the cost and uncertainty of installation. The greatest degree of confidence is in the CAD installations as these are only minor modifications of existing farm waste digestion designs. The most uncertain aspect is in the construction of mixed waste digestion plants as the experience is more limited and thus retrofits and adjustments are more likely to be incurred.

Operational costs

The main risks to the operational costs will be the potential for downtime due to maintenance and breakdown and the cost of disposal of the residues. The operational costs will be largely dependent on two elements, the robustness of design and the quality of the waste feedstock.

Providing the design is robust then there should be good expectation that the maintenance, staff levels etc should remain within the constructor estimates.

The effects of feedstock on the operational costs will be more consistent as the designs are tailored to the expected difficulty of the feedstock.

The other aspect of operational costs is the disposal cost of the residues. Landfill and wastewater disposal costs are unlikely to be reduced in the future and will increase the costs to the plant. The plants with the smallest proportion of residues will be the least vulnerable to these price rises and thus the mixed waste plants will be the most vulnerable.

Revenues

AD has three products, energy (biogas), compost and waste treatment. The revenue from each of these is important to the financial stability of the plant. The biogas is probably the most stable of the three in that energy prices are well established. Whilst there may be some desire to increase the price charged for this energy due to the "green" credentials this can be more problematic. Also the often small scale of generation can make overheads such as network connection or vehicle filling stations a significant disincentive to exploiting the more valuable markets. However, there is support in many countries for renewable energy production and this manifests itself in support for the electricity price.

The compost sales are the most uncertain. There appears to be sufficient market for the composts derived from source separated municipal wastes at the current rates of production. However, additional effort will be required to develop new markets when the implications of the Landfill Directive and recycling targets promote more composting and anaerobic digestion of waste. The biggest issue is contamination, which can make the compost unsaleable, and securing the market for the compost is a vital part of the developing of a project. The least contaminated composts will be derived from agricultural and industrial wastes and hence the CAD plants will be exposed to the least risk to the sales of their compost. The co-operation of farmers in a CAD project will also tie-in customers who have land to accept the compost and as such they will be a significant part of the market for CAD plants. Biowaste plants will generate acceptable composts and thus will be a large part of the revenue for the plant but there will be risks from competition from other wastes (sewage sludge, forestry wastes, spent mushroom compost, etc) which may depress the values attainable. Mixed waste composting plants will generally expect the product composts to be contaminated and thus will not plan for high (or any) revenues from the use of the compost. The key factor will be to ensure that markets are found that avoid the compost becoming a reject requiring disposal. Thus it is essential that the mixed waste plants obtain long term contracts for the compost, otherwise the risks to the financial stability of the plant will be large.

3.7.8.8 Planning

Planning of any waste site is problematical in that public opposition is based on a perception of waste being dirty, causing pollution and affecting house prices. The principal issues for digestion will be odour, combustion emissions and traffic movements. As with all planning issues they have to be resolved on a case by case basis but the principal method of mitigating the problems is to use cites that are sufficiently distant from housing. It is not possible to guarantee that there will be no odour releases, although, good operational practice can minimise these. The enclosed nature of the process will minimise odour emission, but the main point of odour will be the aeration of the digestate where ammonia can be release.

The combustion of the biogas will provide some emission although these are likely to be low and similar to natural gas combustion apart from the effects of residual hydrogen sulphide and good scrubbing of the biogas should under normal circumstances be an appropriate control measure. Emission limits are proposed in the draft Directive for Biodegradable Waste and these are likely to pose a problem for most plants unless the gas is mixed with landfill gas.

3.7.8.9 Health and safety

Care must be taken in all waste management processes where personnel come into contact with MSW and organic wastes from either agricultural or industrial origin. This is due to potential microbial infection hazards and the potential for physical injury arising from sharp contaminants. AD has the added hazard of producing a gaseous product in the form of biogas that can be both an asphyxiation and explosion risk where pockets of gas accumulate. For this reason the plant must be well ventilated particularly in areas handling post-digested sludge. The use of wall-mounted and or personal detectors/ alarms in plant areas is common to warn operators of potential atmospheric hazards. Special attention must be given to maintenance work requiring work in confined spaces and to the removal of all ignition sources.

3.7.8.10 Environmental Impacts Issues

From the combustion of the biogas there will be emissions of nitrogen oxides and sulphur oxides, as well as a range of minor combustion products. These emissions will be similar to those from natural gas combustion but will contain higher levels of SOx emission due to the content of hydrogen sulphide. Controls in most countries are limited due to the low risk from these emissions, so long as H2S removal is performed. Landfill gas whilst similar does have the potential to contain a wide range of contaminants due to solvents and other wastes being present in the landfill. The control of the feedstock to an AD plant will limit this type of contamination. Mixed waste digestion may have some potential for some contamination but if the waste is constrained to household waste the risk of contamination should be low.

These emissions can be offset against reduced need for energy generation elsewhere. Emissions (per unit of electricity generated) from biogas combustion will tend to be higher than for energy generation from high efficiency natural gas plants but lower than generation with coal fired plants.

Odours from the plant will be generated during the feedstock processing and in the digestate treatment where waste in not enclosed in the digester. These parts of the process are normally enclosed within a building and so long as appropriate operational procedures are adopted this should not cause odour problems. The air extracted from the processing areas of the plant is then treated by biofilter of chemical scrubbing. The success of these control measures can be observed at several European biowaste digestion plants that are situated on industrial estates without complaints from the neighbouring factories and offices. In these locations the distances to the neighbouring buildings can be less than 10m.

Water pollution

If the excess liquor is disposed of rather than used then about 100 to 300 kg of surplus water per tonne of incoming wastes will still require treatment and disposal. This can occur on-site or via the domestic sewer system, discharge consents permitting.

The treatment of source separated waste will tend to generate greater proportion of excess liquor as the feedstock is generally wetter than mixed waste. Some mixed waste plants produce no or little excess liquor (Amiens, Vagron) whilst others dispose of higher amounts. The Vaasa plant generates about 100 kg t-1 but the feedstock does contain a large proportion of sewage sludge, which obviously increases the moisture content of the feedstock.

Digestate Application to Land

Soil contamination through heavy metals or other compounds can be caused through the use of composts from wastes. The risk of this contamination is very much reduced with the use of source separated materials. Mixed waste composts would obviously require more extensive monitoring to ensure that damage to the soil does not occur. Current there as no official standard for composts quality and only EU has suggested limit values for composts and digestates in the draft Directive for Biodegradable Wastes.

Noise

The enclosure of AD plants generally limits the noise emission from operations such as shredding and processing of the waste or digestate. Operational plants have problems from complaints about noise. The most likely noise problem will be from the operation of fans and pumps during the night period when background noise is less and sensitivity is higher.

The main source of noise on site will be the generator burning the biogas for electricity. These engines can generate noise levels over 100dB at 1 meter and suitable acoustic enclosures have to be constructed around these units to avoid problems. The use of silencer on the exhaust is also necessary to avoid problems.

3.7.8.11 Contribution to Targets and Policies –Overall Evaluation

This more technologically advanced option for the anaerobic (wet and dry technologies) digestion with energy recovery (with the heavy fraction of municipal waste as the main source) has been initially considered. However, it has to be noted that such facilities are cost intensive and need certain frame conditions to be financially attractive. They cannot compete with low cost landfills. Therefore high landfill taxes or a landfill ban for biodegradable needs to be in place. Investment cost as depicted in the same study ranges from 375 – 515 €/t for wet anaerobic installations, whereas costs from the Consultants experience for installations using the 'simpler' dry anaerobic are of a much lower magnitude, of the order of 210 €/t. A rough estimation of operational costs is 40 to 60 € per treated tonne (of which about 50 % is retrieved from gate fees and 50 % from energy selling). Further anaerobic digestion is working best with a combination of municipal waste and wastes from agriculture/gardening/food industry.

From experience in the development and operation of anaerobic digestion facilities, it has become apparent that these facilities are operating preferably with source separated biowaste, whereas treatment capacities need to exceed 20,000 tons per year. This option can be further considered on a mid/long term basis, as an extension of the regional waste management system.

3.7.9 Mechanical Biological Treatment Facilities (MBT plants)

3.7.9.1 Introduction

MBTs are waste treatment facilities operating to help meet landfill diversion targets and in some cases packaging waste recycling targets. There exists a high diversity of configurations, ranging from very simple to highly sophisticated processes. The aim is first to separate waste into different streams/ fractions (by mechanical processes) and second to stabilise organic matter (by applying biological processes). Thus, a range of outputs may be produced based on the adopted technical configuration, such as

- dry recyclates
- a higher calorific value fraction such as Refuse Derived Fuel (RDF) or Solid Recovered Fuel (SRF)
- biogas
- a biologically stabilised fraction (termed Compost Like Output, CLO)
- a reject fraction going to landfill

In broad terms, the feed undergoes a shredding step for bag opening/ size reduction, trommel separation (screening) and classification into under-, mid- and over-size fractions, enrichment via air classification or ballistic separation or other suitable processes, metal recovery with magnets, post treatment quality control via hand sorting or sensor sorting, transport, loading and storage.

There are three main configurations of MBT system, that can process the organic element of the waste stream:

- Aerobic stabilisation
- Anaerobic digestion
- Biological drying

This will be through some form of shredding and additional treatment to separate the materials from organic to non organic materials. The differences are in the type of the biological treatment (aerobic or anaerobic) and the treatment target (stabilisation or drying to foster subsequent separation stages).

3.7.9.2 MBT Configurations

1. **Recyclable** materials such as ferrous and nonferrous metals, plastics and glass can be recovered and contribute to the packaging and household waste recycling quotas. This is mostly done in picking cabins where operators remove manually materials. The price is governed by the degree of

purity achieved. Paper recovered from mixed waste may be dirty and possibly undesirable by the paper industry. The types of materials recovered almost always include metals (ferrous and non-ferrous) and for simple systems this is the only recyclate extracted. Still, this can help enhance overall recycling levels and remove contaminants (e.g. batteries). Glass reprocessing requires a segregated material of high purity. There are also significant issues with respect to Health and Safety as well as the handling of broken glass objects from mixed waste streams. For these reasons, low percentages of glass can be targeted in MBTs. A reject fraction (fines to a largest degree) are destined for disposal.

In some countries, the "**dirty MRF**" concept has been practiced as a low cost approach that aims to recover recyclables from the mixed waste stream, without subsequent biological treatment. In this application, diversion of biodegrables is only effected from the paper fraction. Similarly, all sorting is done by hand-picking with metal removal by magnets. The high organic content of waste will result in contaminated recyclables. This approach has a low capital but high labour cost.

Recyclables derived from the various MBT processes are of a lower quality than those from a separate household recyclate collection system and therefore have a lower potential for high value markets. Any plastics extracted will mostly be mixed. Instead of this, few MBT processes prefer to utilise part of recyclables as a high calorific value waste-derived fuel, which is easily achieved using conventional mechanical sorting techniques. Still, the use of high-tech optical sorting technology, such as Near Infra-Red (NIR), offers the potential to recover high value material-specific waste streams, such as segregated by polymer type. Application of such techniques is currently applied in a number of plants, for example in Larnaca, Cyprus.

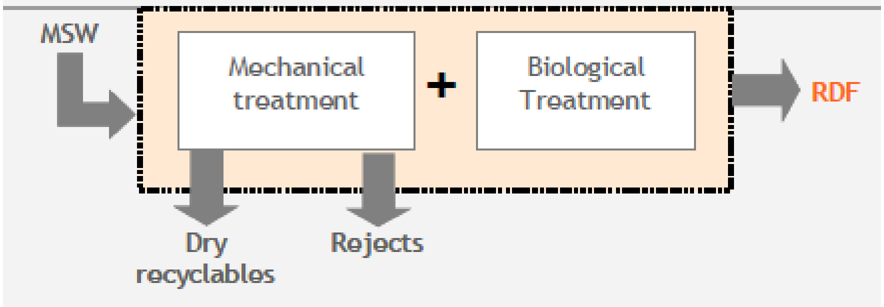
2. A fraction low in biogenic material and rich in paper/plastics (generic flow diagram below) can be also recovered as **RDF or SRF** for co-incineration in power plants, industrial boilers or cement kilns. The removal of moisture, recyclates and organic matter, will tend to increase CV of the waste derived fuel. Generally mixed municipal waste has a CV of about 10 MJ/kg whereas RDF will have a value in the range 11 to 15 MJ/kg. As the input to MBT is highly heterogeneous, a variety of unit operations are employed to yield a more homogenous feedstock required by the end-users:

i) preparation of the feed for the core mechanical/ biological steps (preconditioning)

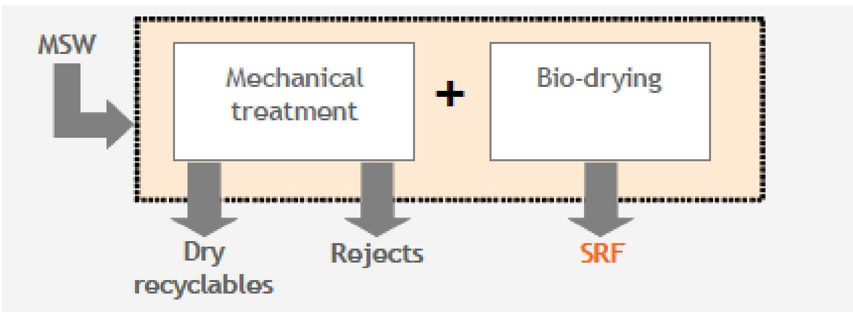
ii) removal of contaminants, and

iii) refining of the outputs

Unlike untreated mixed municipal waste, RDF is suitable for recovery operations. From an economic perspective, the use of RDF in any facility is determined by fuel cost savings (and gate fees which would have been applied), benefits realisable through the EU-ETS (Emissions Trading Scheme), and regulations governing emissions. From a technical perspective, however, issues related to the quality and consistency of the RDF are very important, not least since specific elements (chlorine, for example) can create problems for some facilities. RDF products contribute towards the Renewable Energy Directive for fossil fuels substitution with renewable sources – biomass. Therefore the production of RDF should be part of minimising the environmental impacts of waste management.



3. A recent development is **biodrying** MBTs, that are optimised for SRF production. SRF can be distinguished from RDF in the fact that it is produced to reach a detailed specification, including calorific value, moisture content, density, particle size. In particular, the enriched organic fraction undergoes a rapid incomplete composting step so that most of the biomass content is incorporated into the SRF. The aim is to drive out moisture in the waste through a combination of heating effect from the composting process and airflow through the material. A relatively high organic and low moisture content makes it more suitable for use as a fuel. The marketability of MBT-produced SRF depends largely on the successful implementation of QA/QC schemes, especially in the light of the wider technical, financial, policy, and legislative challenges. European Standards (CEN) for SRF could potentially guarantee the quality of fuel for energy producers, enabling the efficient trading of SRFs, facilitate transboundary movements and increasing public trust.



A variation of the biodrying process would be to first dry the entire waste stream with subsequent mechanical separation. The overall reduction of moisture content by evaporation is approx. 20 % and occurs for example in rotting boxes (see Figure 40). The process output can be easier handled and separated to metals, high calorific fractions SRF and inerts for disposal.

4. In respect to the biological treatment, the heavy fraction from the mechanical processing (screen) contains degradable components like kitchen waste and wet paper can undergo either i) aerobic

digestion or ii) anaerobic fermentation (as mentioned, biological may not necessarily follow mechanical treatment). The key target is to stabilise waste and either produce a compost like output (CLO) or reduce the amount of biodegradable municipal waste going for disposal, on the basis of 1999/31 Landfill Directive. In this way, there is a reduced potential for leachate and biogas generation and thus pollution risk.

A number of alternative marketed technological systems exist with certain specifications. Aerobic systems may be of various types but are almost always closed, so as to confine air emissions and reduce health impacts. These systems have low to medium capital cost even at small scales; they include:

- Windrow composting (in buildings or in open air covered with membranes)
- Bag composting
- Tunnel composting
- Reactor or drum
- Boxes

Representative photos are illustrated in the following Figures.

Figure 3-86: a) biodrying of mixed waste in closed boxes, b) windrow composting in building

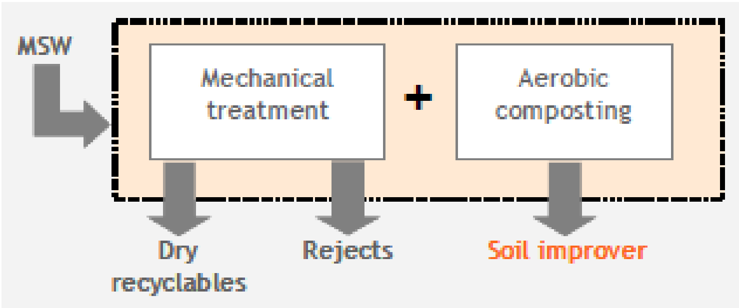
Regardless of the particular type adopted, the same principles described in the previous section apply. Following the intensive composting phase, the material is left for curing or maturation for 6 weeks or more in an open or enclosed area. The decomposition processes consume all the available oxygen in the compost. Forced or sucked aeration replaces the oxygen consumed, ensuring that sufficient oxygen is available for aerobic degradation. Ventilators are equipped with a timer that regulates operating schedule. The aeration strategy of the process can be divided into three phases to ensure a sufficient supply of oxygen and to avoid drying out the compost:

- Week 1-2 (mesophilic phase) strong aeration
- Week 3-10 (thermophilic phase) very strong aeration
- Week 11- (cooling phase) moderate aeration

Figure 3-87: a) composting in tunnel (lanes) with perforated aeration floor, b) composting in bags

Mixing or turning is considered also an important factor, in order to achieve rapid biodegradation levels. Frequent agitation redistributes material to break up temperature stratification, prevent airflow channelling, distribute moisture and expose new surfaces for degradation. Material turning provides for homogeneous conditions of the biomass inside the pile, transversally and longitudinally. There are a variety of mixing systems available, which apart from agitating can also gradually displace compost material it through the compost bay. The turning equipment is normally endowed with a sprinkling system in order to supply water.

Some MBT configurations, entail an additional refining step and maybe a more advanced mechanical separation so as to remove contaminants from the finished compost and attract potential end-users. In some countries (France, Spain, Italy) it is considered sufficiently pure and is used in farmland applications. In other countries it may also find some low value applications such as cover material in landfills and brownfields restoration.



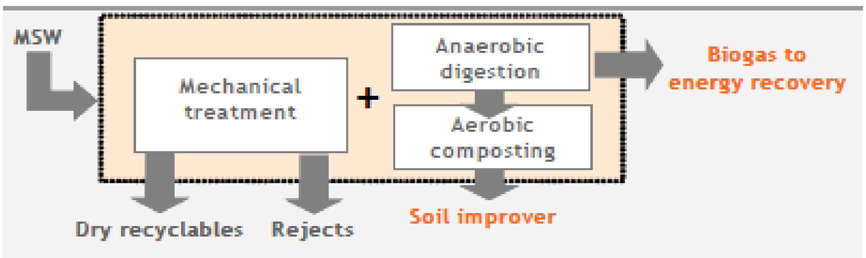
Farm application is a matter of ongoing debate starting from the Second Draft Biowaste Directive in 2001 up to present's Communication on future steps in bio-waste management in EU and a number of working documents on End-of-waste Criteria for Biodegradable Waste/ sludge. It is a matter of argument whether a mixed waste treatment plant will undertake the additional efforts to achieve the superior End-of-waste standards so as to apply CLO to land. Compost derived from mixed waste is of lower quality and value compared to compost derived from source-segregated materials, largely due to higher contamination levels. Trials on mixed waste derived materials have reported large amounts of physical contaminants (e.g. glass) and potentially levels of other elements above limits. Use of bio-waste and sludges of lower quality would be restricted to non-agricultural lands and would be subject to national legislation. The potential for such an output is thus very low. It is mentioned that in UK for example, the BSI PAS 100 standard is by definition valid only for composts derived from source segregated waste.

5. Some countries have followed a "low cost" approach via **Mechanical Biological Stabilisation (MBS)**: waste enters to a trommel, is separated to a light fraction that goes to landfill and a heavy fraction that is first directed to composting. Metals are recovered via magnets, but all other recyclables or RDF are ultimately lost. The stabilized product is mainly landfilled or used for restricted applications where low quality is not an issue, such as dumpsite and brownfields remediation.

This stabilisation process appears an attractive option for countries where budget constraints exist, especially if it is combined with a low cost outdoor biological treatment, such as bags (Figure 41) b) or membrane cover (Figure 42). The aim is to conform with the provisions of the Landfill Directive since overall recovery is minimal. This technology is more applicable for residual municipal waste that has undergone exhaustive source separation, such as dry recyclates, food and/or green waste. Losses account to about 30% of MBT input per mass, and therefore an effectively inert material low in biodegradables in directed for disposal. Long retention times may be required with significant land spaces to allow for the maturation of material. Several European countries have established standards for defining "stabilised matter", based on measures of biological activity. Biological activity tends to be measured by one of two methods, a static respiration index (SRI) or a dynamic respiration index (DRI).

Figure 3-88: Outdoor windrow composting with heap covered with membrane for protection and odour confinement

6. Finally, some MBT technologies have been optimised to encompas a waste **anaerobic digestion** stage. Anaerobic digestion has been practiced for many years on organic waste streams and sewage sludge. Clean biowaste has also been processed by anaerobic digestion, as exemplified in the previous chapter. More technically advanced MBT plants can handle the organics-rich heavy fraction after mechanical separation. The material from the fermentator requires post dewatering and typically a subsequent composting stage. Gas production rate ranges to 90 - 120 m^3/t waste and plants generate electricity from the biogas produced.



The fermentation process is complex and very sensitive to input variation. Besides this, impurities like textiles or sand which can lead to clogging and must be removed before the fermentation process. However a complete separation is not possible. The result is sedimentation of inerts and consequently a reduction of the volume of the tank. Recent process developments can effectively tackle these disturbances and utilise the biogas output that is a highly attractive product with a market security.

Figure 3-89: Storage tank of biogas from a waste fermentator

7. Emissions from MBT plants can be significant. Bio-aerosols, VOCs, odours and dust incur during loading and unloading of materials as well as in points where materials drop. Part of the emissions can be minimized through good design/ management of the feeding lines and the various mechanical units; also, via proper configuration of the composting process to ensure that odour is eliminated and the material remains aerobic.

Eventually, the air in the MBT halls and in the biological processes must be collected and treated in a suitable dedusting and/or deodorization system. The air exhaust control system includes:

- Air collection system
- Treatment unit for the cleaning of polluted air

A collection pipe network with chutes, where necessary, shall be provided for the removal of polluted air from all dust and odour generation points. The building must be kept in under-pressure conditions via a corrosion-resistant fan suitable to overcome losses. Air renewal must be kept at a ratio of 2-4 per hour.

Suitable candidate dust abatement technologies regard cyclones, electrostatic filters and bag filters, with the latter being more popular. In regard to odour control, biofilters regard a low-cost solution. The air is extracted and sent to the biofilter prior to atmosphere release. The biofilter is equipped with an automated system that maintains the moisture content of the bed to proper level. Other odour systems with higher efficiency that will also mitigate ammonia/sulphide emissions are the scrubber and the thermal oxidation units.

Figure 3-90: a) scrubber and b) biofilter with filling material pending to install

8. Prior to commissioning, a market outlet for the MBT products (recyclables, secondary fuel and CLO) is desirable. Potential outlets for RDF/SRF include utilisation in i) cement kilns, ii) power plants and iii) other industrial boilers. In co-incineration of RDF/SRF with fossil fuels, the actual degree of substitution varies, depending on the comparable quality of the RDF/SRF with the rest of the fuels, along with any related legal stipulations. Substitution rates established for various thermal SRF can be as low as 1% w/w, but may reach up to 20% w/w substitution in the long run for coal-fired plants and between 50 and 90% w/w for cement kilns. Of course dedicated incinerators and gasification/pyrolysis plants are not constrained by such limitation. Quality management for RDF/SRF plays a key role in efforts to establish viable market outlets, not least by creating confidence in suppliers, end-users, and regulators. However, standardization in isolation cannot guarantee increased market share. The European market for SRF/RDF is developing and remains unpredictable. The RDF/SRF contaminant properties and combustion behaviour critically affect its potential applications. Problems with low-quality RDF characteristics, particularly high chlorine and trace metals content, have led to a decline in co-combustion applications.

Overall, a significant objective for MBT is to achieve effective material flow management of municipal waste that involves separation of waste fractions into outputs of desired quality. Most of the unit operations currently used in MBT plants have an established track record. The waste input materials, specific MBT plant objectives, and output requirements have evolved considerably since the earlier RDF plants and associated dirty composting plants that relied on mechanical processing. However, there are important wider considerations to be made. MBT is generally a highly mechanized process that is energy intensive. A wider sustainability appraisal of MBT performance, compared with alternative technologies such as anaerobic digestion, therefore warrants investigation to consider issues such as energy consumption, emissions, and value in materials recovery.

3.7.10 Options for Thermal Treatment of Waste

3.7.10.1 Incineration

Introduction

Incineration is a long established thermal treatment process. The technique is widely and reliably implemented across Europe and the United States. Increasingly stricter European legislation has in recent years forced significant progress on incinerator combustion performance and flue gas quality.

In continental Europe, the growth of incineration began with the operation of City of Hamburg's first incinerator in 1895. Shortly after incinerators were established throughout Europe, particularly in Germany and in major cities including Brussels, Stockholm and Zurich.

These early designs of incinerator were based on a batch-wise operation necessitating frequent stops and starts in operation. Control over combustion was also ineffective which resulted in significant amount of combustible material left in the waste residues and stack gases. Consequently, public complaints about odour and smoke were not uncommon. Significant improvements in combustion and emissions were made with the development of mechanical grate systems to provide automatic, continuous waste feeding and better control over combustion air.

Mass burn systems

Mass burn incineration (or energy from waste) is the term that relates to the whole of the waste supplied to the plant (black or grey waste) being burnt. The grate systems that are commonly in use can be divided in to three generic types

- fixed grate
- rotary "kiln" grate
- fluidised bed

Within each of these grate designs there are sub divisions, which will have specific advantages or disadvantages over the others, but overall the differences are minor and do not affect the use of the technology. The only exception to this is that fluidised beds are more amenable to accepting processed fuels and thus are more suitable to refuse derived fuels (RDF).

Pollution abatement plant

An important part of the combustion of waste is the removal of pollutants from the combustion gasesprior to release through a chimney. There are several stages to the process that can be adopted.

- Combustion control
- Acid gas removal
- Dioxin and volatile metal capture
- Particulate removal
- Nitrogen oxides control

These processes need to be used to achieve the limits from legislation and appropriate systems exist to carry this out.

Figure 3-91: Intersection of typical layout of incineration plant

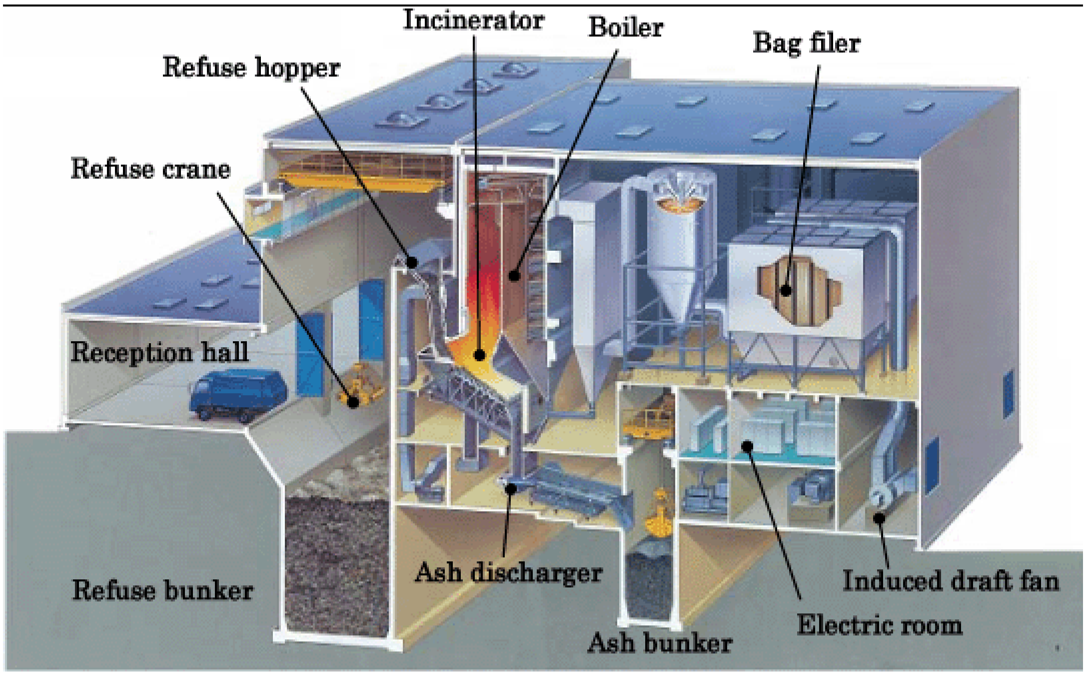
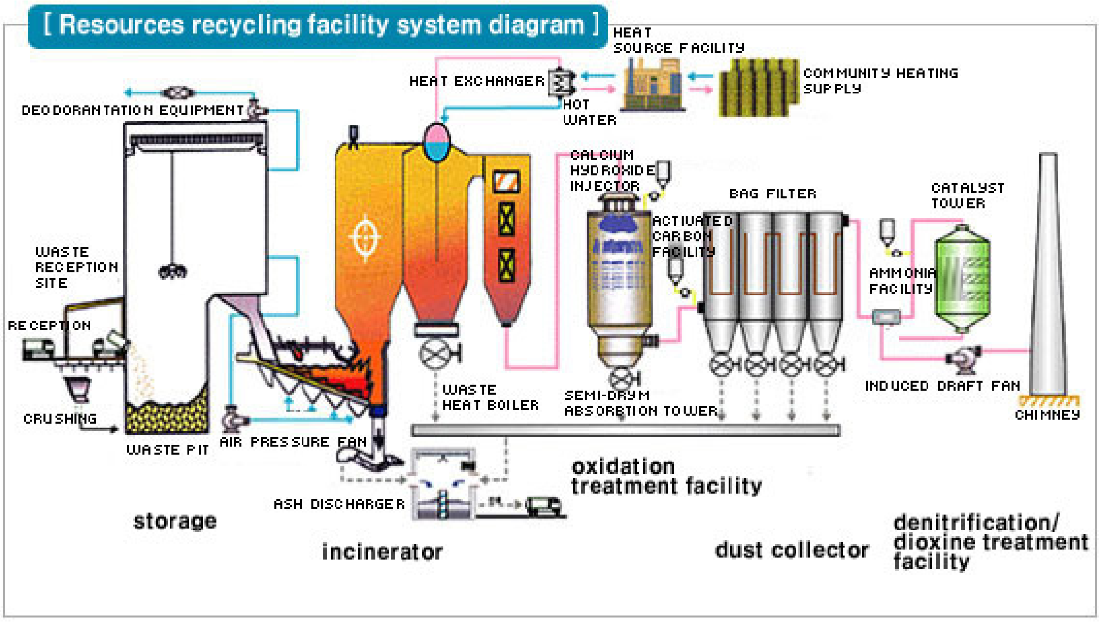


Figure 3-92: Typical layout of incineration plant



Technology Status

The latest generation of incineration plant use relatively sophisticated combustion control techniques and typically feature; selective non-catalytic reduction (SNCR) for NOx, acid gas scrubbers, activated carbon injection and fabric filter abatement technologies. In addition, all the new generation of plant feature energy recovery to generate power and/or heat for export. The sale of recovered energy is integral to the economic viability of these plants.

RDF technology has in the past been centered on d-RDF Modern RDF plants are being planned to combine energy recovery with recycling and composting activities such and new recycling projects that plan to incorporate an element of floc or densified RDF combustion.

A comparison of the proportion of municipal waste incinerated within countries of the European Union is provided in the following table.

Table 3-78: Extent of waste incineration in Europe

Country	% of waste incinerated	Amount incinerated (1000 tonnes)
Austria	14	565
Belgium & Luxembourg	33	1,734
Cyprus	0	0
Czech Republic	6	180
Denmark	54	1,598
Estonia	0	0

Country	% of waste incinerated	Amount incinerated (1000 tonnes)
Finland	2	45
France	46	15,396
Germany	17	7,926
Greece	0	0
Hungary	7	320
Ireland	0	0
Italy	6	1,703
Netherlands	27	2,630
Poland	0	0
Portugal	0	0
Slovenia	0	0
Spain	4	601
Sweden	42	1,756
United Kingdom	7	2,019

Implementation

Financial and Technical Risks

The construction of a modern waste to energy facility is a major engineering and capital cost project with costs typically in the order of 60€ million to 120€ million. These costs exceed the financial resources of most Waste Management Authorities (WMA) and consequently most new incineration facilities are implemented with private sector expertise and finance with collaboration by the WMA and sometimes with partial WMA funding. Potential funding mechanisms include:

- Joint venture arrangements using private finance initiative (PFI) funding. A joint venture company is formed between a WDA, or group of WMAs, and a private sector partner.

- Fully private sector funded with Local Authority collaboration. Typically the Local Authority will invite private sector companies or consortia to bid for the provision of a waste incineration facility. The successful bidder is contractually guaranteed, by the WMA, a minimum amount of feedstock (waste), over period of years, typically 25"30 years.

- Fully public sector funded. WMAs within in a region collaborate and jointly fund new facilities.

The financial risks associated with the construction of a new incineration plant are similar to those for any large-scale engineering project. However, the construction contractors usually assume the risks associated with the plant design and construction.

The financial risks associated with the financing of the project are assumed by the organization sponsoring the project. Where the sponsor is a joint venture company, between the private sector and a WMA then the WMA will retain some of the risk. However, in these circumstances, following successful completion of the project and subsequent operation, the WMA would also normally receive a share in any profits made.

The financial risks associated with the operation of the plant include costs of technical failures, inability to operate to design specification and insufficient waste feedstock.

The risk of technical failure will be minimized through the choice of appropriate proven technologies with a good history of reliable performance. In choosing the appropriate technologies consideration must be given to the required plant capacity (e.g., a technology may be well proven but not on the scale required) and current and future legislative requirements, in particular in relation to air emissions.

The financial risk of technical plant failures may be transferred to the plant constructor or individual equipment suppliers by ensuring that guarantees are obtained on equipment performance and technical support for at least the first few years of the plants operation. However, in the event of long term or recurrent plant performance the WDA may be forced to find alternative methods of waste disposal and may also be, in the long term, liable for the costs of maintaining unreliable and/or inappropriate incineration plant costs following expiry of equipment. Therefore the best option is to ensure proven and appropriate technology is specified in the planning stage, instead of relying on contractual clauses to provide, albeit time limited, financial protection.

Each incineration plant is designed to handle a particular minimum quantity of waste. If a plant were to receive less waste than planned then it would also receive less income from gate fees and energy sales (since energy output is dependent upon the amount and calorific value of the waste combusted) and subsequently the operation of the plant may not be economically viable. These risks can be mitigated through careful and thorough specification of the incineration plant. To address these risks, incineration operators agree long term contracts obliging WDAs to guaranteeing minimum tonnages of waste. However, these agreements can also transfer the risk to the WDA. For example, if a WDA fails to deliver a contractually agreed amount of waste it may be liable to the payment of penalties to the Operator. Similarly where the WMA is part of a joint venture company to incinerate wastes, it will also share in any economic failure of the company.

These difficulties are avoidable through careful specification of the plant capacity. When specifying the capacity of plant to be installed, the current amount of wastes collected in a given area must be carefully assessed and account must be taken of the effects of likely future strategies, policies and targets e.g. recycling targets. This process of assessment must include consultation with the key stakeholders, including in particular the WCAs, to agree a waste management strategy and therefore to facilitate a reliable prediction of future waste disposal requirements.

Planning issues

The construction and operation of a waste incinerator needs an environmental impact assessment (EIA), study approval.

Energy from waste plants (EFW) are often highly visible due to their size and the presence of a large chimney. They are also often sited close to the communities that they serve, in accordance with the proximity principle, to minimize the distance travelled by refuse collection vehicles. Consequently these facilities may receive more public attention than other waste management facilities. Where the incinerator is situated close to residential areas there may also be concerns over noise, odour, traffic movements and stack emissions. All these factors can create public concern about proposals for EfW plant that may be expressed during the planning process. Similarly the public has the opportunity to comment on the application for process authorization.

Detailed consultation with local residents associations, local government associations and environmental groups before a planning application is submitted will enable the prospective developer to identify local concerns at the earliest possible stage. Consequently the developer will have the opportunity to address these concerns in the application for both planning permission and for the authorisation to operate and may significantly reduce the chances of refusal. Similarly, on going liaison with local interest groups throughout the construction and operational phases of the development would facilitate the acceptance and integration of the facility into the local community.

Environmental Impacts Issues

One of the biggest issues of concern over EfW plants relates to the stack gas emissions. In part this concern arises from the poor historical reputation of waste incinerators particularly in relation to dioxin emissions. The required limit of air emission, according to the relative directive (2000/76/EC) for incineration is given in the following table.

Table 3-79: Limits of air emissions – (daily average)

(EC Directive 2000/76/EC – Annex V)

Total dust	10 mg/m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	10 mg/m^3
Hydrogen chloride (HCl)	10 mg/m^3
Hydrogen fluoride (HF)	1 mg/m^3
Sulphur diodixe (SO_2)	50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration	200 mg/m^3 (*)

plants	
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide for existing incineration plants with a nominal capacity of 6 tonnes per hour or less	400 mg/m^3 (*)
(*) Until 1 January 2007 and without prejudice to relevant (Community) legislation the emission limit value for NO_x does not apply to plants and incinerating hazardous waste	

Exemptions for NO_x may be authorized by the competent authority for existing incineration plants:

- With a nominal capacity of 6 tonnes per hour, provided that the permit foresees the daily average values do not exceed 500 mg/m^3 and this until 1 January 2008
- With a nominal capacity of >6 tonnes per hour but equal or less than 16 tonnes per hour, provided the permit foresees the daily average values do not exceed 400 mg/m^3 and this until 1 January 2010
- With a nominal capacity of >16 tonnes per hour but <25 tonnes per hour and which do not produce water discharges, provided the permit foresees the daily average values do not exceed 400 mg/m^3 and this until 1 January 2008

Until 1 January 2008, exemptions for dust may be authorized by the competent authority for existing incineration plants, provided that the permit foresees the daily average values do not exceed 20 mg/m^3.

Releases to Water

Liquid effluents arise from the use of wet or semi-wet gas scrubbers and comprise containing spent scrubber solution and fine fly ash particles. The usually caustic scrubber effluent will contain significant concentrations of heavy metals and organic micro-pollutants. Currently most plants employ dry or semi-dry scrubbers which do not give rise to liquid effluents, however the wet scrubbing process is more efficient and is likely to supersede the dry systems as emission limits further tighten.

Liquid effluents also arise from grate ash quench tanks, used to cool the grate ashes. The grate ash effluent will contain only small concentrations of heavy and currently disposal of these effluents may take place by discharge to a river or estuary, under consent from the Environment Agency or by discharge to the sewerage system.

Releases to land

The incineration of municipal waste in a modern incineration plant gives rise to bottom ash, the coarse residues falling off the end of the grate, and fine particulate matter collected by the APC equipment called fly ash or simply APC residues. Lime and activated carbon that are deliberately added to clean the flue gases is also trapped with the fly ash.

The bottom ashes contain the majority of the metals emitted from the incinerator but these are largely inert, and have been widely used in Europe as building aggregate. In particular, the Netherlands uses some 90% of EfW bottom ash in this way.

Bottom ashes can be used as secondary aggregate in road foundations and other constructional projects. The only treatment required is removal of ferrous and non-ferrous metals and ageing to allow the ash to stabilise. Large amounts of ash are recycled in this way.

Noise

All process plant using mechanical equipment will generate noise and incinerators are no exception. The major sources of noise from incineration plant are usually from fans in the combustion, gas cleaning and emission systems. However, good plant design can reduce this noise to acceptable levels. For example, fans can be housed in sound proofed enclosures and simple measures such as earth banks and trees can further attenuate noise levels. In addition, the specification and purchase of new equipment (e.g. fans) should take noise considerations into account with preference given to quieter running machinery.

Visual Impact

The visual impact of any new development is an extremely important element in planning considerations - no one wants an "eye sore" on their doorstep. The visual impact of an incineration plant depends upon its siting, physical size and design.

An incineration plant should, ideally, be located in an area where it will have minimal visual impact, such as in a major industrial landscape and built to a design sympathetic with its surroundings.

Contribution to Targets and policies

The key target for municipal waste in the Landfill Directive is the requirement to reduce the amount of biodegradable waste landfilled. The precise targets are to reduce the biodegradable municipal waste landfilled to 25%, 50% and 65% of the 1995 quantities by 2010, 2013, 2020 respectively (old EU Member Stattes).

Incineration does not contribute direct to the recycling target, as it is a recovery process. Recycling is performed on the ferrous metal extracted as part of the waste processing or the ash processing and this contributes 3.5% recycling. The use of the bottom ash as a construction material is not included within the recycling definition, but does divert an additional 10.15% of the waste away from landfill. The recent definitions (in the Waste Framework Directive) for recycling and recovery do allow counting incineration for recycling in case that specific energy efficiency is achieved.

RDF processing enables additional recycling to be performed. Options for the recovery of nonferrous metals and the recovery of plastics and textiles and small amounts of paper/card are possible through mechanical and manual processes. Experience from dirty MRF operations and proposals for plants under consideration would suggest that a further 5.8% of recyclables could be extracted through this route. The reject fractions from the processing could be directed to other processes such as AD or composting to produce further products or reduce the pollution potential.

3.7.10.2 Gasification / Pyrolysis

Introduction

Gasification and pyrolysis are two upcoming technologies that promise improved performance over traditional combustion technologies.

Gasification

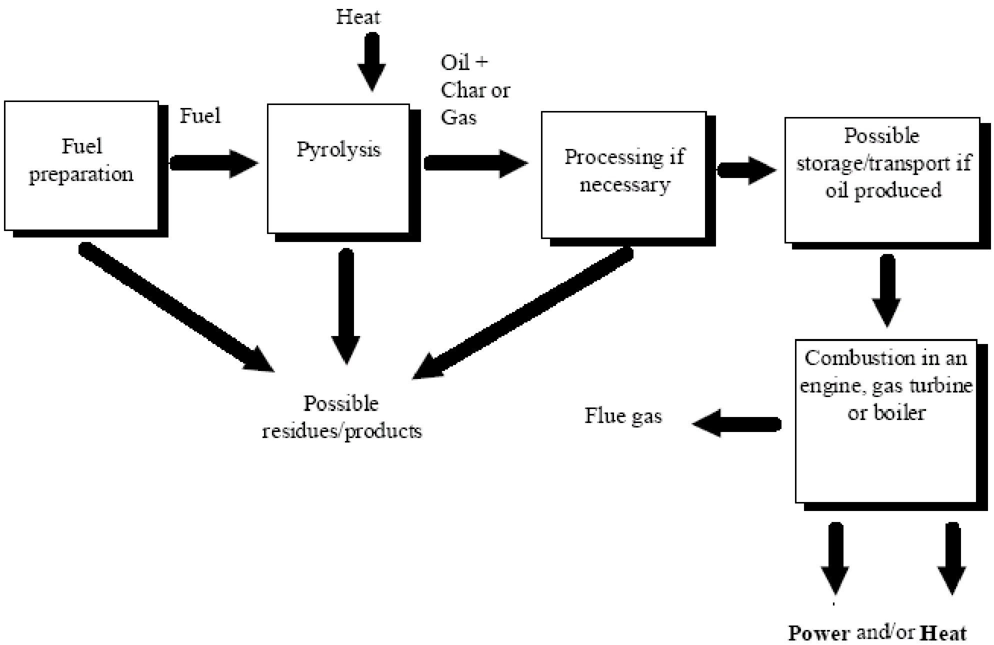
Gasification is the conversion of a solid or liquid feedstock into a gas by partial oxidation under the application of heat and is shown schematically in Figure 6.1. Partial oxidation is achieved by restricting the supply of oxidant, normally air. For organic based feedstocks, such as most wastes, the resultant gas is typically a mixture of carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen and small amounts of higher hydrocarbons. The gas has a relatively low calorific value (CV), typically 4 to 10 MJ Nm (the CV of natural gas is about 39 MJ Nm). This gas, sometimes called producer gas, can be used as a fuel in boilers, internal combustion engines or gas turbines.

Although air is usually used as the oxidant, oxygen enriched air or oxygen can also be used. When not using air, the resulting gas, often called synthesis gas, will have a higher CV (typically 10 to 15 MJ Nm) than that formed using air due to the absence of nitrogen.

For most waste feedstocks, the gas will contain tars and particulate matter, which may need to be removed before the gas, is suitable for combustion. The degree of this contamination will depend on the gasification technology used.

Gasification is not a new technology, although its application to waste feedstocks is still being developed. Coal gasification has been used since the early 1800s to produce town gas and the first four-stroke engine was run on producer gas in 1876.

Figure 3-93: Gasification



<u>Pyrolysis</u>

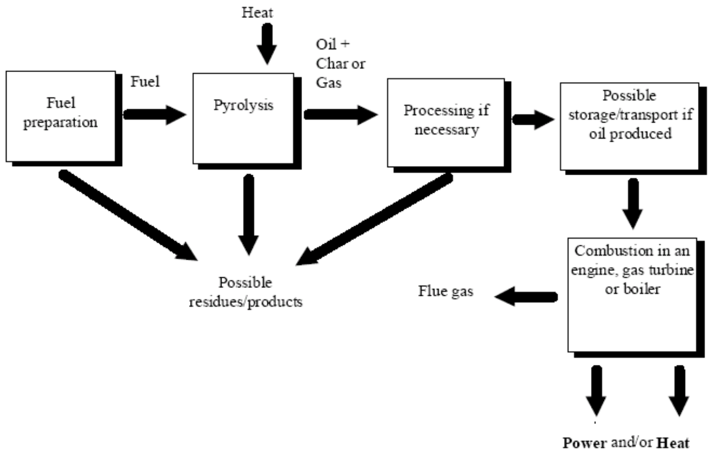
Pyrolysis is thermal degradation of a material in the complete absence of an oxidizing agent (e.g. air or oxygen). In practice, complete elimination of air is very difficult and some oxidation is likely to occur. The process is shown in Figure 6.2.

Typically the process occurs at temperatures in the range 400-800°C. When applied to waste materials, the action of heat breaks complex molecules into simpler ones. This results in the production of gas, liquid and char. These products can have several uses depending on the nature of the feedstock, however for waste based feedstocks the most likely use is as a fuel for energy generation.

The relative proportions will depend on the temperature the material is subjected to, the time for which it is exposed to that temperature and the nature of the material itself. Long exposure to low temperatures will maximise the production of char whereas 'flash' pyrolysis gives up to 80% by weight liquid. Flash pyrolysis involves short exposure (<1 second) to temperatures around 500°C. Rapid quenching is necessary to 'freeze' the reactions and condense gaseous species before simple molecules are formed which are naturally gaseous under ambient conditions.

If a gas is the principal product, then it is likely to have a higher CV (typically 15 to 20 MJ NM^{-3}) than that produced by gasification (in which the gaseous species are partially oxidised).

Figure 3-94: Schematic representation of pyrolysis process



Technology Status

State of deployment in Europe

About forty advanced thermal conversion plants for wastes have been reported identified and about 26 of these are known to have treated MSW or RDF. The scales range from small laboratory plants to about 50 kt y^{-1} demonstration plant. The two processes at the commercial demonstration phase are the TPS Termiska Processer fluidised bed gasifier and the Thermoselect process. Whilst several other developers are close to having a commercial scale demonstration plant and these include the Lurgi, Siemens and Proler. The majority of the plants being developed are likely to operate commercially at less than 100 kt y^{-1}.

A wide range of companies have been involved in the development of these technologies from individuals to large corporations. As the technologies approach commercialisation, increasingly the larger private companies and public companies are beginning to dominate. This is largely due to the difficulty smaller companies find in accessing the capital required to commercialise these plants.

The development of advanced thermal conversion technologies also requires significant resources. Most of those technologies nearing commercial operation started development in the mid to late 1980s. To finance this process, the resources of a large company or access to public funds has typically been necessary.

Wastes processed

Various developers have tested many different waste types. In deciding which wastes to use as a feedstock, developers consider several factors:

- waste availability;

- likely gate fee;
- waste homogeneity.

Some wastes, whilst potentially being attractive feedstocks, will not be readily available as the collection infrastructure does not exist. Plastics often fall into this category, at present usually being co-disposed with other wastes.

Gate fees are likely to be greatest for those wastes that are more hazardous such as clinical waste. However, the total market size for the disposal of such wastes may not be as large as for MSW and handling difficulties may make them unsuitable for use on pilot plant.

Advanced thermal conversion technologies generally require a reasonably homogeneous feedstock. Large variations in feedstock composition can result in problematic fluctuations in the producer gas or liquid fuel CV. Mass burn combustion systems overcome the difficulties associated with feedstock variations through feedstock mixing and the large size of the combustion chamber. It is likely that gasification and pyrolysis processes will accept a range of wastes rather than just MSW or RDF.

As a result of these factors, the most common feedstocks used with advanced thermal conversion technologies are sorted MSW (RDF) and tyres. Some developers have also tested various industrial wastes, wood waste and automobile shredder residue.

Performance

The energy output is ultimately determined by the feed and processing parameters. Net energy outputs are reported to be in the range of 260 - 1000 kWh of electricity per tonne of MSW derived feedstock (i.e. some figures refer to unsorted MSW and some to RDF). The lower end of the range is for plant designed to minimize environmental impacts to all media and so includes ash verification and wastewater treatment. The upper end of this range is a plant utilizing combined cycle technology, which meets the current emissions requirements for waste combustion but not going beyond this, and probably result from highly sorted MSW. Materials with higher calorific values such as rubber and plastics are reported to produce up to 3000 kWh of electricity per tonne.

The residues from the gasification and pyrolysis processes will be biologically inert and thus will contribute to methane generation in landfill. However, many of the processes will use RDF pre-treatment and this will result in unburnt residues for landfill or biological treatment.

Implementation

Financial and Operational Risks

Capital availability is crucial to technology development and commercialisation. The most advanced pyrolysis and gasification technologies have mostly been developed by large engineering companies who have the balance sheets to cover the risks associated with a first-off plant and who have the significant research and development budgets necessary. Public money has also been very important to many developing technologies either through grants or direct R&D in the public sector.

The financial risks are similar to those of incineration and RDF. There are additional risks derived from the untested market position of gasification and pyrolysis and the potential for technical failure of the systems.

Many of the trials of advanced conversion technologies have been carried out with closely specified and screened feedstocks. Commercial systems will need to be more tolerant of feedstock variation if they are to maximize cost effectiveness.

As most of the advanced conversion technologies being reviewed are at relatively small scale, one of the key areas for development is plant scale-up. Typically, scale-up factors of between three and ten times existing plant capacity will be required for commercial plant. Such a scale-up can represent high technical risk.

More generally, there has been a tendency for technology developers to concentrate on the gasifier or pyrolysis unit. Potential customers are likely to require a waste processing system, which includes all front-end materials handling, ash and other residues handling and energy generation/distribution.

Planning issues

Gasification and pyrolysis units are expected to be established as small scale units that fit within a local waste management strategy, which is not seen as economically possible with combustion systems. Whilst within the planning process the same issues exist with these processes as with combustion the scale factors will reduce the problems in the planning process. The biggest benefits from this approach will be in terms of the traffic and visual impacts although the concerns over air emissions are likely to be equally opposed to advanced thermal processes or combustion.

Mass burn combustion (MBC) is generally only economic at greater than about 100 kt y^{-1}. Many advanced thermal conversion plants are being developed to operate at scales below 100 kt y^{-1} and so may be more able to meet the requirements of the proximity principle, especially in rural areas.

Environmental Impact Issues

The atmospheric emissions from a process will depend on pollution abatement (PA) plant used, but for pyrolysis and gasification cleaning up the producer gases before combustion offers potential cost savings when compared to MBC. This is because there are lower gas volumes involved (which can be less than one-tenth of those for MBC) and consequently the pollution abatement (PA) plant can be smaller. For some advanced conversion systems, cleaning the producer gas can mean high temperature gas cleaning (cooling gases before cleaning reduces thermal efficiency) which may be a problem.

Some of the advanced conversion plants being developed have inherently lower emissions than MBC and may require less sophisticated PA plant to be fitted. There are several reasons for these lower emissions:

- Waste sorting produces a more homogeneous fuel;
- Lower gas flows reduce carry-over of particulate matter;
- Improved combustion through the production of an intermediate gaseous or liquid fuel.

  - Water emission

The sources of liquid residues from MBC plant are boiler blow down and wet scrubbing systems, when used for flue gas cleaning. Whilst these sources remain for gasification and pyrolysis systems using steam cycles or wet scrubbers, these technologies can also produce liquid residues as a result of the reduction of organic matter. Such residues have the potential to be highly toxic and so require specialised disposal. Any releases of liquid residues into the environment should therefore be carefully considered.

  - Solid emissions

Gasification and pyrolysis have the potential to produce less ash than MBC and the solid residues, which are produced often, have a market value. There are several reasons for this and the reasons vary with technology. The two most significant factors are firstly, that several technologies involve waste sorting before thermal treatment, hence the fines, which contain a significant portion of the ash forming minerals, are discarded.

The second factor is that some of these processes involve a high temperature stage, which results in ash vitrification (ash is melted and forms a glass-like substance on cooling). Vitrified ash is more likely to pass leaching tests and may therefore be safer to landfill and more suitable for use as a construction material.

Two elements, which are commonly recovered for re-use from advanced thermal conversion technologies, are carbon and sulphur. Sulphur removal from producer gas is relatively simple and the char left by gasification or pyrolysis of many wastes is often predominantly carbon.

- Nuisance

Nuisance from gasification and pyrolysis plant from noise, odour and visual impact will be similar to other thermal conversion processes. The noise an odour issues are easily contained, so long as good modern design of the waste reception facilities are adopted. Visual impact issues may well be reduced compared to combustion due to the smaller scale of the facilities, but the difficulties over hiding the chimney will still remain.

Contribution to Targets and Policies

The ashes and APC residues will be biologically stable when landfilled. However, the APC residues will have chemical reactivity from the lime present and thus will require specialised disposal. The residues from RDF production will vary depending on the intensity of the process. Some fractions will be rich in glass stones and metals and as such will have a low level of biodegradability and as such will contribute to the reduction of landfill of biodegradable materials. Other fractions, principally the initial fines fraction will contain a high proportion of organics and thus will provide a more concentrated fraction for landfill and it may be necessary to compost this material prior to landfill. Overall the RDF fraction will remove biodegradable material from the waste stream and thus the total amount of biodegradable material remaining for landfill will be reduced. The precise degree of this reduction will depend on the process adopted and the quantity and nature of the rejects generated.

Gasification and pyrolysis do not contribute to the recycling target, as they are recovery processes. Recycling is performed on the ferrous metal extracted as part of the waste processing or the ash processing and this contributes 3-5% recycling. The use of the bottom ash as a construction material is not included within the recycling definition, but does divert an additional 10-15% of the waste away from landfill. The new definitions (Under Waste Framework Directive)for recycling and recovery do allow for counting of recycling, in case specific energy efficiency it is achieved.

RDF processing as a pre-treatment enables additional recycling to be performed. Options for the recovery of non-ferrous metals and the recovery of plastics and textiles and small amounts of paper/card are possible through mechanical and manual processes. Experience from dirty MRF operations and proposals for plants under consideration would suggest that a further 58% of recyclables could be extracted through this route. The reject fractions from the processing could be directed to other processes such as AD or composting to produce further products or reduce the pollution potential.

3.7.11 Options for Landfilling

3.7.11.1 Introduction to Landfilling

Although waste disposal is the least preferred option, it still regards a necessary part of an integrated waste management system. The technical requirements for the construction, sitting, operation and aftercare of landfill sites have to conform to the Landfill Directive (1991/31/EC) and the respective national legislation, in order to assure sound environmental and health safeguards. Sanitary landfills provide an adequate high level of environmental protection by a reduced impact (low odours, animals and risk of fire), health risks and a better control over waste; they require a significant degree of engineering in order to configure the site & cells and control emissions.

Initially, suitable candidate locations for a landfill must be sought, that take into consideration requirements relating to:

(a) the distances from the boundary of the site to residential and recreation areas, waterways, water bodies and other agricultural or urban sites;

(b) the existence of groundwater, coastal water or nature protection zones in the area;

(c) the geological and hydrogeological conditions in the area;

(d) the risk of flooding, subsidence, landslides or avalanches on the site;

(e) the protection of the nature or cultural patrimony in the area.

Planning and permitting has to comply with Article 7, containing for example the description of the types and total quantity of waste to be deposited, the proposed capacity of the site, the operation, monitoring and control plan, the methods for pollution prevention and abatement, an impact assessment, a financial security provision, etc. In the design phase, three stages should be considered:

- The construction stage, when barriers and networks for the safe management of pollutants are installed (membranes, lining systems, leachate and biogas collection systems)

- The operation stage, when daily cover of disposed waste takes place, while monitoring the environmental impacts related to waste deposition

- The Closure and aftercare stage, when the application of the top cover takes place for the minimization of the environmental impacts related to the deposited waste. Also, the monitoring of the environmental impacts related to the landfill continues for several years, while activities for the utilization of the site take place (i.e. golf courses, sport facilities)

3.7.11.2 Landfilling: Technical description

The regional landfill in the East region will accommodate the waste from all 11 urban and rural municipalities. It is preferable to locate the site in an area that allows easy access via regional roads for all municipalities. The overall landfill is developed in cells – phases, separated normally by embankments. The bottom of the cells is configured in the shape of V, typically with 5% longitudinal and 3% transversal slope, whereas inclination of slopes ranges from 1:3 to 1:2,5. The life-time of first cell is normally for 5 to 8 years whereas the total lifetime of landfill is 20-30 years. The capacity must take into account the waste forecast over the project horizon, the various waste flows (recovery or disposal operation), the compacted waste density (equal to 0,8 t/m^3), the daily soil coverage typically 12,5% volume and a safety factor.

In essence, a sanitary landfill provides proper environmental and health safeguards for the disposal of waste. The main operations in a sanitary landfill consist of the compaction of refuse in a lined pit and covering of the compacted refuse with an earthen cover. Waste is unloaded, compacted with bulldozers, and covered with compacted soil. The landfill is built up progressively in cells. The landfill further includes an entrance gate, the internal access road, the buildings, the leachate treatment plant, the gas flare and areas reserved for particular purposes. The disposal area is divided into cells with ramps to enable the vehicles to reach the unloading zone.

Bottom sealing

The main component of the landfill is the sealing system, the purpose of which is to minimise or eliminate the negative environmental impact of waste deposit (e.g., infiltration of leachate). The system must be designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater or surface water and ensuring efficient collection of leachate. Protection of soil, groundwater and surface water is to be achieved by the combination of a geological barrier and a bottom liner during the operational/active phase.

The geological barrier is determined by geological and hydrogeological conditions below and in the vicinity of a landfill site providing sufficient attenuation capacity to prevent a potential risk to soil and groundwater. The landfill base and sides shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to the one resulting from the following requirements:

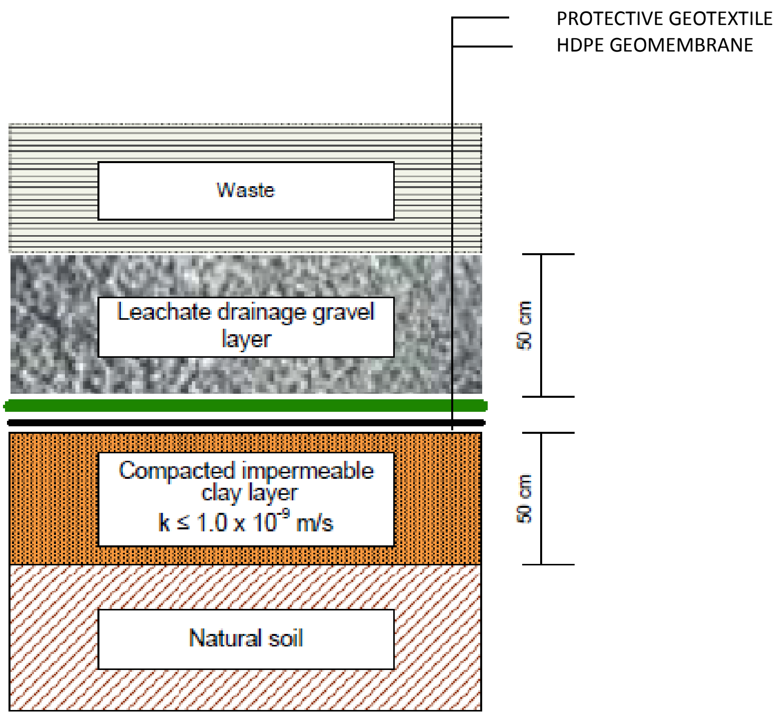
- Landfill for hazardous waste: $k \leq 1.0 \times 10^{-9}$ m/s; thickness ≥ 5 m;
- Landfill for non-hazardous waste: $k \leq 1.0 \times 10^{-9}$ m/s; thickness ≥ 1 m;

- Landfill for inert waste: k ≤ 1.0 x 10^{-7} m/s; thickness ≥ 1 m.

Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0.5 meters thick. The bottom sealing consists of the following (Figure …):

- ground base level and compaction to a 20cm depth
- Layer of 0.5 m of compacted non permeable clay, with permeability coefficient of k≤1.0x10^{-9} m/s. The geological barrier will be compacted with a vibrating roller, assuring a surface as smooth as possible.
- Watertight HDPE membrane, 2 mm thick placed over clay layer;
- Protective geotextile of 500 g/m^2, thickness of 2,5 mm, in order to prevent any damage of geomembrane by coarse particles of the drainage layer;
- Leachate drainage layer of minimum 0.5 m, placed above the geotextile, with drainage pipe system for collection and transport of leachate towards the leachate treatment facility.

Figure 3-95: Design of Bottom Liner Construction



In case that there is no source of impermeable clay with the set permeability characteristic at close distance, there are two options for consideration:

a) The excavated clay or clay soil will be mixed with bentonite on the site, or

b) The excavated soil will be compacted to form a layer of 50 cm and on top of this a geosynthetic clay layer (GCL) will be laid.

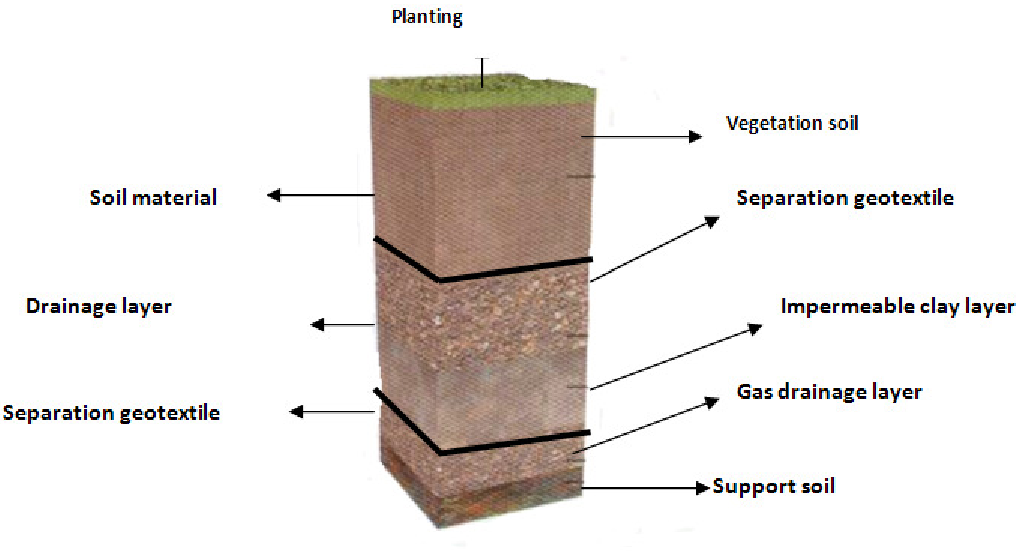
Geotextiles are used for protection of the polymer liner against tear and wear during the installation works and against damages from particles in the drainage layer. The geotextile shall be a non-woven geotextile of UV-stable polypropylene, polyethylene or polyester capable of resisting exposure to the sun for minimum two years. The weight of the geotextile shall be indicatively 500 g/m^2.

Final cover

After the cell is filled, it has to be covered with a final surface sealing in order to prevent any impact on public welfare and the environment. Construction of the final surface sealing system consists of (from the bottom up):

- Support compacted soil layer of 0,20 m thickness
- Gas drainage layer made of gravel material 8/32 mm 0,30 m thickness with $k > 1x10^{-4}$
- Separation geotextile (recommended), 200 g/m^2
- Impermeable clay layer of a minimum thickness of 0,50 m and $k < 5x10^{-9}$ m/s. Alternatively, a Geosynthetic Clay Liner can be laid, having an equivalent permeability value
- Rainwater drainage layer made of granular materials of minimum thickness 0,50 m and $k > 1x10^{-3}$ m/s. Alternatively, an artificial drainage layer can be laid, achieving an equivalent permeability value
- Separation geotextile (recommended), 200 g/m^2
- Top soil cover of a 1,0 m thick, of which the upper 0,30 m layer is vegetation soil.

Figure 3-96: Construction of top cover layers



Flood protection

Flood protection works are constructed in the site, in order to avoid storm water entering the landfill and mixing with waste and leachates, structural stability of landfill and protect the buildings and the roads from water erosion. Rain water must be drained and diverted outside the landfill. The flood protection works of the site consist of the following:

- Ditches in the perimeter of the landfill cells
- Ditches for the protection of facilities and embankments
- Ditches for the protection of internal road network
- Drainage well of ditches and sewers.

Leachate collection

The formation of leachate in a sanitary landfill is mainly caused by the percolation through the waste mass of water from precipitation. In contact with the decomposing waste, it becomes loaded with various substances and degradation products and moves slowly to the base of the landfill.

Leachate collection is done at the landfill bottom via perforated leachate pipes HDPE preferably DN310 or higher. The inclination of the landfill base must ensure safe leachate drainage to the lowest point. Leachate wells are placed periodically, in order to ensure easy maintenance and cleaning (flushing) of the pipes. The leachate is directed to the leachate treatment plant.

Auxiliary facilities

The landfill must be equipped also with a number of auxiliary facilities for its proper operation. These include:

- Main entrance
- Fencing
- Security house
- Weighbridge
- Tyre wash

The sanitary landfill site will be entirely fenced. The security house is located next to the main entrance of the facility and is equipped with the necessary electronic equipment for control.

After passing the entrance gate, incoming vehicles pass from the weighbridge for recording and weighing. The incoming trucks will be directed to the unloading areas.

Before leaving the site and entering the public roads, all vehicles will undergo tyre cleaning. The purpose of the wheel washing system is to wash the tyres of transportation vehicles from mud and waste residues. The washing water contains a disinfectant solution.

Buildings

A. Administration: this building serves the project administration, the personnel and the visitors. Next to it, parking area for personnel and visitors is envisaged.

B. Maintenance: The building is planned to cover the maintenance and lubricating purposes of the trucks and other mechanical equipment. For the proper operation of the project, a fuel station to serve mobile equipment is proposed.

C. Washing facility for vehicles: it serves the purpose of washing of collection vehicles and mobile equipment.

D. Garage – parking space for vehicles.

E. Energy Building: it will host Transformer, Emergency Power Generator and Electric Panel rooms. It can be also “kiosk” type.

Leachate treatment

Once collected, the leachate has to be treated and discharged according to regulations.

Possibilities for leachate treatment can include:

- Preliminary treatment of leachate with recirculation to landfill and disposal to the municipal sewer system.
- Full treatment and discharge to the nearest surface water recipient

The second option allows discharge of wastewater into a local water body. The first option requires the wastewater to be transported to a connection point where it can be inserted into the sewer system. This transport may be done by a pipe line or a truck.

A range of technologies have been applied for leachate treatment, including (i) biological methods (ii) physical and iii) chemical methods (see Table 5). However, in order to meet stricter quality standards allowing treated leachate to enter a surface acquifier, a combination of chemical, physical and biological steps, would be required.

Table 3-80: Leachate treatment technologies

Treatment	Applicability (removed components)
Physical treatment processes	
Air stripping	Methane stripping – the use of diffused air to strip out or reduce the dissolved methane content of leachate is commonly used. Ammoniacal-N removal – is depended on pH and temperature, to be effective it may be necessary to raise the pH and heat the leachate. Stripping of other volatile contaminants – is dependent on the contaminants present and is unlikely to remove all contaminants completely
Reverse osmosis	Has been used to treat leachate in a number of European countries. The reverse osmosis process generates a high quality effluent.
Solids removal	Sedimentation and Settlement – this is currently the most common method of reducing the suspended solids content of leachate. If the particle sizes are colloidal it may be necessary to add a flocculent. Sand filtration – Occasionally used if the solids are very fine or colloidal. Sand filtration has a high initial capital cost and requires a high degree of control. Dissolved air flotation – This is sometimes used when available land does not allow the construction of settlement tanks. Leachate usually requires conditioning prior to treatment and there are high capital costs associated with this method of treatment.
Activated carbon adsorption	Powdered activated carbon (PAC) – Is sometimes used as an absorbent particularly for the removal of organic compounds in the final polishing after biological treatment, however the consumable costs can be high. Granular activated carbon – has the same uses but may be generated

Treatment	Applicability (removed components)
	and although its use is associated with higher capital costs than PAC the operational costs may be lower than those for PAC.
Ion exchange	Resins typically made of synthetic organic material remove ions from solution by the exchange of anions or cations. The very high concentrations of anions and cations within leachate means that the use of this process is currently limited.
Evaporation/concentration	This process can be used to dispose of concentrates from the reverse osmosis process but is currently not very common.
Chemical treatment processes	
Chemical oxidation processes	Ozonation – ozone is sometimes used to oxidise complex organic constituents that do not easily biodegrade. It is also used as a sterilising agent. Ozone is highly toxic and requires rigorous implementation of safety procedures. Hydrogen Peroxide – hydrogen peroxide has been principally used to oxidise sulphide. It can also be used to treat phenols, sulphite, cyanide and formaldehyde. As a strong oxidising agent it should be stored and handled with care.
Precipitation/coagulation/ flocculation	Chemical precipitation of metals – Heavy metal concentrations in leachate from landfills accepting primarily domestic waste tend to be low when compared to raw sewage and can be reduced using oxidation and normal settlement processes. Consequently chemical precipitation is not widely used. Coagulation and flocculation – Flocculants can be used to remove particles that do not readily settle out. It is currently rarely applied in the UK to raw leachate treatment and only occasionally to biological retreated effluents.
Aerobic biological treatment processes	
Suspended growth systems	Aerated lagoons – These are generally effective for only relatively dilute leachate. Low water temperatures during the winter can reduce performance. Activated sludge – Is the most widely used aerobic biological process. It can provide a high degree of treatment for high strength leachate. Sequencing batch reactors (SBRs) – This uses the principles of activated sludge but with the biological treatment and final settlement all taking place within the same vessel. Tank based systems are less effected by seasonal temperature variations. Membrane bioreactors (MBRs) – This is an advanced form of the traditional activated sludge process that uses a membrane to capture the solids in preference to gravitational settlement.
Attached growth systems	Percolating filters – This process is rarely used for leachate treatment. Rotating biological contactors – Have been used historically in the UK

Treatment	Applicability (removed components)
	for leachate treatment. However they can suffer from the problems associated with percolating filters in that high concentrations of metals particularly iron can adhere to the media inhibiting biological activity. Biological aerated filters / submerged biological aerated filters – These are occasionally used for treating leachate but are susceptible to toxic materials adhering to the media inhibiting biological activity. Biofilm reactors – These are high rate reactors capable of high carbonaceous removal.
Anaerobic biological treatment processes	
Upflow anaerobic sludge blankets	Upflow Anaerobic Sludge Blankets (UASB) – This system is not very common.
Aerobic/ Anaerobic biological treatment processes	
Engineered wetlands	Horizontal flow reedbeds – Frequently used to provide tertiary treatment to reduce Biochemical Oxygen Demand and solids. Vertical flow reedbeds – These require less land area than horizontal flow reedbeds and are more efficient at reducing ammonia. Wetland ponds – Pond systems can combine gravitational settlement, gravel filters and marginal plants that can provide tertiary treatment.

The hydraulic load, m^3/day, of the leachate treatment system is calculated from meteorological data and the surface of landfill cell. To this, the other sources of wastewater (washes, etc) are added. In particular, sanitary wastewater (personnel sewage) and washes from vehicle cleaning will be pumped via a standard prefabricated PE pumping pit also to WWTP, as the WWTP is compatible with any kind of biodegradable wastewater. At the same time it will provide with a source of phosphorous. In case that the length of pipe is uneconomically long, sewage can be alternatively temporarily stored in septic tanks and emptied periodically by trucks.

Landfill gas collection and treatment

Landfill control systems are employed to prevent unwanted release of landfill gas into the atmosphere or soil. Recovered landfill gas can be used to produce energy or to be flared under controlled conditions to eliminate the discharge of greenhouse gases to the atmosphere.

Landfill gas is composed of a number of gases, but mainly methane (CH4) and carbon dioxide (CO2) at approximate percentages of 55% and 45% respectively. It also has other minor components such as hydrocarbons, hydrogen sulphide (H2S), ammonia (NH3), oxygenated and halogenated organic compounds. The principal gases are produced from the decomposition of the organic fraction of MSW. The landfill gas management system consists of the following:

- Gas extraction wells
- Gas collection and transmission system including pipe work, dewatering unit and gas sub-

station

- Flare system (including gas booster).

The gas extraction system contains numerous gas wells and gas pipes to the collection stations (containers) with the gas collections beams from which the gas will be led to the flare to be finally burned. The flare shall be a closed-type, allowing high efficiency with combustion at least at 1.000 °C and 0,3 s residence time to ensure compliance with the emission regulations. In this case the estimated peak gas quantity for landfill is 400 m3/h. The gas flare must be designed with a 15-20% safety factor, as well as to allow combustion of variable gas flow rate at a typical ratio 1:5 or 100 - 500 m3/h.

During the first five to eight years of operation, the landfill gas will be flared, as the landfill gas production is too poor in quantity and quality to be used for energy production purposes. After the amount and quality of the landfill gas is stable, corresponding studies may be carried out in order to test the feasibility of installing a landfill gas conditioning unit and a unit for co-generation of heat and electricity.

Figure 3-97: Sample landfill gas treatment facility at landfill

3.7.11.3 Design Considerations

Landfill design requires a significant degree of engineering in order to shape the cells, control emissions and minimize potential environmental effects. In the design phase, three stages should be considered:

- The construction stage, when barriers and networks for the safe management of pollutants are installed (membranes, lining systems, leachate and biogas collection systems)
- The operation stage, when daily cover of disposed waste takes place, while monitoring the environmental impacts related to waste deposition
- The Closure and aftercare stage, when the application of the top cover takes place for the minimization of the environmental impacts related to the deposited waste. Also, the monitoring of the environmental impacts related to the landfill continues for several years, while activities for the utilization of the site take place (i.e. golf courses, sport facilities)

The successful operation of the landfills depends on:

- Good sitting: the location of the landfill should be selected according to technical, financial, regulatory, political environmental and social criteria.
- Consideration of the following parameters:
  - Bottom liner
  - Leachate collection/treatment system
  - Landfill gas collection/utilization/combustion system
  - Top cover
  - Environmental monitoring features
  - Rainfall / storm water management measures
  - Onsite facilities
- Good operation of the landfill: including compaction of the waste and daily coverage and waste building in cells in a systematic and well-organized way as well as monitoring of the necessary environmental parameters.

Figure 3-98: Illustration of a landfill setup

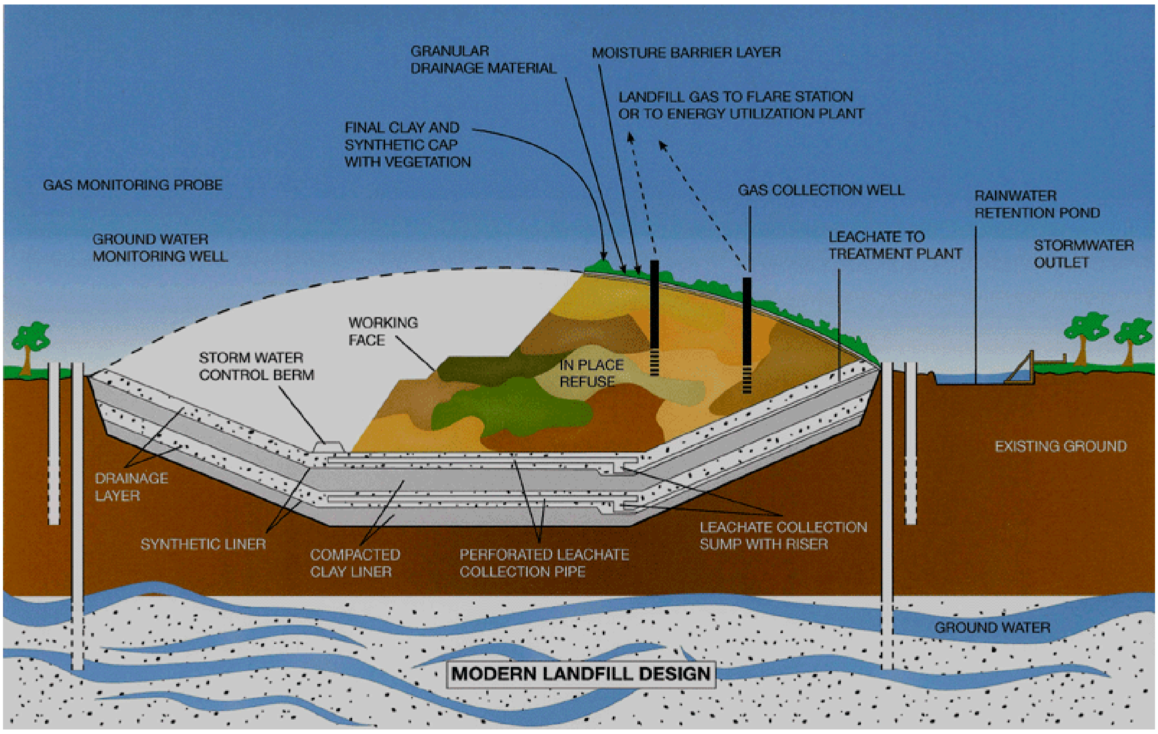


Figure 3-99: Modern Landfill scheme

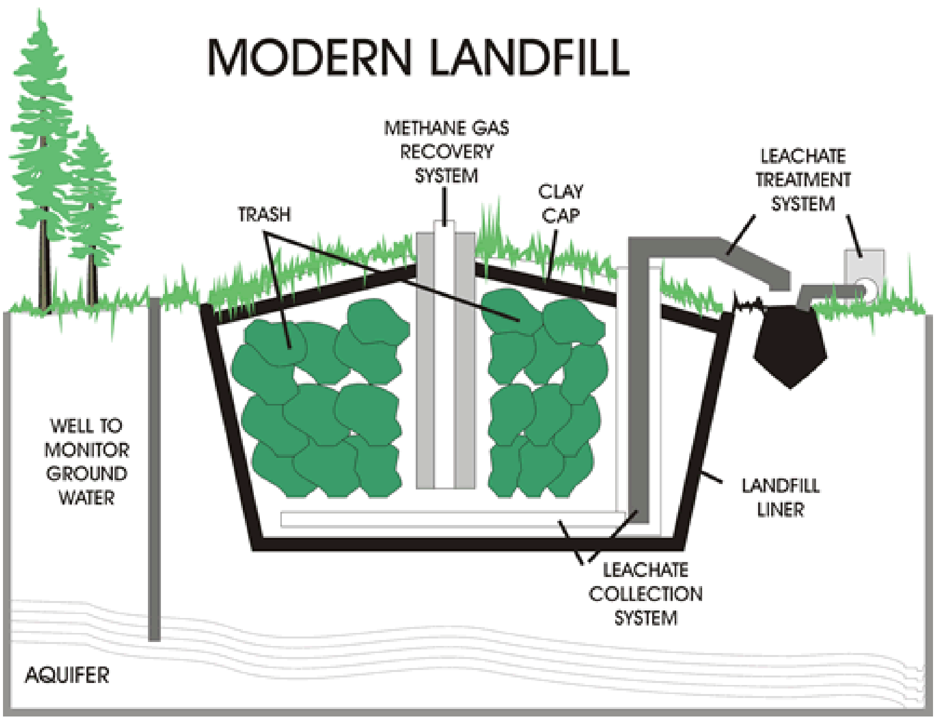


Figure 3-100: Monitoring intersection scheme

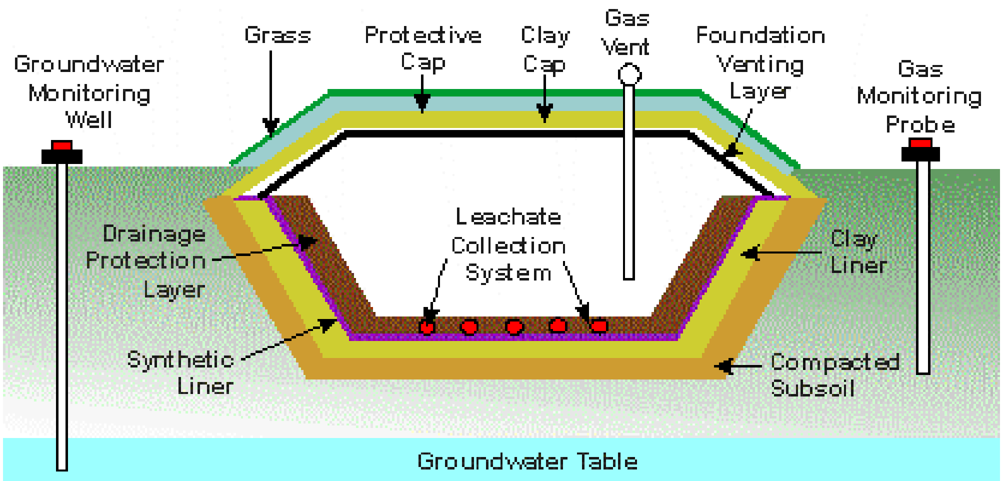
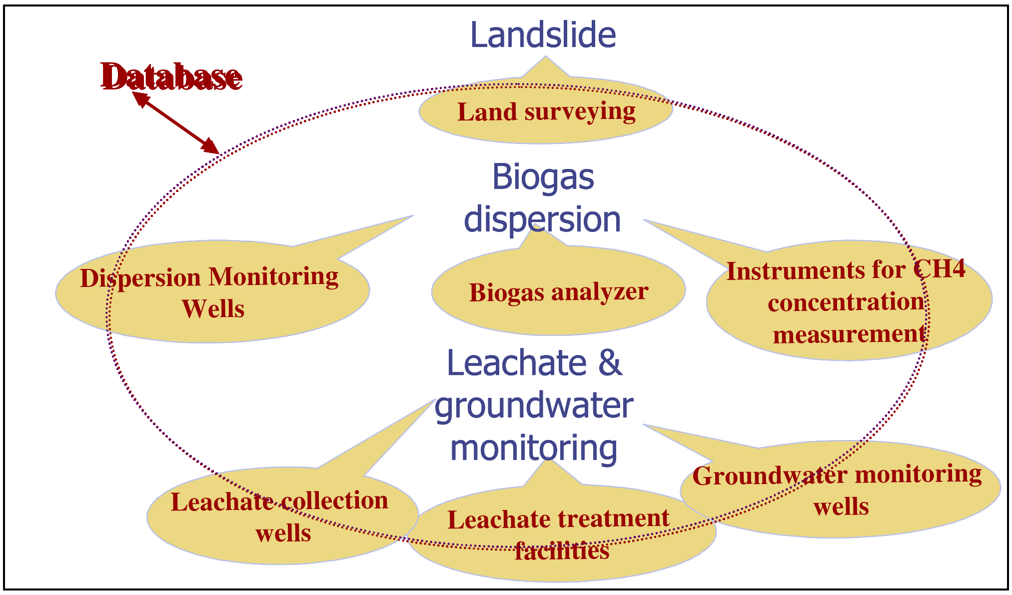


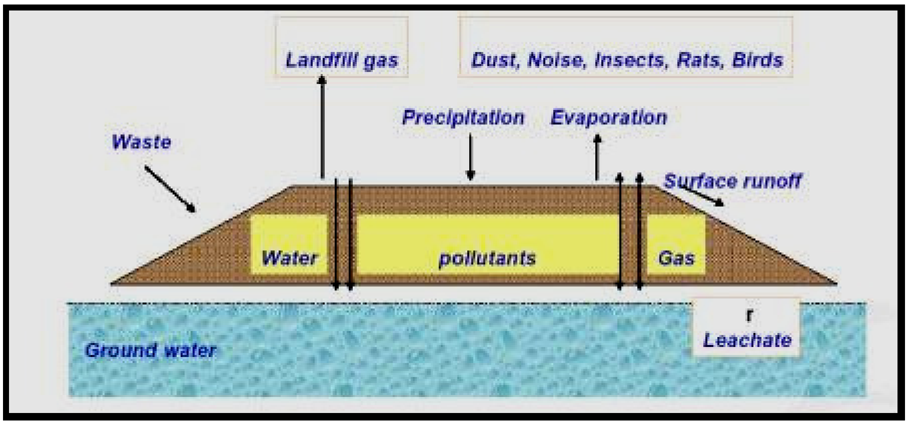
Figure 3-101: Environmental monitoring of landfills



- Landfill closure and aftercare: using the following methods:
  - Top cover technology
  - Macro – encapsulation
  - On site secure land burial
  - Landfill mining
  - Extraction and off site treatment

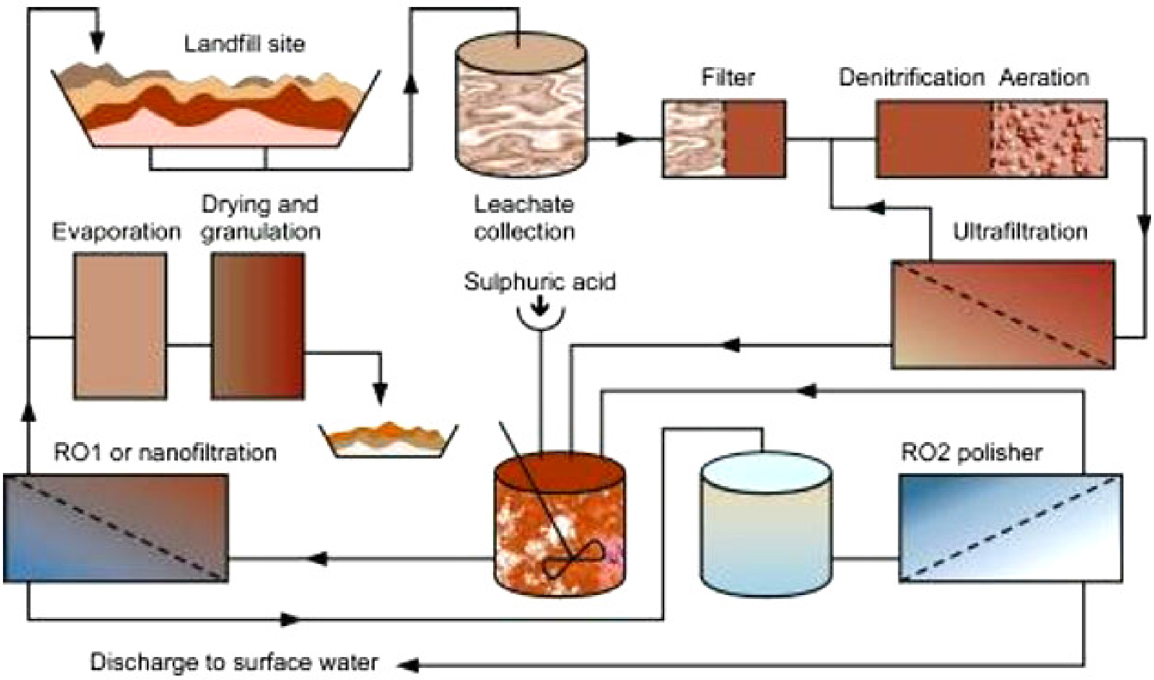
The following scheme indicates the main forms of environmental pressures related to landfills

Figure 3-102: Environmental impacts related to landfill



Special emphasis should be given in the collection and treatment of leachate and biogas. The alternative treatment routes for leachate include:

Figure 3-103: Leachate treatment



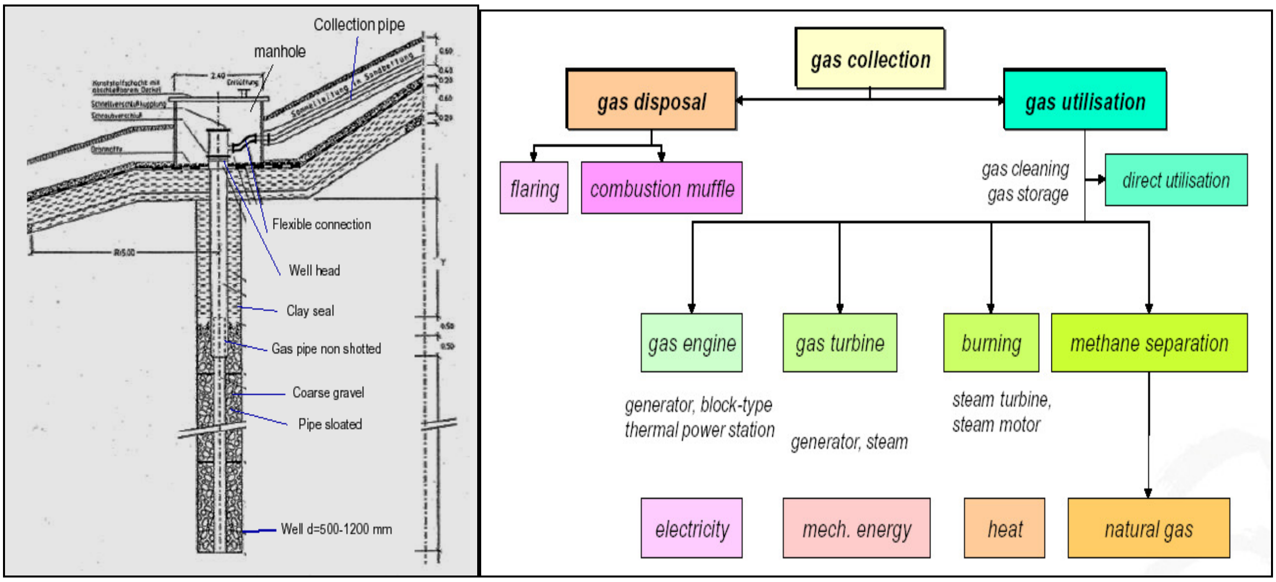
Typical problems related to the generation of the landfill gas include:

- Methane contributes 21 times more than carbon dioxide to greenhouse effect and climate change
- Methane is flammable at concentrations between 5 and 15% in air, potentially leading to fire and explosion risks if allowed to accumulate in confined spaces

- Landfill gas is odorous and corrosive

The biogas may also be utilized for the recovery of energy or disposed via combustion, as follows:

Figure 3-104: (a) Biogas collection and (b) Biogas utilization



Significant environmental impacts are also connected to the transportation of the waste to the landfills by heavy trucks.

3.7.11.4 Major Provisions of Landfills Directive 99/31

The main objective of this Directive is "to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life-cycle of the landfill".

For the first time in the legislation, there are given clear **definitions** of important elements in Article 2 of the Directive, such as:

a) "Waste": any substance or object which is covered by Directive 75/442/EEC

b) "Municipal waste": waste from households, as well as other waste which, because of its nature or composition, is similar to waste from household;

c) "hazardous waste": any waste which is covered by Article 1(4) of Council Directive 91/689/EEC of 12 December 1991 on hazardous waste(7)

d) "Non-hazardous waste": waste which is not covered by paragraph (c);

e) "Inert waste": waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leach ability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater;

f) "Landfill": a waste disposal site for the deposit of the waste onto or into land (i.e. underground), including:

1. internal waste disposal sites (i.e. landfill where a producer of waste is carrying out its own waste disposal at the place of production), and

2. a permanent site (i.e. more than one year) which is used for temporary storage of waste,

3. but excluding:

a. facilities where waste is unloaded in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere, and

b. storage of waste prior to recovery or treatment for a period less than three years as a general rule, or

c. storage of waste prior to disposal for a period less than one year;

g) "Treatment": the physical, thermal, chemical or biological processes, including sorting, that change the characteristics of the waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery;

h) "operator": the natural or legal person responsible for a landfill in accordance with the internal legislation of the Member State where the landfill is located; this person may change from the preparation to the after-care phase;

i) "Biodegradable waste": any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard;

j) "Holder": the producer of the waste or the natural or legal person who is in possession of it;

k) "Applicant": any person who applies for a landfill permit under this Directive;

l) "competent authority": that authority which the Member States designate as responsible for performing the duties arising from this Directive;

m) "Liquid waste": any waste in liquid form including waste waters but excluding sludge;

Moreover, in Article 4, three **classifications of landfills** are given, namely:

- Landfill for hazardous waste,

- Landfill for non-hazardous waste,

- Landfill for inert waste.

Article 5 obliges Member States to set up a **national strategy** for the implementation of the reduction of biodegradable waste going to landfills. The meanings to achieve the targets of this strategy are recycling, composting, biogas production or materials/energy recovery.

Article 6 states the different **classes of waste** to be accepted in landfill:

- Waste that has been subject to treatment may be landfilled;

- Hazardous waste that fulfils the criteria set out in accordance with Annex II;

- Landfill for non-hazardous waste may be used for:

• non-hazardous waste of any other origin, which fulfills the criteria for the acceptance of waste at landfill for non-hazardous waste set out in accordance with Annex II;

• stable, non-reactive hazardous wastes (e.g. solidified, vitrified), with leaching behavior equivalent to those of the non-hazardous wastes (…) which fulfill the relevant acceptance criteria set out in accordance with Annex II. These hazardous wastes shall not be deposited in cells destined for biodegradable nonhazardous waste.

In Article 6, it is defined the waste to be accepted in the different classes of landfill as these are given in Article 4.

According to **Article 7,** Member States shall take measures in order that the application for a landfill permit must contain at least particulars of the following:

Application for permit: (Art. 7)
(a) Identity of applicant and operator
(b) Description of types and total quantities of waste to be deposited
(c) Proposed capacity
(d) Description of disposal site (incl. Hydrogeology and Geology)
(e) Proposed methods for pollution prevention and abatement
(f) Operation, monitoring and control plan
(h) EIA accord. 85/337/EEC if required
(i) Financial security

The conditions of the permit are given in detail in Article 8, as it is shown below:

Conditions of permit: (Art. 8)
Issue of permit only if
a (i) relevant requirements fulfilled
a (ii) management in hand of person technically competent; development and training provided
a (iii) necessary measures taken to prevent accidents and limit consequences
a (iv) adequate provisions (financial security) to ensure obligations including after-care
(b) In line with relevant WMP
(c) inspection by competent authority prior to commencement of disposal

Specifying and supplementing the provisions set out in Article 9 of Directive 75/442/EEC and Article 9 of Directive 96/61/EC, the landfill permit shall state at least the following:

Permit shall state (Art 9)**:**
(a) **Class** of landfill
(b) Defined **types** and total **quantity** of waste authorized for deposition
(c) Requirements for **preparation, operation, monitoring, control** incl. Contingency plans (Annex III,4B), provisional requirements for closure and after-care
(d) Obligation of **annual reporting** to competent authorities on type and quantities of waste disposed and results of monitoring (acc. Art. 12/13 and Annex III)

Furthermore, Member States shall take measures in order that prior to accepting the waste at the landfill site record keeping and control is undertaken:

(Art. 11(1) b):

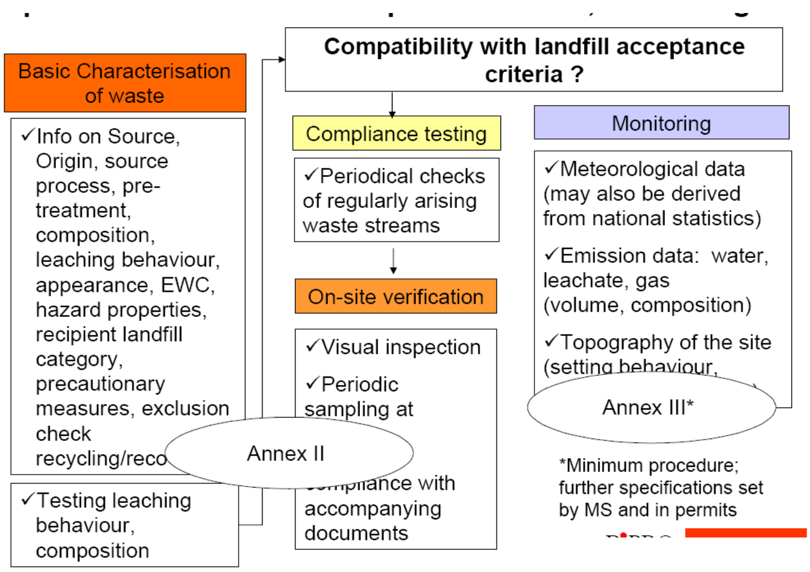
Install register on :

- Quantity
- Characteristics
- Origin (producer, collector)
- Location on site (for hazardous waste: precise location of the waste - mapping of landfill cells)

→ Make this information available, on request to the competent authority

The control and monitoring procedures in the operational phase and closure phase that have to be followed are outlined in Article 12 and 13 respectively – further specifications are given in detail in Annex III.

Acceptance control and monitoring according to Directive 99/31



Closure and aftercare of landfills according to Directive 99/31

Start of closure according to:
-permit,
-at request of operator
-at decision of authority

Operator responsible for maintenance, monitoring, control as long as required by authority

Monitoring (acc. Annex III Landfill Directive) →

• Meteorological data
• Emission data: groundwater, leachate, gas (volume, composition)
• Topography of the site (structure and composition, setting behaviour)

Notification of any significant adverse environmental effect revealed by control procedures

Execution of corrective measures following on decision of authorities

Last, but not least, following are given in detail all the general requirements for all classes of landfills, being the most important the following ones:

Location 1.1. The location of a landfill must take into consideration requirements relating to: (a) the distances from the boundary of the site to residential and recreation areas, waterways, water bodies and other agricultural or urban sites; (b) the existence of groundwater, coastal water or nature protection zones in the area; (c) the geological and hydrogeological conditions in the area; (d) the risk of flooding, subsidence, landslides or avalanches on the site; (e) the protection of the nature or cultural patrimony in the area. 1.2. The landfill can be authorised only if the characteristics of the site with respect to the abovementioned requirements, or the corrective measures to be taken, indicate that the landfill does not pose a serious environmental risk.
Water control and leachate management Appropriate measures shall be taken, with respect to the characteristics of the landfill and the meteorological conditions, in order to: - control water from precipitations entering into the landfill body, - prevent surface water and/or groundwater from entering into the landfilled waste, - collect contaminated water and leachate. If an assessment based on consideration of the location of the landfill and the waste to be accepted shows that the landfill poses no potential hazard to the environment, the competent authority may decide that this provision does not apply, - treat contaminated water and leachate collected from the landfill to the appropriate

standard required for their discharge.

The above provisions may not apply to landfills for inert waste.

Protection of soil and water

A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater or surface water and ensuring efficient collection of leachate as and when required according to Section 2. Protection of soil, groundwater and surface water is to be achieved by the combination of a geological barrier and a bottom liner during the operational/active phase and by the combination of a geological barrier and a bottom liner during the operational/active phase and by the combination of a geological barrier and a top liner during the passive phase/post closure.

The geological barrier is determined by geological and hydrogeological conditions below and in the vicinity of a landfill site providing sufficient attenuation capacity to prevent a potential risk to soil and groundwater.

The landfill base and sides shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to the one resulting from the following requirements:

- landfill for hazardous waste: K <= 1,0 × 10- 9 m/s; thickness >= 5 m,
- landfill for non-hazardous waste: K <= 1,0 × 10- 9 m/s; thickness >= 1 m,
- landfill for inert waste: K <= 1,0 × 10- 7 m/s; thickness >= 1 m,

m/s: meter/second.

\Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0,5 metres thick.

In addition to the geological barrier described above a leachate collection and sealing system must be added. If the competent authority after a consideration of the potential hazards to the environment finds that the prevention of leachate formation is necessary, a surface sealing may be prescribed.

Gas control

Appropriate measures shall be taken in order to control the accumulation and migration of landfill gas (Annex III).

Landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared.

The collection, treatment and use of landfill gas under paragraph 4.2 shall be carried on in a manner which minimises damage to or deterioration of the environment and risk to

human health.
Nuisances and hazards Measures shall be taken to minimise nuisances and hazards arising from the landfill through: - emissions of odours and dust, - wind-blown materials, - noise and traffic, - birds, vermin and insects, - formation and aerosols, - fires. The landfill shall be equipped so that dirt originating from the site is not dispersed onto public roads and the surrounding land.
Stability The emplacement of waste on the site shall take place in such a way as to ensure stability of the mass of waste and associated structures, particularly in respect of avoidance of slippages. Where an artificial barrier is established it must be ascertained that the geological substratum, considering the morphology of the landfill, is sufficiently stable to prevent settlement that may cause damage to the barrier.
Barriers The landfill shall be secured to prevent free access to the site. The gates shall be locked outside operating hours. The system of control and access to each facility should contain a programme of measures to detect and discourage illegal dumping in the facility.

3.7.12Options for Landfill Restoration

Determining factor when choosing a method of rehabilitation is the assessment of environmental risk of existing roads for transport of pollutants and sites under the influence established by:

- Qualitative and quantitative composition of land filled waste;
- Participation rates of different types - domestic, organic (plant and animal), construction and industrial non-hazardous;
- Evaluation method of storage of the waste;
- Evaluation of existing conditions for migration of contaminants through groundwater and surface water, and soil, and;
- Presence and / or near the sites under protection - settlements, water catchments areas, surface water flows, flooding areas, protected areas, etc.

Measures proposed in connection with the closure of existing landfills and selection of remediation activities are based on the assessment of environmental risk associated with a particular facility and best practices of member states of the EU waste management. In the choice of remediation activities for landfills with a very high risk to the environment has been paid particular attention to the need for detailed studies that include:

- Geodesic survey of the site for the exact determination of the area subject to reclamation and volume of the waste subject to vertical planning;
- Hydrological and hydro-geological study to determine the parameters of the surface water and the depth and qualitative composition of the groundwater in the project area;
- Fetermination of soil near the landfill, through sampling of soils and geologic base, located in the easement of the landfill;
- Assessment of gas emissions and the need for their treatment;
- Determining the location and number of stations for monitoring of the landfill.

In the selection of measures for rehabilitation of landfills is attached individual approach, taking into account the characteristics of each facility separately. Technical solutions are discussed, including the possibilities:

- Establishing a system for the capture and sequestration of surface water;
- Establishing a system for gas drainage;
- Application of shielding layer of clay / bentonite mats;
- Application of ground masses for reclamation layer;
- Application of modern technologies to ensure stability of slopes using geo-grids in the case that it is possible to execute reshaping.

3.7.12.1 Type of remediation methods

The proposed basic methods for remediation of 11 municipality landfills generally are: securing "in situ" and the application of safeguard measures. They are justified on the results of risk assessment and best practice in waste management of member states of the EU.

The possibilities for application of the "ex-situ" and various "in-situ" remediation scenarios for landfills in municipalities of Shtip, Probishtip, Kochani, Cheshinovo-Obleshevo, karbinci, Zrnovci, Vinica, berovo, Pehchevo, Delchevo and Makedonska Kamenica were reviewed. The final choice of method for remediation plan can be made only after a detailed study of soil and groundwater, studies which are not within the scope of this project.

- Securing “ex-situ” – It applies to illegal landfills of up to 1000 m^3. The method provides excavation and re-deposition of the waste on the municipality landfill in whose territory they are. Applying this method results in a remediation:
  - significantly reduce the cost of closure and 30 years monitoring of wild landfills, the total number within the North-East Region is 62;
  - complete elimination of waste and recovery of land for alternative use;
  - Possibility to remove the negative impact on the environment of the affected areas, and;
  - The method is applicable to deposits with very high and high risk, and landfills with medium risk (minimum volume of accumulated waste).
- Securing “in-situ” – It is used for shielding (encapsulation) of the waste by constructing upper insulation layer including a mineral insulation layer, gas drainage and soil cover - the measure is applicable to landfills with the risk of migration of hazardous substances and risk assessment of sites under protection high to very high. In this context, the implementation of these activities of the remediation program is necessary to select bulk materials (clays and / or bentonite hydro-geo-membranes) to meet the necessary requirements ($k = 1 \times 10^{-9}$ m/s).

3.7.12.2 Application of protective measures

As protective measures are proposed:

- Monitoring of waste landfills;
- Complete construction or restoring the integrity of existing fences;
- Day and night control at the entrance of the landfill in the stage of residual exploitation;
- Placing warning signs for forbidding: waste incineration, land filling outside designated areas;
- Placing warning signs for permitted waste disposal, and;
- Mass informing the population of unauthorized access (outside the specified time for disposal) to landfill.

Good practice in the Member States of the EU requires the development and implementation of a system for long-term observation period of 30 years after closure of the landfill. The monitoring system includes minimum procedures necessary to monitor the parameters of the environment, both during the implementation of redevelopment activities and after closure of the landfill. In the developed sanitation program, the monitoring system for landfill provides control and monitoring of:

- Runoff: flow and seepage of effluent;
- Gas: composition and quantity of biogas from landfill;
- Water: composition of groundwater off-site disposal and composition of surface waters, and;
- Topography of the site after closure and remediation.

3.7.12.3 Closure and remediation of „dumpsites" and abandoned „dumpsites

At the beginning of this stage is clarified the staging of remediation activities for different risk groups of landfills. A list has been consolidated with technical measures for types of work for remediation and reclamation, taking into account best practices of member states of the EU, as well as the methods described in the preceding paragraph. Pooled data for all five municipal landfills are included in the program for the gradual rehabilitation of landfills. With the program was developed and implemented a schedule for phased closure of landfills. Program for phased rehabilitation of landfills include disposal or protection them by applying:

Model "A" - Waste disposal by method "ex-situ" by cleaning the waste and its redisposal on the municipal landfill

This method is applicable to the remediation of illegal small (wild) landfills with a volume to 1,000 m^3.

- Municipality of Berovo (v.Machevo, Budinarci-Bregalnica under the primary school, v.Mitrashinci, under the bridge in the village and above the bridge, v.Vladimirovo, v.Ratevo, v.Dvorishte, v.Suvi Laki, v.Smojmirovo and city of Berovo-Ciganski potok) with general volume of the waste of 495 m^3;
- Municipality of Shtip (v.Vrsakovo, v.Dragoevo, v.Lakavica, v.Chardaklija, v.Selce) with general volume of the waste of 360 m^3;
- Municipality of Cheshinovo-Obleshevo (Teranci, Gubre, Kuchichino, Ularci, Cheshinovo, Spanchevo, Banja) with general volume of the waste of 1,972 m^3;
- Municipality of Karbinci (v.Krupishte, v.Radanje, v.Kozjak, v.Argulica) with general volume

of the waste of 768 m^3;

- Municipality of Probishtip (v.Buchishte, v.Gajranci, v.Gorni Stubol, v.Dobrevo, at the entrance of the village and in the closed mine, v.Kundino, v.Lezovo, v.Pishica, v.Pleshenci, v.Strmosh, at the and of village, Reka, Bel kamen, Zletovo, before the bridge and Gorno Maalo, Tursko rudare, Bunesh, dreveno, Ratavica and Tripatanci) with general volume of the waste of 1,323 m^3;
- Municipality of Delchevo (city of Delchevo – at the market and Bunishte, Gabrovo, Trabotivishte) with general volume of the waste of 534 m^3;
- Municipality of Kochani (city of Kochani – Trajanovo grlo, Romsko maalo, Madzirski bavchi, Trkanje, Grdovci, Orizari – at entrance and output and Ilin dol) with general volume of the waste of 1,253 m^3;
- Municipality of Pehchevo (city of Pehchevo – Govedarnik, Ravna reka, Crnik) with general volume of the waste of 250 m^3, and;
- Municipality of Vinica (v.Vinichka Krshla) with 100 m^3 volume of waste.

Remediation activities for the implementation of the model include:

- Removal of disposed waste. According the present conditions, removal can be done with a bulldozer / front loader or excavator;
- Transport and redeposition of waste to the existing municipality landfill (distance to 100 km);
- Compacting the waste with roller, and;
- Bilogical recultivation (grass) on areas cleared of waste.

Limiting indicator for application of model "A" is the volume of deposited waste on unregulated landfills. According the expert evaluation of unregulated landfills with volume of deposited waste above 1,000 m^3 are in: Municipality of Cheshinovo-Obleshevo (vil. Teranci "Stara deponija" – 1,125 m^3), Municipality of Karbinci (vil. Taranci, "Reka" locality – 2,250 m^3), Municipality of Probishtip (city of Probishtip – 26,250 m^3); Municipality of Delchevo (city of Delchevo, "Pat do Kiselica" locality – 5,000 m^3) and Municipality of Vinica (vil. Istibanja, "Stari lozja" locality and vil.Blatec, Pochivalo locality – 3,960 m^3) . Because of the limited capacity of local landfills and high transport cost, sanitation program provides implementation of the Model "B" - safe disposal "in-situ", which is the practice in the Member States of the EU.

Limiting indicator of application of model "B" for remediation of unregulated landfills is ownership of the terrain. In cases when ownership of the land occupied with dumps is not municipal, before the remediation should be provide measures for getting the land property from the municipality.

The uncontrolled dumpsites falling in remediation model "A" are presented in the following table.

Table 3-81: Uncontrolled dumpsites falling in remediation model "A"

Municipality	Settlement	Location
Berovo	Machevo	Road
Berovo	Budinarci	Under the bridge of r. Bregalnica
Berovo	Budinarci	Over the primary school
Berovo	Mitrashinci	Under the bridge in the village
Berovo	Mitrashinci	Under the bridge
Berovo	Vladimirovo	Bridge befor tne village
Berovo	Ratevo	Pilana, bridge in the centre
Berovo	Dvorishte	Bunishte
Berovo	Suvi Laki	Suvi Laki

Municipality	Settlement	Location
Berovo	Smojmirovo	River
Berovo	Berovo	Ciganski Potok
Shtip	Vrsakovo	Reka
Shtip	Dragoevo	Gladno Pole
Shtip	Lakavica	Lakavichka reka
Shtip	Chardaklija	Kaj Reka
Shtip	Selce	Sred selo
Cheshinovo Obleshevo	Teranci	Teranci Gubre
Cheshinovo Obleshevo	Kuchichino	
Cheshinovo Obleshevo	Ularci	
Cheshinovo Obleshevo	Cesinovo	Gorica
Cheshinovo Obleshevo	Spancevo	Poichanski pat
Cheshinovo Obleshevo	Banja	Stara Deponija
Karbinci	Krupishte	Laki
Karbinci	Radanie	Tashlak
Karbinci	Kozjak	Likach
Karbinci	Argilica	Bajrak
Probishtip	Buchishte	Road
Probishtip	Gajranci	Gully
Probishtip	Gorni Stubol	In the centre
Probishtip	Dobrevo	Gully of entrance in the village
Probishtip	Dobrevo	In the close of mine
Probishtip	Dolni Stubol	Along bridge of entrance
Probishtip	Kundino	
Probishtip	Lezovo	
Probishtip	Pishica	River
Probishtip	Pleshenci	centre
Probishtip	Strmosh	In the end of the village
Probishtip	Strmosh	Reka
Probishtip	Strmosh	Bel Kamen
Probishtip	Zletovo	bifore bridge
Probishtip	Tursko rudare	In the close of fountainTursko Rudare
Probishtip	Zletovo	Gorno maalo
Probishtip	Zletovo	In the close of bridge Tursko Rudare
Probishtip	Bunesh	in village
Probishtip	Dreveno	In the end of the village
Probishtip	Ratavica	Along road and bridge to Bunesh
Probishtip	Tripatanci	below the bridge
Delchevo	Delcevo	Along market
Delchevo	Gabrovo	river
Delchevo	Trabotivishte	Along river
Delchevo	Grad	Bunishte
Kochani	Kocani	Trajanovo Grlo
Kochani	Grdovci	Dolno Gumenje
Kochani	Orizari	entrance
Kochani	Orizari	exit of Orizari
Kochani	Orizari	Ilin dol
Kochani	Kocani	Roma neighbourhood, TPDW
Kochani	Kocani	Roma neighbourhood, centre
Kochani	Kocani	Madzhirski bavchi
Pehchevo	Pehcevo	Govedarnik
Pehchevo	Crnik	Before the village
Vinica	Vinichka Krshla	Sushica

Model "B" – Safe disposal "in-situ"

It is proposed for remediation of landfills with medium risk and very high risk and volume of disposed waste to 100,000 m^3 in medium term. Under these restrictive conditions wastes remain at the disposal, their rehabilitation will be implemented in the long or medium term, and includes the following activities:

- Surface layer, at least one meter thick, and the upper layer 0.4 m containing organic matter (humus) are suitable for grass ;
- Geo-textile (400g/m^2);
- Mineral drainage - minimum 0,5 m (gravel, min. k > 10^{-4} m/s);
- 2 x 25 cm mineral insulation (min. k> 10^{-9} m/sec) or equivalent bentonite mat;
- Gas drainage and gas collection layer (gravel), and;
- Household waste.

Activities included in the model are evaluated by broad indicators:

- Profiling of waste deposited, spreading and leveling with a bulldozer;
- Laying leveling layer of ground masses with thickness 0,1 – 0,15 m;
- Laying the geo-textile separator (300 - 400 g/m^2);
- Construction of a mineral layer of compacted clays (0,5 m – 2 × 25 cm thick, k = 1×10^{-9} m/s);
- Laying drainage layer of washed river gravel fraction 12/35 for removal of infiltrated water with k>10^{-4} m/s (0.5 m);
- Laying geo-textile separator (300 - 400 g/m^2);
- Construction of remediation layer with thickness of 1 m;
- Landfill monitoring (for landfills with volume of deposited waste above 15,000 m^3), and;
- Biological remediation of landfill - grass and construction of protective belts.

The municipality and unregulated landfills falling in remediation model "B" are presented in the following table.

Table 3-82: Uncontrolled dumpsites falling in remediation model "B"

Municipality	Settlement	Location
Berovo	Iladin Valog	Iladin valog
Shtip	Shtip	Treshtena Skala
Pehchevo	Pehchevo	Dabova suma
Cheshinovo-Obleshevo	Obleshevo	Bukeski dol
Karbinci	Karbinci	Bel Breg
Cesinovo Oblesevo	Teranci	Stara deponii
Karbinci	Tarinci	Reka
Probishtip	Probishtip	Entrance
Delchevo	Delchevo	Pat to Kiselica
Vinica	Istibanja	Stari Lozja
Vinica	Blatec	Pocivalo

Model "C" - Safe disposal "in-situ"

It is proposed for landfills with very high risk and significant volume of disposed waste (from 100,000 to 500,000 m^3) in short term. Under these restrictive conditions wastes remain at the disposal, their rehabilitation will be implemented in the short term and includes the following activities:

Activities included in the model are evaluated by broad indicators:

- Profiling of deposited waste, spreading and leveling with a bulldozer;
- Laying leveling layer of ground masses with thickness of 0,1 – 0,15 m;
- Construction of gas drainage system (drainage blanket of gravel);
- Construction of gas drainage and gas venting system for flaring of the captured gas emissions from landfill (model C1 - used for landfills with volume of deposited waste from 100,000 to 500,000 m^3);
- Construction of gas drainage and gas venting system for utilization of landfill gas emissions (model C2 - used for landfill volume of waste disposed of over 500 000 m^3);
- Laying of geo-textile separator (300 - 400 g/m^2);
- Construction of a mineral layer of compacted clays (0,5 m – 2 × 25 cm thickness, $k=1\times10^{-9}$ m/s) or hydro-geo-membrane;
- Laying drainage layer of washed river gravel fraction 12/35 for removal of infiltrated water with $k>10^{-4}$ m/s (0.5 m);
- Laying of geo-textile separator (300 - 400 g/m^2);
- Construction of remediation layer with thickness of 1 m;
- Biological remediation of landfill - grass and construction of protective belts, and;
- Landfill monitoring (for landfills with volume of deposited waste above 15,000 m^3).

The municipality and unregulated landfills falling in remediation model "C" are presented in the following table.

Table 3-83: Uncontrolled dumpsites falling in remediation model "C"

Municipality	Settlement	Location
Probishtip	Neokazi	Ozren
Kochani	Kochani	Tupanec
Delchevo	Delchevo	Ostrec
Vinica	Leski	Vrshi Dol

3.7.13 Overview of Alternative Options

3.7.13.1 SWOT Analysis of Waste Management Options

A SWOT analysis is a strategic planning method that is aimed at identifying key Strengths, Weaknesses, Opportunities and Threats of the subject of interest. Strengths and opportunities can be considered attributes that are helpful in achieving the objective, whilst weaknesses and threats are likely to prevent objectives being achieved. Strengths and Weaknesses are attributes that can be found within the waste industry at present, whilst opportunities and threats are more attributes of the external environment. The SWOT has been completed for Green Points, Separate collection of packaging waste, Separate collection of biowaste, Household composting, Green waste composting, conventional combustion and MBT/MBS/MRF Process.

Green Points

Strengths

- Separation is easier for residents as one place receives all their waste streams.
- Jobs creation
- Large recovery rate of materials
- The Recycling centers are versatile; they can have their own income and be financially sustainable by : a)charging the disposal of big quantities, b) selling sorted materials, etc
- Extends the lifetime of landfill
- Reduces landfill costs

Weaknesses

- An area in the city is required for the construction
- A small investment and operational cost is required
- Licensing is required
- Residents must transport the goods themselves.

Opportunities

- Reduction of waste for final disposal
- Costs reduction of final disposal
- Job creation

Threats

- Negative backlash from citizens that have to transport their goods.

In Green Points will be collected WEEE, C&D waste, hazardous household waste and some small amounts of recyclables.

Separate Collection and Recycling of WEEE

Separate Collection and Environmental Management of Hazardous Household Waste

Strengths

- There is extensive experience available at EU level.
- Separate collection of these wastes has significant positive impact on environment and health.
- Job creation
- Significant support from residents.

Weaknesses

- Must have an efficient collection system that meets the demands of the local population.
- Requires good public awareness.

Opportunities

- Creation of new jobs
- Provides significant benefits to environment.
- Local authority acquires environmentally positive profile.

Threats

Separate Collection of Construction and Demolition Waste

Strengths

- National and EU legislation exists
- Environmental and health protection
- Results in new permanent jobs
- Raw materials recovery and contributes to GHG emissions reduction

Weaknesses

- Requires basic organization for collection system
- Participation of local authorities in the citizens' information campaign

Opportunities

- Creation of new jobs
- Provides significant benefits to environment.
- Local authority acquires environmentally positive profile.

Threats

Separate Collection of packaging waste

Strengths

- EU and National legislation exists
- National producer responsibility schemes are in place
- It can contribute to the valorization of a significant amount of municipal and household waste.
- It can extend landfill lifetime expectancy.
- There are economic gains while implementing these incentives.
- The residents have knowledge on how these systems work and they participate in them.
- There is general support from society as a whole
- Indirect incentives to residents for participation
- Creation of new jobs.
- It is a tried and proven method.
- There are diverse technologies, methods and equipment to choose from, for application.
- Higher quality materials are collected for recycling
- It contributes to the reduction of greenhouse gases.

Weaknesses

- The more separation of source streams are required, the higher effort is required by residents.
- The Municipality must develop highly efficient collection systems and increase services.
- Residents must be educated often to reach higher targets.
- Where there are more than one producer responsibility schemes in place, competition may evolve between them.

Opportunities

- Contributes to local, regional and national authorities in meeting their respective legislative targets.
- New jobs are created in the community.
- Materials are available in the community for local industry and they do not have to import.
- Results in a decrease of waste production.
- Opportunity to generate income from the sale of materials.
- Increases community solidarity-residents acknowledge they are doing something good for their local environment.
- Local authority acquires environmentally positive profile.
- Provides residents with the incentives to participate in waste prevention activities.

Threats

- There are cases where geographic location of Local Authorities lead to a reluctance of the producer responsibility schemes to integrated them as it is more costly.
- Inefficient collection schemes may create negative backlash from residents.
- There are initial expenses related to these projects (e.g.. public awareness)

Separate Collection of Biowaste

Strengths

- EU legislation exists
- Can combine different sources of organic waste, such as : agricultural activities, slaughter houses, olive processing plants, etc.
- Has the potential to manage 100% of MSW organic fraction
- Increases landfills' life span
- Lower costs for the technology involved, compared to other methods such as MBT and thermal treatment
- Results in new permanent jobs
- There is social consensus in this method
- A useful and valuable material is produced
- Contributes to GHG emissions reduction

Weaknesses

- Requires separate collection infrastructure (bins)
- Requires integrated planning and operation control
- Requires space for the composting facility
- Problems related to the establishment of the facility (area selection, permits, social reactions)
- High initial costs (bins, facilities)
- Constant information and sensitization campaigns for quality and quantity assurance
- Cooperation with and training of waste collection personnel of municipality

Opportunities

- Waste reduction
- Reduction of final disposal costs
- Results in new permanent jobs
- Active participation of citizens that can become more active in other waste management related issues
- Positive environmental profile of the municipality that can lead to privileged access to environmental funding, increased tourism etc
- Positive political profile with increased acceptance levels from citizens

Threats

- Can work only if it is accepted by the citizens
- Negative reactions from waste collection personnel of municipality
- Improper participation from citizens can lead to bad quality compost

Household composting

Strengths

- Supports European legislation
- Widespread applicability
- Can have significant impact source reduction
- Increases life-span of landfills
- No permits required
- Cost-benefit interest for the Municipality
- Benefit for citizens (citizens benefit from the use of compost)

Weaknesses

- When implemented at large-scale local level requires good planning to take all factors at household level into account.
- There is a cost (although small)
- Requires very good public awareness and support to citizens

Opportunities

- Garners strong support from citizens
- Creates the opportunity for green job creation (directly and indirectly)

Threats

- Low awareness of population (if not properly informed especially initially may have backlash)

Green Waste Composting

Strengths

- Greenwaste are valuable and always on demand from composting facilities
- EU legislation exists
- Simple and widely spread know-how on management methods
- Has the potential to manage 100% of MSW green waste fraction
- Increases landfills' life span
- Lower costs for the technology involved, compared to other methods such as MBT and thermal treatment
- Results in new permanent jobs
- There is social consensus in this method
- A useful and valuable material is produced
- Contributes to GHG emissions reduction

Weaknesses

- Requires integrated planning and operation control
- Requires space for the composting facility
- Small number of composting facilities in some countries
- A relatively small capital cost is required for the initiation
- Cooperation with and training of waste collection personnel of municipality

Opportunities

- Waste reduction
- Reduction of final disposal costs
- Results in new permanent jobs
- Active participation of citizens that can become more active in other waste management related issues
- Positive environmental profile of the municipality
- Positive political profile with increased acceptance levels from citizens

Threats

- Can work only if it is accepted by the citizens
- Negative reactions from waste collection personnel of municipality
- Low participation levels from citizens

Conventional Combustion

Strengths

- Established, mature and reliable technology.
- Significant experience and operational data on wide range of waste feedstocks.
- Can process multiple fuels, and is tolerant of fluctuations in fuel quality and composition.
- Fuel is generally not dependent on pre-treatment, with the exception of fluidised bed technology.
- Several designs available : moving grate, bubbling fluidised bed, circulating fluidised bed, and fixed bed designs.
- Can reduce the volume of the waste by up to 95%.

Weaknesses

- Combustion processes require sophisticated gas cleaning monitoring and control system that may require significant capital expenditure.
- Process produces small volumes of fly ash and APCr that must be handled as hazardous waste.
- Power generation from combustion is only possible by means of raising steam to drive a steam turbine delivering low electrical efficiency. Gross electrical efficiencies of such processes tend to be in the order of 15-30%.
- Potential net increase in greenhouse gas emissions.
- Low value by-product associated

Opportunities

- Diversion of biodegradable materials from landfill and associated reduction in greenhouse gas generation potential.
- Opportunities for electricity and heat generation.
- Incinerator bottom ash can be diverted from landfill due to potential uses as an aggregate substitute.

Threats

- Combustion suffers from poor public image, thereby presenting difficulties in gaining public and political support for the development of such processes.

MBT/MBS/MRF

Strengths

- Combines proven and well established technologies
- Further recovery of recyclable waste and diversion of biodegradable BMW from landfill
- Provides an alternative to landfill and incineration
- Can be tailored to meet local requirements
- Can have built in flexibility to respond to changing inputs

Weaknesses

- Quality of outputs may be low, i.e. recyclables may be low grade
- Potential lack of benchmarks and quality standards for some outputs
- May still result in a fraction that will need to be landfilled
- Is dependent on market demand for outputs
- High cost

Opportunities

- Offers a flexible and versatile solution
- May be perceived as a more publicly acceptable solution
- Can be designed at appropriate scales, and is not as influenced by economies of scale as incineration
- Can treat a wide range of waste streams, i.e. MSW, C&I
- Can preserve nutrients in Compost Like Output (N,P,K)

Threats

- Market volatility
- Product risk
- Discourages source segregation of waste streams
- Uncertainty of biodegradability of outputs

3.7.13.2 Overview of Alternative Technologies

The following Table provides an overview comparison of the whole discussed treatment technologies.

Table 3-84: Comparison of the technologies for the Treatment Waste

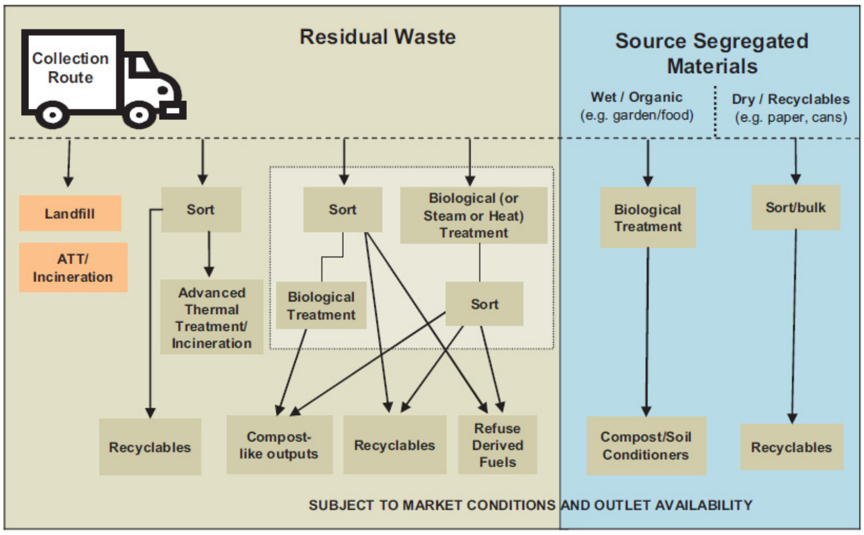
	Biological methods		Thermal methods		
	Composting	**Anaerobic digestion**	**Incineration**	**Pyrolysis**	**Gasification**
Economic					
Cost of treatment	Low to high, depending on technology. Based on a simple facility, 11-14 €/t. for a fully covered facility	Costs depend on scale of unit and fate of residuals. Costs of anaerobic digestion alone: capital 66 €/t O&M 46 €/t Annualised cost 58 €/t, after allowing for an offset of 8 €/t for gas. For a smaller unit (5-20,000 t/year) the cost is likely to be 25-34 €/t.	High, in the order of 144 €/t, to which must be added collection costs.	Medium to high. No reliable figures available.	High to very high. No reliable figures available.
Technology					
Basic principle	Degradation by Aerobic microorganisms	Degradation by Anaerobic microorganisms	Combustion	Anaerobic Thermochemical conversion	Thermochemical conversion
Proven technology, track record	Yes; Very common	Yes; common	Yes; very common	Partly; few	Partly; few
Suitability	Good	Good	Good	Medium	Depending on Technology
Waste acceptance	Source separated waste only since matter and nutrients is to be recovered as pure as possible	Source separated wet waste only since matter and nutrients are to be recovered as pure as possible	All waste since air cleaning technology is good and residual solids are minimised by volume reduction	In particular suitable for contaminated, well defined dry waste fractions	Source separated dry waste only unless combined with better cleaning technology
Acceptance of wet household waste	Yes	Yes	Yes	Possible but normally no	Possible but normally no
Acceptance of dry household waste	Yes	Yes	Yes	Yes	Possible
Acceptance of garden and park waste	Yes	Yes	Yes	Yes	Possible
Acceptance of waste from hotels and restaurants	Yes	Yes	Yes	Yes	Possible but normally no
Acceptance of	Small amounts of	No	Yes	Yes	Possible

	Biological methods		Thermal methods		
	Composting	Anaerobic digestion	Incineration	Pyrolysis	Gasification
Economic					
paper and board	paper possible				
Excluded waste Fractions	metal, plastic, glass, plants without high sanitary treatment, no waste of animal origin	Metal, plastic glass, garden waste(plants without high sanitary treatment: no waste of animal origin)	None	Wet household Waste	Wet household Waste
Environment					
Solid residues	High	Medium - high	Medium - high	Medium	Medium
Air impact	Low	Medium	Medium -high	Medium	Medium - high
Water impact	Medium - high	High	High	Medium - high	Medium - high
Control of odour	Bad - good	Bad - good	good	Medium - good	good
Working environment	Bad - good	Medium - good	good	good	good
Energy recovery	No	Yes; 3.200 MJ/ tonne waste	Yes; 2.700 MJ/ tonnes waste	Yes; ≈ 70 % of incineration + energy contained in the char	Yes; comparable to incineration
Carbon cycle (% of weight)	50 % in compost 50 % to air	75 % in fibres/liquids 25 % as biogas	1 % in solids 99 % to air	20–30 % in solids 70–80 % to air	2 % in solids 98 % to air
Nutrient recovery (kg nutrient/tonne waste input)	Yes; 2.5–10 kg N 0.5–1 kg P; 1–2 kg K	Yes; 4.0–4.5 kg N 0.5–1 kg P; 2.5–3 kg K	No	No	No
Products for recycling or recovery, (weight- % of waste input) 40-50 % compost 30 % fibres, 50–65 % fluids, 3 % metal 15–25 % bottom ash (incl. Clinker grit, glass), 3 % metal 30–50 % char (incl. bottom ash, clinker, grit, glass) 15–25 % vitrified bottom ash (incl. clinker grit, glass), 3 % metal					
Residuals for other waste treatment or for land filling (Weight- % of waste input)	2–20 % overflows sieving (plastic, metal, glass, stones)	2–20 % overflows sieving (plastic, metal, glass, stones)	3 % fly ash (incl. flue gas residues)	2–3 % flue gas residues	2 % gas cleaning residues
Compliance related					
no particular issues					
Implementation risks					
			Sitting of an incinerator can be difficult –		

	Biological methods		Thermal methods		
	Composting	Anaerobic digestion	Incineration	Pyrolysis	Gasification
Economic					
			negative popular perception		

A flow diagram with the combinations and possible applications of all these technologies in an Integrated Waste Management system, it is shown in the follow in figure.

Figure 3-105: Options for Recovery & Treatment of Municipal Solid Waste (DEFRA 2007)



3.7.14 Technical Criteria for Siting of Waste Management Facilities

3.7.14.1 Terms of adequacy and exclusion criteria – finding alternative candidate areas of sitting waste management facilities

3.7.14.1.1. Porpuse of qualification procedure

The purpose of the detection of suitable positions for the waste treatment works and disposal of waste, is choosing the most appropriate place:

- To maximize the contentment of the needs of the region
- To minimize environmental impact
- To ensure greater social acceptance for the project
- To minimize the cost of construction and operation of the project.

But obviously because the disposal of the solid waste which will be executed with sanitary burial is more restrictive in relation to the preparation on the requirements of the premises deemed suitable, the investigation will be moving in the direction of the search for positions which meet the requirements of sanitary landfills, which is unfavorable. Similarly, the area of premises should allow performing any other processing operations of Solid Waste.

So below is a description of the selection criteria of sanitary landfill while the general research philosophy will be moving in the direction of finding sites that are suitable for the development of sanitary burial, while construction on the same site of the proposed treatment plant.

3.7.14.1.2. Exclusion criteria

An area which will host SWM facilities must meet a large number of parameters in order to satisfy the purpose, as developed previously. If a position does not meet a minimum degree of certain basic criteria, eg safety, land use compatibility or healthy, you can not proceed with further investigation for sitting SWM projects.

So it is possible, in some region SWM facilities to be sited only with exclusion criteria, criteria which exclude certain positions from the sitting of such projects and in particular sanitary landfill which as mentioned above are the most stringent criteria.

Exclusion criteria proposed in accordance with guidelines of the World Health Organization (Petts & Eduljee, 1994) are as follows:

1. Unstable or weak soils (organic, swelling, delicate sands etc.)
2. Areas where there are or potential subsidence.
3. Saturated soils (eg, wetlands, coastal zones)
4. Groundwater recharge area. Where a protective waterproof layer requires special investigation.
5. Areas that flood. You must ensure return period of at least 100 years.
6. Areas upstream concentration of surface waters, eg reservoirs, water points for drinking or irrigation water or anywhere can decline due to rapid surface water contaminant transport.
7. Atmospheric conditions are not conducive to safe dispersion of pollutants from escaping after extraordinary event.
8. Major natural hazards: landslides, increased seismic movements.
9. Natural ecosystems: Habitat endangered species, parks, forests, nature protection areas.
10. Areas of economic or cultural significance.
11. Historical and archaeological sites and buildings or areas associated with local traditions. In these positions definitely avoid the destruction or contamination and avert visual, aural and functional disturbance.
12. Sensitive locations, such as airports, warehouses flammable or explosive materials etc.
13. Special population concentrations eg hospitals, prisons.
14. Occupying space that leads to inequality between population groups due to the destruction of cultural traditions or relationships with the area.

Moreover it is prohibited to install SWM facilities within the following areas:

- Areas of archaeological cultural interest, ie officially proclaimed and statutory archaeological sites.
- Traditional Settlements
- Statutory protection areas and individual elements of nature and landscape (Natura 2000, National Parks, areas RAMSAR Treaty etc.)
- Residential areas
  - Areas within the project boundaries and within city limits settlements

- Areas private urbanization for residential use.
- Areas for which a special or general prohibitory provision, and National Defense and Security.

3.7.14.1.3. Excusion areas

In order to identify areas in principle suitable for the sitting of treatment works and disposal of solid waste throughout the area of interest, conditions and limitations of suitability will be laid down in accordance with international practice and the requirements of national legislation.

The basic terms and restrictions placed are:

- **Geologic constraints:** Firstly you need to try to avoid areas dominated geological Permeability. In case of difficulty finding areas which geologically constructed of impermeable formations, selecting areas with impermeable bedrock not a criterion for exclusion.
- **Hydrological constraints:** Avoid principle areas which are watersheds where dams exist, but this is not an exclusion criterion.
- **Permanently restricted hunting areas or Wildlife areas** : designated as permanently closed hunting areas, or wildlife sanctuaries are excluded .
  - **NATURA 2000:** Excluded areas are part of the Natura 2000 Directive 92/43 and Directive 79/409
  - Any other protected area under national legislation.
  - **Archaeological sites:** areas declared as archaeological sites are excluded .
  - Besides the above mentioned areas, SWM facilities **within a zone of 500 m from the statutory settlement boundaries are forbidden** .

Also taken into account land use throughout the Limassol District, as given by the land use plan Corine, but also on the details of Urbanism.

Based on the above restrictive parameters specified **are wider suitable locations,** within the limits of which can be done to identify suitable locations for sitting Works and Integrated Waste Management Facilities.

3.7.14.1.4. Criteria for selecting candidate sites for processing - WASTE DISPOSAL facilities appropriate to wider areas

The first important factor for the location of waste treatment and disposal, is the selection of suitable site, which will definitely affect the progress of implementation of projects and operations and especially landfill and will be the basis for future reintegration of the area.

The disposal of waste with the sanitary burial method, meets today reactions of the surrounding community, and that because it often precedes without design, planning and proper organization of the area. The areas chosen are often unsuitable because empirically derived and mainly only the criterion of the absence of reactions from residents, while for the limited financial resources are not performed the necessary infrastructure and the area does not work correctly.

<u>Good planning starts by analyzing the current situation and possible environmental and technical and economic criteria, so as to give a pragmatic solution that guarantees as much as possible to protect the environment.</u>

The selection process begins with the identification of suitable sites using maps at appropriate scale and content (geological, hydrogeological, topographical, mortgage, etc.). Determine the form of terrain (flat, valley, slope), geology sites, distance from settlements, the region's road network, as well as the water resources of the region. After the initial assessment and obtain data from charts, studies (eg hydrogeological, regulators) or reports (eg archeology, forest inspections, etc.) becomes more systematic identification and evaluation of properties after repeated field visits.

A number of criteria that should be taken into account for the identification and default properties are as follows:

<u>a) Capacity</u>
It is important to ensure sufficient land for the construction of processing and parallel to provide the necessary capacity for the landfill. The large capacity acts favorably on the functionality of the site. It allows a better exploitation of the design space and the implementation of more efficient or infrastructure due to the amortization of these projects in a long time. Sufficient time is considered as 20 years - 25 years, and the duration of the area seen from the available volume in relation to the volume of waste produced and the required coating material.

<u>b) Distance from settlements and concealment</u>
This criterion should be treated as a single, taking into account for each site the distance and concealment. The distance is not meant in the strict geometric sense, but in relation to all functions and activities of the settlement reference. The element of concealment has to do with the insertion of natural barriers. Particularly favorable considered interference massifs and large forest land. Generally, the space must be located in isolated and remote from populated areas, transportation routes and crowded areas. It is obvious that the distances and transportation of waste, act decisively in the design and operation of the management system. Also centrorial position as a disposal site for the served areas, positive effect on the functioning of the management and the cost of transporting the waste.

<u>c) Topography and coating material</u>
The form of the terrain significantly affects the type of operating procedures landfill equipment requirements and scope of work required to make the area suitable for use. The possibility of making the coating material from the site itself greatly facilitates the work and minimizes the cost to the coating material. Otherwise, the required borrow material coating formulation and additional design, planning and implementation of the work of finding and renting the appropriate soil space or purchase of material and transport it to the disposal site.

<u>d) Geology - Hydrogeology</u>
It is perhaps the most important factors in terms of environmental suitability of the area for treatment, but particularly for the sanitary burial of waste. And if sufficient clay (or other) seal a disposal site is considered the most basic measure to protect the aquifer, the existence of natural protection aspects assessed very positively. Such parameters are principal, the nature of the soil material and the depth of the water. Better protection of groundwater offers compact rock, rocks

with small discontinuous cracks, clay and soil material with clay blend. Considered acceptable and fine soil materials and sandy soils because, although permeable, filter and purify the leachate after certain measures their path. The existence of abstraction points downstream of the site even if they are away from it are considered unfavorable.

e) The water - climate

The local hydrological conditions are important for the calculation of the necessary drainage systems to be built. The climatic conditions affect the function of the area. The climatic data hamper the smooth functioning of the area make it difficult to isolate the rainwater - leachate and hinder the operation of leachate disposal system. The intensity and wind direction are also crucial to the functioning of the area. Strong winds hamper the work of the workers and pilots. Carrying light objects (eg paper), dust and odors easily and to a greater extent. For example, if the prevailing winds blow from the area towards the vicinity of the village talking to unfavorable wind data.

f) Effects on areas of outstanding beauty, cultural sites and recreation areas

The expected impact in developed tourist areas, recreation areas, landscapes of outstanding beauty, archaeological sites, potential residential extensions, is a detrimental factor.

g) Effects on the fauna and flora of the wider area

The creation and operation of treatment works and disposal is certainly a blow to the local ecosystem. The more interesting the ecosystem is (or rich and rare fauna, flora developed) the greater the expected impact of the intervention projects. This intervention regarding fauna may be exercised either directly (by removing the limiting quantitatively different species) or indirectly by attracting various types of unwanted animals will supersede previously (eg stray dogs, gulls, etc.). Particular attention should consider whether the scope of the project are protected areas, the availability of which may be a prohibitive factor.

h) Effects on economic activities – land uses

Livestock suffers the consequences of a treatment and disposal site, where it is part of an active pasture or when the execution of projects and the operation, interposes obstacles in animal crossing. Also the same happens if other animals harmful to the animals that graze are attracted to the area. Agriculture suffers if there is a failure in the projects, no surface leachate escaping to adjacent crops, but if there are aggregate and other hydrological factors. Severe impact can have projects and in adjacent land plot value either because proximity or access.

i) Effects on the natural micro-landscape of the disposal site

The criterion is located in the natural micro-landscape only to the extent of the under construction site of the SWM facilities and potential access road. The more developed is the landscape, the more adverse effect (dust, noise, odors). An abandoned quarry, or a bare soil cavity is of the best cases. Generally the dense forest is a reflection factor for choosing a specific area and for landfill facilities.

j) Ownership

This criterion examines the cost effectiveness for the acquisition of land, if it is not state land or the alternative cost of a possible different exploitation. At the same time considered the possibility and the procedure and the time required for the acquisition of the land, if necessary expropriation proceedings.

k) Social acceptance

With this criterion, the likely reactions from residents and local organizations of the facilities region is considered, in some cases it is possible to abort the project, even if it is an optimal choice scientifically and technically.

l) Cost of infrastructure-operating-restoration of the site and transport costs

This criterion involves the cost of their projects which vary in relation to each particular area. Not address the cost of the building code works, internal roads, fencing of firewall. Unlike taken, whether imposed and in what order of magnitude the execution of the following works:

- Earthworks for formatting the basin of the disposal site
- Waterproofing bottom and sidewalls
- Perimeter collector trench
- Outdoor access roads on site

Also estimated:

- The cost for obtaining a coating material
- The purchase cost of the area
- The cost for the final restoration-rehabilitation of the area significantly affected by the morphology of the area, the quality of the wider environment and the needs of their community councils.

Also consider the cost of transporting waste, which is directly related to the distance and transportation time.

m) Final use

The future site restoration is examined to adapt to the environment and its use for other activities (parks, playgrounds, etc.).

In summary, the successful selection of an area, is based on the following conditions:

1. Being located in a remote location and away from populated areas, transportation routes and crowded areas.
2. Does not flood by rain or hold stagnant water .
3. Must not be exposed to strong winds, particularly when they are directed to the nearest settlement .
4. Sufficient access road is provided to the disposal site .
5. Does not lie over the aqueduct pipelines and no pollution of groundwater is ensured.
6. Do not be environmentally developed so as not injured , at least substantially , landscape
7. To ensure the necessary quantity of material for coating the waste .
8. Social acceptance.

It is evident from the above that it is difficult if not impossible for a place to meet all the stated requirements. The aim is to combine those features to meet specific needs as far as possible the requirements of the process and minimize the environmental impact of the operation of waste treatment and disposal facilities.

3.7.14.1.5. Map of exclusion areas – Greater suitable areas

Based on what has been said about the exclusion criteria and the areas covered in them, at least those attributable cartographic , are reflected in the relevant map " Protected and sensitive areas."

This map is a detailed mapping of areas of exclusion , so that the greater appropriate locations are clear . These are areas which do not fall within the exclusion criteria and cover completely the requirements of current legislation and the selection criteria.

Within these areas appropriate positions are identified firstly, which will be evaluated and prioritized with more precise criteria and analyzed in the next section .

It is reminded that in order for a position to be judge as appropriate, it must both belong to a "suitable greater area" and to present various features suitability in relation to:

- The geological suitability of the site, so within feasible to safeguard groundwater, without the need for any special technical measures that have related economic costs,
- Spatial suitability of the location, so as not to cause annoyance in particular structured urban and suburban environment and the proximal region,
- Environmental suitability of the site, as to cause the least possible impact on the natural and human environment and the proximal region,
- The functional relevance of the position to ensure the technical integrity of the project for which it is intended, in the context of techno-feasibility.
- Social acceptance

3.7.14.2 Methodology and evaluation criteria – Hierarchy of alternative candidate areas of sitting Waste Management Facilities

3.7.14.2.1. Multiple criteria Analysis

3.7.14.2.1.1. Introduction

For the evaluation - hierarchy of the areas that were finally chosen, the method of ''Multiple criteria analysis'' is going to be used as a methodological tool. A theoretical description of the methodology follows.

The simplest case of the decisions making is when the choice is made based one and only criterion.

When the object should be chosen based on several criteria, the process is called multi-criteria analysis. From the entire waste treatment and disposal facilities, the choice especially of the sanitary landfill position exemplifies MCA.

In such cases, where multiple criteria exist, the decision demands the shortening of the criteria to one and only measure of decision. This unique measure which is typically, named ''Scale of suitability'' (meaning that it is indicative of the various degrees of suitableness or the required target) can be utilized with one set of rules similar to the case where we have only one criterion. In general, there are two kinds of criteria : Restrictions and Factors.

3.7.14.2.1.2. Restrictions

The restrictions are being set as limits in the choices that can be made.
In the multiple criteria analysis, these restrictions should have a mathematical function that does not allow to take into consideration, the areas beyond the defined limits, while allows the evaluation of the areas inside the limits.

This means in the mathematical language that the logical ''AND'' and the logical ''OR'' are used.

When most inputs are mainly of qualitative nature, while others are of quantitative nature, the latter can be transformed in order to allow a common way of analysis. For example, the "Inclination of the ground" can be transformed in a scale with restrictions (limits) ranging from the very steep to the very smooth.

3.7.14.2.1.3. Factors

The factors are continuous criteria, so as to act as a continuous function of the appropriateness of an area for the subject.

For example, it can be defined the proximity of an area go an existing road is desired. Similarly, it can be defined that the inclination of ground has to be smallest.

In such cases, the transformation of criteria to the form of a weighed linear function is used.

$S = Sum (w_i x_i)$

where S = Suitability

w_i = Gravity co-efficient of factor i

x_i = Rating of factor i

In the case where restrictions hold, the process is modified with the multiplication of the suitability which actually comes from the factors, and specifically the product that arises from the restrictions.

namely

$S = Sum w_i x_i * P c_j$

where c_j = Rating (0/1) of restrictions

P = product

3.7.14.2.2. Analytical description of evaluation criteria

3.7.14.2.2.1. Introduction

The criteria can be used to evaluate alternative locations for siting the waste treatment and disposal facilities, given by category follows:

A. GEOLOGICAL CRITERIA

- Permeability of the underground layer liable of the IWMF
- Tectonic structure as a factor of permeability
- Position of water intake works – Large aquatic works
- Usage of underground water

- Ground Erosion – Stability of the slope
- Active tectonics
- Protection of surface water
- Protection of underground water
- Geomorphology of the area
- Covering demands

B. ENVIRONMENTAL CRITERIA
- Green areas, ecological characteristics, landscape
- Optical isolation
- Annoyances by smells
- Annoyances by biogas
- Annoyances during access

C. LAND-PLANNING CRITERIA
- Distance from settlements
- Agricultural activities
- Cattle breeding activities
- Industrial and mining activities
- Proximity to incompatible uses
- Tendency to residential/ tourist development
- Ownership status
- Access network

D. FUNCTIONAL CRITERIA
- Climatologic conditions
- Capacity
- Adequacy of covering layer

E. ECONOMIC COST CRITERIA
- Size/magnitude of infrastructure works
- Value of the land
- Availability networks of common utilities
- Cost of transportation – Distance from the main waste production

In the following paragraphs describe in detail are the individual sub-criteria included in each criteria category and mainly shows how each of the sub-criteria is scored depending on the individual characteristics that it can display. This methodology contributes significantly to the objective evaluation of the sites that will be selected - evaluated, since the method of scoring individual cases that may occur is determined from now.

3.7.14.2.2.2. Category A: Geology - Hydrogeology and Hydrologic criteria

A. Generally

The importance of the geological, hydrogeological and hydrological characteristics of the candidate landfill lies mainly in the possibility of pollution of groundwater and surface water, which exists from the establishment of the facility. In areas with scarcity of water resources, it is the most important issue. The degradation of water quality from a particular IWMF and specifically from a sanitary landfill can be derived:

1. During normal operation of the site, there is always potential for a loss of a small quantity of leachate to the subsoil and surface rinses to the ground. The problem is addressed by the siting of the facility in an area where there is no compromising important water resources and optimal design of waterproofing works.
2. After an accident, where larger amount of pollutants are driven to the water recipients. Such accidents that can lead to the destruction of the means of landfill sealing can be:
   - floods
   - landslides of slope or foundation
   - active faults within or very close to the area
   - Rising groundwater above the lowest level of waterproofing

The purpose of the selection is to minimize the possibility of an accident by avoiding problematic positions. Complementary to the successful selection and depending on local conditions, properly constructed technically works. Such as: sealing the area, protection from water runoff, flood control works, slope protection, and more.

B. Characteristics that determine the susceptibility of groundwater pollution

- **Refeeding**: The feed zones of aquifers are the most dangerous areas for the pollution of groundwater.
- **Territorial area**: Territorial zone usually plays an important role in the retention of pollutants that carry water infiltrating water. In the case of landfill this factor is significantly reduced because usually the territorial zone removed or disturbed.
- **Unsaturated zone**: It is extremely important for the protection of groundwater especially in hilly and mountainous areas

The main elements are the thickness (up to the saturated zone), lithology and permeability (mainly vertical). The existence of a thick unsaturated zone with low permeability significantly reduces the possibility of pollution of potential underlying aquifer.

- **Saturated zone (aquifer)**: It is advisable to protect any useful aquifer. Key elements are:
  - the feed area
  - the geometry of the aquifer
  - type of aquifer (free, under pressure, some pressure, etc.)
  - hydraulic characteristics mainly with interest the hydraulic conductivity (permeability K)
  - flow direction

The following table gives the characterizations of Permeability of geological formations.

Table 3-85: Categories lithological formations according to the liquid permeability (K), (Castany, 1982)

CHARACTERIZATION	YDROPERATOTITA (R) M / SEC
Very permeable (large K)	$> 10^{-2}$
Permeable (large K)	10^{-2} - 10^{-6}
Semipermeable (small R)	10^{-6} - 10^{-9}
Practically dry (very small K)	$<10^{-9}$

- **Protection useful aquifer.**

It is one of the main goals in choosing the IWMF position and especially the position of the basin of the landfill. The usefulness of an aquifer depends on:

- The use of water, irrigation etc.
- The size of the population served or activity
- The possibility of hydro prevention
- The possibility of substitution from another source

- **Protection of hydro prevention works**: The effort to protect groundwater in many cases focused on maintaining the quality of water in places od hydro prevention projects. Important role in this, beyond (and parallel) of geometric and hydraulic characteristics of the aquifer plays the dilution of the pollutant associated with the refresh rate of groundwater and contaminant input distance - the catchment.

C. Detailed description of the geological - hydrogeological criteria

A1. Permeability of the underlying layer of the IWMF

	PERMEABILITY CHARACTERIZATION	GRADE
1	Very small (tight)	10
2	Small (semipermeable)	7
3	Large (permeable)	3
4	Extremely large (extremely permeable)	1

A2. Tectonic structure as a Permeability factor

	DESCRIPTION	GRADE
1	No fractures	10
2	Fractured formations with some plasticity	8
3	Toggle compact and non-compact disrupted formations	5
4	Fractured unconnected Formations	3
5	Fractured compact formations / rhegmatogenous selective flow zones	1

A3. Position of hydrant works- Great water works

	POSITION OF HYDRANT WORKS GREAT WATER WORKS	GRADE	
		Primary porosity *	Karst formation
1	None in area	10	10
2	Upstream in distance> 1km and none downstream	9	7
3	Downstream at> 2km / upstream: 500m - 1km	7	5
4	Hydro catchment projects downstream and at> 1-2km	5	3
5	Hydro catchment projects downstream and distance> 500m - 1km	3	2
6	Hydro catchment projects downstream or upstream and less than 500m	1	1

* Partition into two types because the permeability of the aquifer and therefore risking the project catchment is characterized by the movement of the contaminant in raw materials or porous karst conduits.

A4. Usage of underground water

	DESCRIPTION	GRADE
1	No Use	10
2	Industrial use	7
3	Irrigation / Water stock	6
4	Fodder	3
5	Drinking	1

The use of water resource which is potentially compromising according to the analysis of the previous criterion A3, is evaluated.

A5. Ground Erosion – Stability of the slope

	SLOPES (%)		a)
	Loose-earthen	Rocky	
1	0-15	generally	10
2	15-30		7
3	30-50		4
4	50-100	rock falls	3
5	> 100		1

In rocky terrain throughout the slope range is considered excellent, unless significant rock falls occur . For loose - earthen soils, the scaled escalates.

A6. Active Tectonics

	DISTANCE AREA - ACTIVE RIFT	GRADE
1	Distance> 1000m	10
2	Distance 500-1000m	8
3	Distance 500-300m	6
4	Distance 100-300m	1
5	Distance <100m	NO (rejected)

A.7. Protection of surface waters

This criterion is rated as:

A. The use of the recipient or the use of surface waters downstream of the proposed site. All occurring are taken into account, but have different gravity.

b The distance of IWMF- Recipient along the stream.

A.7a. Type and use the main recipient (X0, 50)

	TYPE AND USE OF MAIN RECIPIENT	GRADE
1	SEA	10
2	RURAL AREA	8
3	URBAN AREA	7
4	RESERVOIR IRRIGATION	6
5	IRRIGATION	5
6	RECREATION	5
7	FORAGE	3
8	RESERVOIR WATER	2
9	WATER	1

A.7b. Distance IWMF - Recipient (X0, 50)

	DISTANCE IWMF - RECIPIENT	GRADE
1	> 9000	10
2	7000-9000	9
3	4000-7000 m	7
4	2000-4000 m	5
5	1000-2000 m	4
6	≤ 1000 m	3

A.8. Protecting underground water

A.8a. Due to infiltration (XO.50)
The issue arises from the treatment of hydrogeological characteristics and has been rated (A1, A2). Since the importance of these two criteria are approximately equal, so we accept that A8 = (A1 + A2) / 2. For the reason that it has already been given special importance to this criterion in the previous criteria even though it is the main mode of transport in groundwater pollution at this point has only 50%.

A.8b. Due to supply via surface waters (X0, 50)
To cause pollution from this road there must be a significant supply of groundwater from polluted surface waters. So the area downstream of the streams passing should result in a zone of high permeability (sands, gravels, sink, active karst, fractures, etc.)

Distance IWMF – High Permeability Zone

	DISTANCE	GRADE
1	> 9000	10
2	7000-9000	9
3	4000-7000 m	7
4	2000-4000 m	5
5	1000-2000 m	4
6	≤ 1000 m	3

A.9. Geomorphology of Area

A.9a. Hydrological characteristics (X0, 60)

The upstream basins that feed with run-off the area in question, determine the technical characteristics of the drainage and the possibility of pollution of surface waters in the event of failure.

	UPSTREAM BASIN AREA (ACRES)	GRADE
1	<100	10
2	100-300	9
3	300-500	8
4	500-700	7
5	700-900	6
6	900 - 1100	5
7	1100 - 1300	4
8	1300 - 1500	3
9	1500 - 1700	2
10	> 1700	1

A.9b. Configuring surfaces and slope protection (X0.40)

	SLOPE OF AREA AND SIDES	GRADE
1	0-15% favorable	10
2	15-30%	7
3	30-40%	5
4	> 40% (prohibitive in the main area of development)	3
5	problematic side slopes to a large extent	1

A10. Covering demands

The waterproofing requirements are an important part of the protection of the under layer . The various key features are rated as follows:

	WATERPROOFING METHOD	GRADE
1	Without further waterproofing	10
2	Simple waterproof layer (Clay or geomembrane)	8
3	Advanced waterproof layer (A combination of clay and geomembrane)	5
4	Double waterproof layer	1

D. Category B: Environmental criteria

B1. Green areas, Ecological characteristics, Landscape

This is not considering existing protected areas of outstanding ecological importance because they have already been ruled out as positions. A characterization of regions in terms of vegetation characteristics, their ecological importance and character of the landscape. The degree may be due to only one or some combination of features.

	VEGETATION TYPE AND CHARACTERISTICS	GRADE	
		SEIZURE	APPROACH
1	Brushwood / Region ordinary ecological features / crops	10	10
2	Shrubs	5	5
3	Shrubs with scattered trees / area moderate ecological importance / interest large-scale landscape	4	4
4	Riverine vegetation	2	2
5	Forest / Area of special ecological importance / rare landscape	1	1

B1a: seizure (x 0.60)

B1b: approach (X 0.40)

B2. Optical Isolation

	DESCRIPTION	GRADE	
		Increased eye contact	Limited sight
1	Full optical isolation	10	10
2	Visible from cobbled street	6	8
3	Visible from primary or secondary roads	2	5
4	Visible from individual houses	3	5
5	Visible from highway / places of tourist interest	2	4
6	Visible from settlements	1	2

B3. Annoyance by smells

Annoyance by odors in settlements or other gatherings of people is examined. Important factors in the problem is the distance from the receiver and the direction of prevailing winds. In calm weather the distance from the receiver and terrain are particularly important

B3a. Distance recipient (X0, 5)

	DISTANCE	GRADE
1	> 3 km	10
2	2-3 km	7
3	1,5-2 km	5
4	0,5-1,5 km	3
5	<0,5 km	1

B3b. Winds (X0, 5)

	WINDS	GRADE
1	Favorable prevailing winds or settlements located> 3000 m	10
2	Interim statement	5
3	Adverse prevailing winds	1

B4. Annoyance from biogas

The disturbance of the biogas that is produced from the degradation of waste and can escape for some reason, is caused by two ways:

a) through the air

b) through the unsaturated zone of the subsurface

B4a. Dissemination through the air (X 0.40)
The behavior is almost similar with that of odors. Therefore in this position sets the degree of annoyance by odors. Ie B4a = B3

B4b. Dissemination through the subsurface (X 0.60)
The motion of the gas is mainly through the permeable and especially karst formations or disrupted. This raises the level of the liquid permeability of the underlayer of the landfill and fractures. Ie B4b = (A1 + A) / 2

B5. Annoyance during access
B5a. Annoyance from traffic (X 0.30)
Movement from road network traffic is graded

	FEATURES ROAD	GRADE
1	Highway (4 lanes)	10
2	Primary roads (two lanes - asphalt)	8
3	Secondary roads (one lane - asphalt)	6
4	Cobbled road passable	4
5	Cobbled street not passable	2

B5b. Annoyance settlements (x 0.70)

	DESCRIPTION	GRADE
1	Crossing from settlements	10
2	Crossing the ring road settlement	6
3	Crossing through settlement / primary roads	5
4	Crossing through the village section / secondary roads	3
5	Crossing through part settlement / local minor pathway	1

E. Category C: Land-planning criteria

C1. Distance from settlements
Very important criterion for social, health, psychological and environmental factors.

	IWMF DISTANCE OF SETTLEMENTS	GRADE
1	> 5km	10
3	3.5-5 km	8
4	2-3.5 km	6
	0.5-2 km	4
8	<0.5 km	rejected

C2. Agricultural activity
C2.a. Occupation of land (X0, 7)
C2.b. Proximity (X0, 3)

Consider the agricultural land that currently dominate in this area.

	MAIN AGRICULTURAL ACTIVITY	PROXIMITY	LAND OCCUPATION
1	pathogenic soil	10	10
2	heaths	9	9
3	pasture	7	7
4	Degraded agricultural land	5	5
5	Mild farming	3	3
6	Highly productive agricultural land / irrigated	1	0

C3. Forage activity within <of 1.000m.

	DESCIPTION	GRADE
1	Lack of livestock farming	10
2	Limited breeding activity	5
3	Intensive livestock farming	3
4	Main ranching operation	1

C4. Industrial activity

Although the IWMF siting in larger areas with existing industrial activities are compatible and often desirable, however think that the immediate vicinity of existing plants is undesirable. Therefore scoring is as follows

	IWMF DISTANCE OF INDUSTRIAL ACTIVITIES	GRADE
1	> 3 km	10
2	2-3 km	8
3	1-2 km	5
4	0,5-1 km	3
5	<0,5 km	1

C5. Proximity to conflicting uses

	PROXIMITY TO INCOMPATIBLE USES	GRADE		
C5a	Area protection and high forest	<1000m	1-3000m	> 3000m
		1	5	10
C5b	Landscape protection area	<500m	500-1000m	> 1000m
		1	5	10
C5c	Tourist zone	As distance from settlements (Criterion C1)		
C5d	Archaeological site	<1000m	1-3000m	> 3000m
		1	5	10

C5a = 0.25, C5c= 0.25, C5c = 0.25, C5d= 0.25
These areas or are institutionalized or practically have described the character.

C6. Tendency to residential/ tourist development

Special consideration because it is probably the largest generator of surplus land, while further evaluated proximity to respective uses.

	TENDENCY TO RESIDENTIAL - TOURISM DEVELOPMENT	GRADE
1	Low voltage	10
2	Medium voltage	5
3	High Voltage	1

C7. Network access to the final area

C7a. Type of network (X 0.50)

	DESCRIPTION	GRADE
1	Freeway - primary roads	10
2	Secondary roads that requires improvements	8
3	Street requiring improvement / new opening	5
4	Requirement opening a new route in difficult terrain	1

C7b. Necessary access projects (X 0,50)

Determined by the length and quality of the road network. Quantified according to the type and size of work to be done in order to be able to seamlessly access the garbage in the area of the IWMF. For every 2 km drilling / road improvement 2 points are deducted.

	PARAMETER	GRADE
1	Access without performing any work	10
2	Drilling / improvement 0.5-1 km	9
3	Drilling / improvement 2.1 km	7
4	Drilling / improvement 2.3 km	5
5	Drilling / improvement 3.4 km	3
6	Drilling / improvement of> 4 km.	1

F. Category D: Functional criteria

D1. Climatologic conditions

The parameters related to the functionality of the site and are possible to differentiate how project functions are examined.

D1.a. Elevation (X 0.40)

	ALTITUDE AREA	GRADE
1	<200 m	10
2	200-300 m	8
3	300-500 m	5
4	500-700 m	3
5	> 700 m	1

D1.b. Exposure to winds (X 0.60)

	REPORT OF WINDS	GRADE
1	Small	10
2	Moderate	5
3	Great	1

D2. Adequacy of the available area - Expansion Capabilities

	DURING OPERATION	GRADE
1	Great	10
2	Moderate	6
3	Small	3

D3. Adequate coating material

	BORROW DISTANCE	GRADE
1	within the area	10
2	<500m	8
3	500-2000m	5
4	> 2000m	1

G. Category E: Economic cost criteria

E1. Size/magnitude of infrastructure works

The ease of implementation, the size and simplicity of the required technical infrastructure etc, are examined and rated.

	INFRASTRUCTURE MAGNITUDE	GRADE
1	Small	10
2	Moderate	7
3	Large	5

E2. Earth Value

The surrender value of the land is necessary based primarily on the trend of housing and tourist development and secondarily by the seizure of land from agricultural uses, are examined and rated. Therefore:

E2a = C6: Tendency to residential - Tourism development (X 0.70)
E2b = C2: Agricultural activity (X 0.30)

E3. Availability networks of common utilities

The combined availability of network utilities ie water, electricity supply etc. in terms of necessary projects for water, electricity etc. installation, are examined and rated. Criterion scoring is the distance from the nearest point of supply.

	DISTANCE FROM COMMON UTILITY INSTALLATION	GRADE
1	<500 m	10
2	500 - 1000 m	7
3	1000 - 2000 m	5
4	> 2000 m	3

E4. Estimated cost of transport - Distances from the main production area of solid waste
The cost of transporting waste to IWMF is a permanent operating costs and is generally directly proportional to the distance traveled. For every 5 km subtracted from 10, 1 point, so the maximum distance being rated 1. As we consider the maximum distance of 45 km.

	DISTANCE IWMF – MAIN PRODUCTION AREA (km)	GRADE
1	<5	10
2	5.10	9
3	11-15	8
4	16-20	7
5	21-25	6
6	26-30	5
7	31-35	4
8	36-40	3
9	41-45	2
10	> 45	1

3.7.14.2.3. Summary of comparative evaluation methodology

3.7.14.2.3.1. Generally

The methodology followed in this study, as already mentioned, is a method of Multiple Criteria Analysis (Multiple Criteria Analysis). The model consists of five steps:

1. Purpose: Set the basic purpose or objective.
2. Quantification criteria: Mathematical description (graduation with the help of coefficients) of each criterion.
3. Weights criteria: Determination of the relative importance of these criteria to the success of the basic objective.
4. Marking area: Calculation of total score (based on a pooled basis) of each of the alternative candidate sites.
5. Hierarchy sites: Comparative assessment and prioritization of alternative candidate sites

These steps of the model are summarized below.

Advantages of the method:

i. It takes into account a large number of the criteria , as well as the interactions between the criteria with the help of the Decision analysis tree (Step 2).

ii. It allows the analytical and the more rationalistic definition of the importance of the criteria with a comparison table between all the criteria. (Step 3)..

iii. It allows the marking of an area even when the elements are not completely precise but are given with a certain degree of uncertainty with in a range of confidence. (Step 4).

iv. The final hierarchy of the areas takes place with greater reliability, since the areas that do not differ greatly, are classified in the same category (Step 5).

3.7.14.2.3.2. Purpose

The general purpose for the disposal of solid waste is to minimize the negative effects of the disposal area. The mathematical coefficients that are defined for each criterion and the final marking provide a degree of the extent that the natural environment can inherently retain or allow the spreading of leachate or other of dangerous materials or gases outside the IWMF after a hypothetical disorder of the area.

3.7.14.2.3.3. Quantification criteria

The first step in the development of the model is the setting of the effects of the Sanitary Landfill Site according to every criterion. This is done for every criterion with the description of the impacts and the determination of marking that corresponds to the scale 1-10. Normally, this is done with the help of a mathematical relation of one factor with the corresponding consequences, or with a table that presents the consequences as a gradual function in the scale 1-10. In some cases, a criterion can be further analyzed in other sub-criteria with the help of a tree of impacts. Every one of the sub-criteria is dealt with in the following way, i.e. as a separate criterion. This aspect of the model gives the possibility for cross interactions examinations between the criteria , where one criterion appears as a sub-criterion of another one.
This step for the used subcriteria, has been developed in detail in a previous section of this chapter.

3.7.14.2.3.4. Weighing (importance) of criteria

In many decision problems, we can conclude that the criteria do not contribute to the satisfaction of the main target or that from the perspective decision maker, the criteria have variable graduation of importance. The relevant emphasis on the criteria is specified with a separate analysis of the tables and is applied as a percentage of gravity in the stage of the marking. The importance of the criteria that are going to be used are given in the following section 6.3.7. "Specifying weights of evaluation criteria."

3.7.14.2.3.5. Marking of the alternative sites

The weighing for the criteria are combined using a cumulative function, which involves the rating of each criterion weighted but with the help of weighing. Furthermore, for reasons of better understanding of the marking process and without reliability compromise, the criteria are subdivided into four categories or groups of criteria which have fixed gravity coefficients. The emphasis coefficients that express the relevant importance of one criteria group compared to all others are determined according to international specifications as well as the local conditions.

To determine the sensitivity of the results on the importance of criteria can be formulated evaluating different scenarios, with different sub-groups of gravity benchmarks. This study proposed and used in the following scenarios:

Table 3-86: Alternative scenarios EVALUATION OF candidate positions of IWMF

	A' Scenario	B' Scenario	C' Scenario
I. Geological - Hydrogeological suitability	20%	30%	25%
II.Environmental suitability	20%	25%	25%
III Land-planning suitability	20%	15%	30%
IV. Functional fitness	20%	15%	10%
V. Economic parameter	20%	15%	10%
Total	100%	100%	100%

So, if we call these groups of the criteria A, B, C, D and E and by using the above weights the cumulative function is the following :

S= 0,20A + 0,20B + 0,20C + 0,20D + 0,20E (A' Scenario)
S = 0,30A + 0,25B + 0,15C + 0,15D + 0,15E (B' Scenario)
S = 0,25A + 0,25B + 0,30C + 0,10D + 0,10E (C' Scenario)

3.7.14.2.3.6. Hierarchy of candidate positions

For the hierarchy, every site receives a final marking, resulting from the cumulative function S. The areas are finally classified to a relative order from top to bottom, i.e. the area with the highest marking is classified first, the next in the marking second, etc.

3.7.14.2.3.7. Definition of gravity coefficients of the evaluation criteria

According to the above methodology, the below weighing of sub criteria of each general group of criteria follows:

Table 3-87: Defining gravity coefficients

A. GEOLOGICAL CRITERIA	GRAVITY COEFFICIENT (%)
• Permeability of the underground layer liable of the Sanitary Landfill Site	20
• Tectonic structure as a factor of permeability	18
• Position of water intake works – Large aquatic works	10
• Usage of underground water	10
• Ground Erosion – Stability of the slope	5
• Active tectonics	5
• Protection of surface water	7
• Protection of underground water	10
• Geomorphology of the area	10
• Covering demands	5
TOTAL	**100**
B. ENVIRONMENTAL CRITERIA	**GRAVITY COEFFICIENT (%)**
• Green areas, ecological characteristics, landscape	20
• Optical isolation	25
• Annoyances by smells	20
• Annoyances by biogas	20
• Annoyances during access	15
TOTAL:	**100**
C. PLANNING CRITERIA	**GRAVITY COEFFICIENT (%)**
• Distance from settlements	30
• Agricultural activities	10
• Cattle breeding activities	4
• Industrial and mining activities	6
• Proximity to incompatible uses	15
• Tendency to residential/ tourist development	20
• Ownership status	15
TOTAL:	**100**
D. OPERATING CRITERIA	**GRAVITY COEFFICIENT (%)**
• Climatic conditions	10
• Capacity	60
• Adequacy of coating layer	30
TOTAL:	**100**
E. CRITERIA ECONOMIC COST	**GRAVITY COEFFICIENT (%)**
• Size/magnitude of infrastructure works	35
• Value of the earth	20
• Availability networks of common utility	15
• Cost of transportation	30
TOTAL:	**100**

3.8 PROPOSED SCENARIOS FOR REGIONAL WASTE MANAGEMENT

3.8.1 Introduction

In order to support decisions regarding future solutions for the Waste Management Plan in East Region, reliable strategies and concepts are needed. For this purpose, four waste management scenarios (including sub-scenarios) have been defined. The scenarios are based on objectives and recent national legislation for waste management and take into account regional waste production and composition as well as existing waste system infrastructure. For each scenario, the following material flows were quantified:

(1) wastes that would be sent to collection systems, such as green waste, biodegradable waste, electric and electronic waste (WEEE), hazardous material, Construction and Demolition waste, recyclable waste (paper/cardboard, glass, plastic, Fe, Al);

(2) wastes that would be sent to different processes, such as those of mechanical-biological treatment, mechanical-recycling facility, mechanical-biological stabilization, incineration;

(3) residues to be diverted to landfills;

(4) materials recoverable by recycling processes (mechanical separation)

(5) energy obtainable by waste-to-energy plants.

Also for each scenario are quantified carbon dioxide emissions (CO_2) from waste management activities. CO_2 is one of the major GHG emissions generated by MSW management and of significant interest under the Kyoto Protocol (IPCC 1997, 2006). For the quantification of GHG emissions used the SWM-GHG calculator that follows the Life Cycle Assessment (LCA) method. Different waste management strategies can be compared by calculating the GHG emissions of the different recycled (glass, paper/cardboard, plastics, metals, organic waste) and disposed of waste fractions over their whole life cycle. The tool sumps up the emissions of all residual waste of recycling streams respectively and calculates the total GHG emissions of all process stages in CO_2 equivalents. The emissions calculated also include all future emissions caused by a given quantity of treated waste. This means that when waste is sent to landfill, for example, the calculated GHG emissions, given in tone CO_2 equivalents per tonne waste, include the cumulated emissions this waste amount will generate during its degradation. This method corresponds to the 'Tier 1' approach described in IPCC.

The waste management sector contributes to the greenhouse effect primarily through emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). But in the greenhouse gas (GHG) inventories based on IPCC (Intergovernmental Panel on Climate Change) methodology, positive impacts of reducing, re-using or recycling of waste as well as waste-to-energy strategies on climate protection are either attributed to other source categories-in particular to the energy sector and to industrial processes-or they are not accounted for at all.

Developing countries and emerging economies could not only considerably reduce their GHG emissions at comparably low costs but also significantly contribute to improve public health conditions and environmental protection if they were to put in place sustainable waste management systems. GHG produced by the waste management sector in developing countries and emerging economies are highly relevant, in particular because of the high percentage of biodegradable components contained in the waste streams. Stepping up recycling could further reduce emissions by energy savings.

Climate change is considered one of the greatest global challenges of the 21st century. A general consensus exists among the vast majority of climate experts that global warming is the result of rising concentrations of greenhouse gases in the Earth's atmosphere. Since industrialization began, human activities have intensified the natural greenhouse effect, which is caused largely by water vapor, carbon dioxide, methane and ozone in the atmosphere, through anthropogenic emissions of greenhouse gases, resulting in global warming.

The waste management sector contributes to the greenhouse effect primarily through emissions of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). The IPCC's Fourth Assessment Report puts the contribution made by the solid waste and wastewater management sector to global greenhouse gas emissions at 2.7%, which might at first sight appear to be comparatively low. But in fact, waste management can contribute indirectly to significantly larger GHG emissions reductions.

The 2.7% of global GHG emissions assumed for the waste sector by IPCC do not fully reflect the actual potential for reducing GHG emissions by the waste management sector. The IPCC calculations take into account only end-of-pipe solid waste management strategies, such as:

- Landfill/waste dumping
- Composting
- Waste incineration (in case the generated heat energy is not utilized)
- Sewage disposal

In this way, potential emissions reductions in the waste sector are assumed to exist predominantly in avoiding methane production from landfills. The positive impacts of reducing, re-using or recycling waste, as well as waste-to-energy solutions on climate protection are either attributed to other source categories – in particular to the energy sector and to industrial processes – or they are not accounted for at all in the GHG inventories reported to the United Nations Framework Convention on Climate Change (UNFCCC) under the Kyoto Protocol.

Several strategies can be used for the reduction of GHG emissions in waste management:

- Methane reduction: Collection and flaring of landfill gas can already cut the emissions in half because it leads to CO_2 emissions instead of methane emissions. Even more, waste incineration or composting have significantly less global warming potential than landfilling.
- Recycling: The use of secondary raw materials instead of primary raw materials reduces the energy consumed in industrial processes. In glass production, 35% of energy can be saved, in paper production 50% and in aluminum production, the use of secondary raw materials can even save 90% of energy use compared to the use of primary raw materials. In addition to the savings in energy, recycling also avoids the emissions and environmental impact resulting from the exploitation of primary raw materials. Composting of organic waste generates alternative fertilizer which leads to less energy consumption for producing chemical fertilizer.
- Energetic use: Waste can be used energetically in many ways. Waste fractions with a high calorific value can be used as alternative fuel resources, and organic waste can be digested

to produce biogas. When waste is used to substitute primary fossil fuels in these processes, this leads to reductions of emissions.

The emission savings resulting from recycling processes vary significantly according to the material recycled. When for example waste paper is recycled and not disposed on a landfill, this results not only in reducing the emissions that would have occurred by the material degradation on the landfill, but also in reducing the emissions caused by cutting trees as well as the energy and emissions from processing wood for paper production and part of the energy used for processing cellulose.

Especially in developing countries and emerging economies, greenhouse gas emissions produced by the waste management sector are highly relevant, in particular because of the high percentage of biodegradable components contained in the waste streams. The potential to reduce greenhouse gas emissions is significantly higher than the 2.7% figure in the IPCC statistics would lead us to assume. A study conducted on behalf of the Federal Ministry for Economic Cooperation and Development (IFEU 2008) estimates that developing countries and emerging economies could reduce their national GHG emissions by around 5% merely by adopting municipal waste management systems. The authors calculate that if other waste types, especially waste containing high levels of biodegradable organic matter, in particular the residues of agricultural activities and the food industry or other, similar industrial wastes are included in the waste management system, the reduction of greenhouse gas emissions in these countries could be doubled, i.e. in the order of 10%.

For the quantification of GHG emissions, the SWM-GHG calculator has been used, that follows the Life Cycle Assessment (LCA) method. KfW Entwicklungsbank in cooperation with German Technical Cooperation agency (GTZ) commissioned the elaboration of SWM-GHG tool to calculate GHG emissions in solid waste management. The objective of this tool, which was elaborated by IFEU (Institute for Energy and Environmental Research) is to help to understand the effects of proper waste management on GHG emissions.

As it is mentioned before, the calculation method used in the SWM-GHG Calculator follows the Life Cycle Assessment (LCA) method. Different waste management strategies can be compared by calculating the GHG emissions of the different recycled (typically glass, paper and cardboard, plastics, metals, organic waste) and disposed of waste fractions over their whole life cycle. The tool sums up the emissions of all residual waste or recycling streams respectively and calculates the total GHG emissions in CO_2 equivalents. The emissions calculated also include all future emissions caused by a given quantity of treated waste. This means that when waste is sent to landfill, for example, the calculated GHG emissions, given in tone CO_2 equivalents per ton of waste, include the cumulated emissions generated during waste degradation. This method corresponds to the ‘Tier 1’ approach described by the Intergovernmental Panel on Climate Change (IPCC 1997, 2006) for emission quantification.

The SWM-GHG calculator comprises different sheets where the users enter basic information and can define the status quo waste management practices as well as scenarios for future waste management options.

- *Waste characteristics*. In a start sheet, users specify the waste amount, waste composition, and the country-specific electricity grid

- *Definition of waste recycling options*. In the recycling sheet, users define the percentage of different waste fractions (organic and non-organic) that are currently recycled or valorized. For organic waste, there are the options of composting and digestion.
- *Definition of disposal options*. For the residual waste remaining after recovery, specifications have to be introduced regarding different treatment and disposal options in the disposal sheet. Different treatment types and technologies exist. Some should be avoided as they cause health hazards to the population and damage the environment, some are very simple but at least less hazardous and finally there are advanced treatment technologies. The treatment technologies represented in the SWM-GHG calculator are divided in three groups. The first group includes common practices that should be avoided. They affect waste which is not regularly collected but usually scattered or delivered to a wild dump site. Additionally, scattered waste is sometimes burned in the open air, producing huge amounts of toxic substances (in particular dioxins, furans, aromatic hydrocarbons etc.). The second group is that of simple treatment and disposal technologies. Apart from disposal to controlled landfills (with or without landfill gas collection) this includes simple biological stabilization before disposal whereby methane emissions are reduced. The third group includes advanced technologies. Apart from waste incineration this include treatment options with the purpose of separating recyclable fractions before stabilizing the remaining waste biologically prior to sending to landfill or to produce a refuse derived fuel that may be incinerated e.g. in cement kilns

In this study different scenarios have been defined for solid waste management. For quantification of GHG emissions from the treatment of MSW in each of the scenarios, SWM-GHG calculator was adopted.

3.8.2 Overview of proposed scenarios

With the Regional Waste Management Plan should be covered the minimum requirements set by the national waste management legislation for packaging and packaging waste. Also should be covered a set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills. The national targets for management of packaging and packaging waste and diversion of biodegradable municipal waste from landfills were presented in previous paragraph.

To fulfill the objectives of waste management, four main alternative waste management scenarios have been examined and presented afterwords via a flow diagram. All proposed waste management scenarios include some common elements like green points that will be a collection point for fractions such as electric and electronic waste (WEEE), hazardous municipal waste, construction and demolition waste and recyclables. Also all proposed scenarios include separate collection of green/garden waste and sorting at source of recyclables or packaging waste based on each examined scenario. Finally the proposed scenarios including a collection system with the use of either 1 bin, 2 bins and 3 bins. Obviously, based on the collection system, the proposed treatment facilities (including home composting), are also differentiated, accordingly by the way some sub-scenarios (a, b, c) are also developed, which are involving different technologies to treat waste that are collected with the same concept (1 bin, 2 bin or 3 bin system).

The table below presents a summary of the scenarios analyzed in the current chapter

Table 3-88: Scenarios overview

	Scenario 1 (1 bin)		Scenario 2 (2 bins) Mixed + Biowaste	Scenario 3 (2 bins) Mixed + Recyclables			Scenario 4 (3 bins) Mixed + Recyclables + Biowaste
	1a (MBT)	**1b (Incineration)**	**2**	**3a (MRF+ Aerobic Composting)**	**3b (MRF + MBS + Aerobic Composting)**	**3c (MRF + Incineration)**	**4 (MBT)**
Waste Collection	One Bin collection system		Two Bin collection system (*Organic Waste Bin* and *Mixed Bin*)	Two Bin collection system (*Recyclable Waste Bin* and *Mixed Bin*)			Three Bin collection system
Green Points	√	√	√	√	√	√	√
Home Composting	√	-	-	√	√	-	-
Mixed Bin Treatment	Mechanical Biological Treatment (MBT) with Aerobic Composting	Incineration	Dirty MRF	Disposed to Landfill	MBS (Biostabilization)	Incineration	Disposed to Landfill
Recyclable waste bin treatment	-	-	-	MRF	MRF	MRF	MRF
Organic waste bin treatment	-	-	Aerobic Composting	-	-	-	Aerobic Composting
Green waste treatment	Aerobic Composting	Incineration	Aerobic Composting	Aerobic Composting	Aerobic Composting	Incineration	Aerobic Composting
Landfill	√	√	√	√	√	√	√

3.8.3 Scenario 1: One Bin collection system (Mixed Waste Bin)

3.8.3.1 Key Features

Scenario 1 is based in one bin collection system (mixed waste) and includes two sub-scenarios depends on the treatment technology selected to treat residual waste, sub-scenario 1a, which includes MBT Plant and sub-scenario 1b which includes Incinerator. The key features of scenario 1 are:

Collection

- *One Bin Collection system for mixed waste*. According to calculations, the total number of waste bins (capacity 1.1 m^3) that needed for scenario 1a is 2430 and for scenario 1b is 5559. However because there are already existing bins with this capacity in East Region, the necessary bins that needed to be purchased in scenario 1a are 593 and in scenario 1b are 1904. The amount of waste collected in this system is 42,432 t/y (83.2% of total generated waste) for scenario 1a and 97,647 t/y (87.97% of total generated waste) for scenario 1b.
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials (Green Points)*. The following assumptions have been made: (i) Collection of 100% of electric and electronic waste fraction i.e. 0.07% of total generated waste (36 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0.25% of total generated waste (128 t/y), (iii) Collection of 30% of construction and demolition waste fraction, i.e. 0.42% of total generated waste (214 t/y) and (iv) Collection of 3% of recyclable materials until 2020, i.e. 0.85% of total generated waste (434 t/y). The total collection of waste in green points in East Region is 1.59% of total generated waste (811 t/y). All these assumptions are the same for scenario 1a and 1b, but in scenario 1c the total collection of waste in green points is 1.82% due to difference in waste composition (unified waste composition for two regions).
- *Separate collection of Green Waste.* The assumption which has been done is that collected the 40% of green waste fraction, ie 6.85% of total generated waste (3,494 t/y). This assumption is common for scenario 1a and 1b, but scenario 1b has a different percentage 5.68% of total generated waste (6,305 t/y) due to difference in waste composition.
- *Sorting at Source for packaging waste (Collective Schemes)*. The minimum requirements that needed to be achieved in year 2020 are: glass packaging 47.19%, plastic packaging 10.18% (6.02% 2018), paper packaging 37.58%, Fe packaging 33.55% and Al packaging 33.55% (all of these percentages are of generated packaging waste fraction).For the achievement of these percentages we assumed that sorting at source of packaging waste will start from 2016 with smaller percentages and gradually will increase until 2020. The total percentage of collected packaging waste in 2020 for scenario 1a, after calculations, is 22.31% of total generated packaging waste and 4.77% of total generated waste (2,433 t/y). For scenario 1b, the total percentage of collected packaging waste in 2020, is 20.52% of total generated packaging waste and 4.53% of total generated waste (5,028 t/y). According to calculations, for scenario 1a needed 1548 bins, with capacity 0.12 m^3, and 314 bins, with capacity 1.1 m^3 for packaging waste sorting at source. Respectively for scenario 1b needed 3306 bins with capacity 0.12 m^3 and 416 bins with capacity 1.1 m^3.

Treatment of Mixed Waste Bin

- Collected Mixed Waste from the mixed Bin processed to a Mechanical Biological Treatment

Plant with aerobic composting process (scenario 1a) or to an incineration plant (scenario 1b).

Treatment of Biodegradables sorted at source (Home Composting)

- *Home Composting*. For the estimation of quantities that will be directed to home composting process is assumed that the 20% of rural population will be served, ie 20%*35.2%=7%, and the fractions that can be used in this process are green waste, biodegradable waste and wood. According to calculations, the total number of waste bins (capacity 0.2 m^3) that needed for scenario 1a and home composting process is 4100. Home composting process takes place only in scenario 1a.

Treatment of Green Waste

- Collected Green Waste will be directed either to the treatment process together with the waste from the mixed Bin after its exit from the mechanical separation process (scenario 1a), or in incineration plant (scenario 1b). Especially for scenario 1b collected green waste can also be directed to windrow composting process for the production of high quality compost.

Table 3-89: Assumptions and calculations for scenarios 1a and 1b

		Scenario 1a % Collection (Average 2018-2042)	Scenario 1b % Collection (Average 2018-2042)
Green Points	A* A A A C*	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction Total collection: 1.59% of generated waste	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction Total collection: 1.82% of generated waste
Sorting at source of packaging waste (Collective Schemes)	A A C	21.45 % of packaging waste [9.04% (2018)-22.31% (2020-2042)] 4.59% of generated waste	20.52% of packaging waste [8.68% (2018)-21.34% (2020-2042)] 4.53% of generated waste
Green Waste	A C	40% of green waste fraction 6.85% of generated waste	40% of green waste fraction 5.68% of generated waste
Home Composting	A C	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste+Wood 3.77% of generated waste	-
Packaging waste Mechanical Treatment/Incineration	A C	29.95% of packaging waste 6.42% of generated waste	-

*****A: Assumption, C: Calculation*

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MBT Plant (scenario 1a) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Recovery % (Assumption)	Final Recovery %	Recovery of packaging fraction*
Paper	8.42	30	2.53	1.40
Plastic	11.79	40	4.72	4.42
Glass	2.01	20	0.40	0.28
Fe	0.47	70	0.33	0.23
Al	0.12	70	0.09	0.09
Total	22.81		**8.06**	**6.42**

**Paper packaging=100%Tetrapak+90%Cardboard+25%Paper=6.03% of generated waste or 55.24% of total paper fraction*
**Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles=12.59% of generated waste or 93.68% of total plastic fraction*
**Glass packaging=70%Glass=2.15% of generated waste or 70% of total glass fraction*
**Fe metal packaging=70% Fe metal=0.44% of generated waste or 70% of total FE metal fraction*
**Al metal packaging=100% Al metal=0.19% of generated waste of 100% of total Al fraction*

For determine of Fe metals and electric energy production from the incineration plant (scenario 1b) the following figures were used:

Parameter	Origin
60% recovery only of Fe metals (from Fe metals that inserts the incineration plant)	A*
Calorific value of incoming waste in incineration plant 9984KJ/kg	C*
Net electricity production = (incoming waste in WtE)*22%*9984/3600 (MWh/y)	C
Annual operational hours 7488	A
Net electric power = Net electricity production/7488 (MW)	C

**A: Assumption, C: Calculation*

3.8.3.2 Achievement on national targets for Recylcing and Biodegradables

The following tables are based on the detailed calculations included in Annex III. These tables presented the achievement of national targets for recycling and biodegradable waste for landfilling.

Packaging waste

Recycling of packaging waste % (2020)	Scenario 1a	Achievement on recycling targets	Scenario 1b	Achievement on recycling targets
Total % of recycling of packaging waste	55.26%	Yes	24.34%	No
% glass packaging	63.31%	Yes	50.19%	No
% plastic packaging (2018)	44.11%	Yes	9.02%	No
% paper packaging	63.71%	Yes	40.58%	No
% Fe packaging	88.66%	Yes	18.01%	No
% Al packaging	81.89%	Yes	18.01%	No

Biodegradable waste

Reduction of BMW	Scenario 1a	Achievement on targets of BDW	Scenario 1b	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2020)*	96.62%	Yes	100.00%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	96.43%	Yes	100.00%	Yes

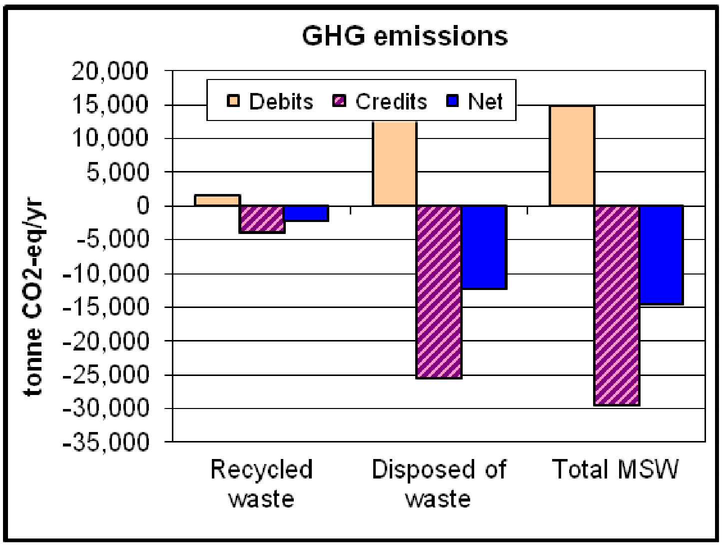
* *Biodegradable municipal waste in territory 1995=305,000 t (Rulebook LoWM Article 87)*
Total population of country 2,062,294 (statistical office 2012)
East Region Population 178,551 (8.66% of territory)
*Biodegradable municipal waste in East Region 1995, 8.66%*305,000=26,413 t*

3.8.3.3 Greenhouse gas emissions

For calculation of greenhouse gas emission impact applied SWM-GHG Calculator, a tool for calculating greenhouse gases in solid waste management.

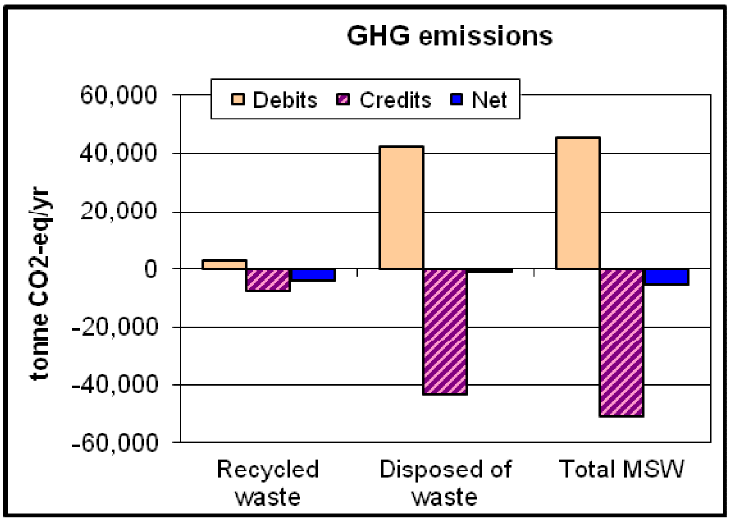
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e. difference between debits and credits

Scenario 1a



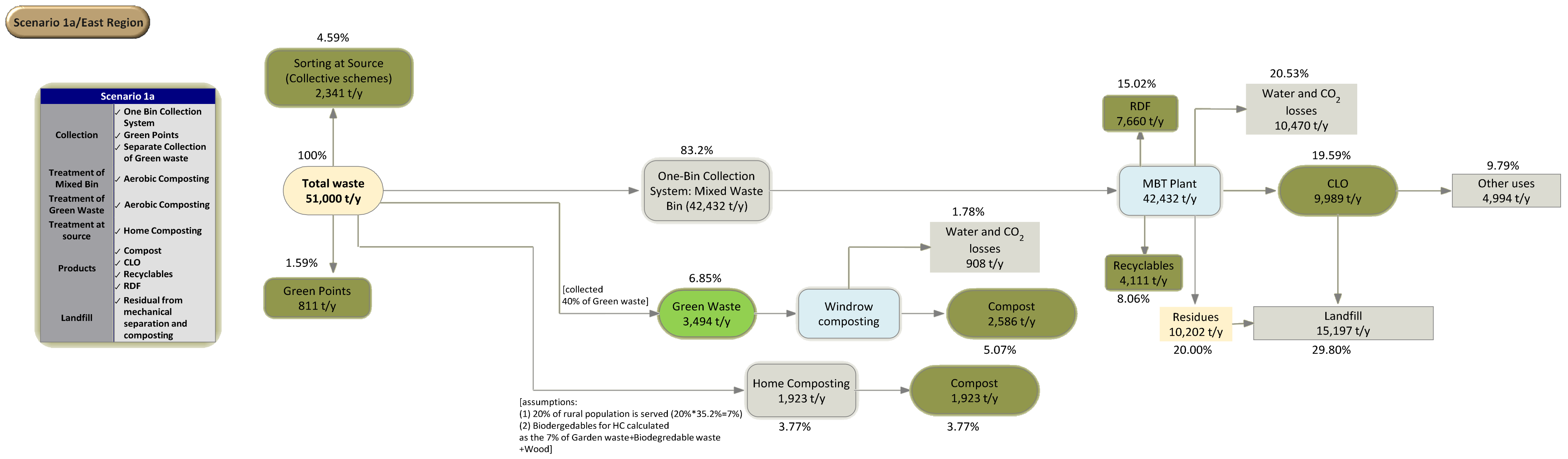
t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	1,598	13,253	14,851
Credits	-3,840	-25,584	-29,425
Net	-2,242	-12,331	**-14,574**

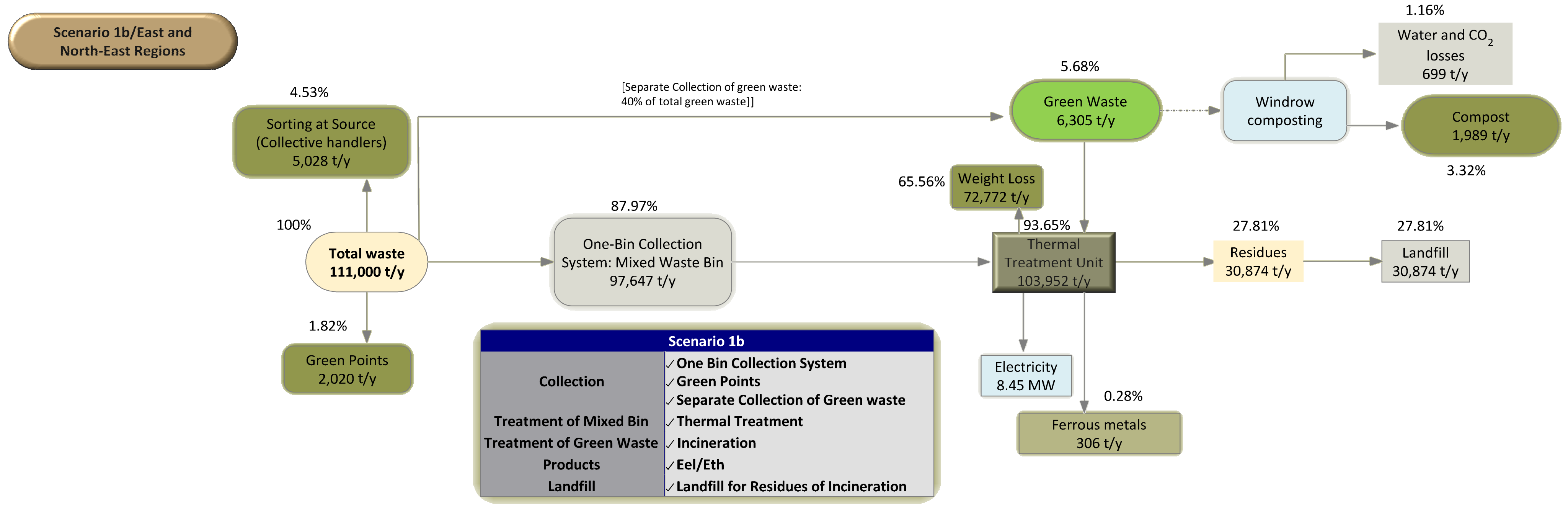
Scenario 1b



t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	3,069	42,115	45,184
Credits	-7,313	-43,260	-50,574
Net	-4,244	-1,146	**-5,389**

3.8.3.4 Detailed flow diagrammes





3.8.4 Scenario 2: Two bin collection system (Mixed Waste & Biowaste)

3.8.4.1 Key Features

Scenario 2 is based in two bin collection system (mixed waste and biodegradable waste) and does not include sub-scenarios. The key features of scenario 2 are:

Collection

- *Two Bin Collection system*. One *organic waste bin* for separate collection of biowaste at source and one *Mixed Bin* for residual waste. According to calculations, the total number of mixed waste bins (capacity 1.1 m^3) that needed for scenario 2 is 1606 and the total number of organic waste bins (capacity 0.66 m^3) is 701. However because there are already existing bins with capacity 1.1 m^3 in East Region, the necessary mixed waste bins that needed to be purchased in scenario 2 are 0. The amount of waste collected in mixed waste bin is 28,035 t/y (54.97% of total generated waste) and the amount of waste collected in organic waste bin is 16,320 t/y (32% of total generated waste).
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials (Green Points)*. The following assumptions have been made: (i) Collection of 100% of electric and electronic waste fraction i.e. 0.07% of total generated waste (36 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0.25% of total generated waste (128 t/y), (iii) Collection of 30% of construction and demolition waste fraction, i.e. 0.42% of total generated waste (214 t/y) and (iv) Collection of 3% of recyclable materials until 2020, i.e. 0.85% of total generated waste (434 t/y). The total collection of waste in green points in East Region is 1.59% of total generated waste (811 t/y).
- *Separate collection of Green Waste*. The assumption which has been done is that collected the 40% of green waste fraction, i.e. 6.85% of total generated waste (3,494 t/y). This assumption is common for scenario 1a and 1b.
- *Sorting at Source for packaging waste (Collective Schemes)*. The minimum requirements that needed to be achieved in year 2020 are: glass packaging 47.19%, plastic packaging 10.18% (6.02% 2018), paper packaging 37.58%, Fe packaging 33.55% and Al packaging 33.55% (all of these percentages are of generated packaging waste fraction).For the achievement of these percentages we assumed that sorting at source of packaging waste will start from 2016 with smaller percentages and gradually will increase until 2020. The total percentage of collected packaging waste in 2020, after calculations, is 22.31% of total generated packaging waste and 4.77% of total generated waste (2,433 t/y). According to calculations, for scenario 2 the number of bins required is 1548, with capacity 0.12 m^3, and 314 bins, with capacity 1.1 m^3 for packaging waste sorting at source.
- Sorting at Source for biodegradable waste (Organic waste bin). The minimum requirements that needed to be achieved in year 2020 and 2027 are: 66.36% collection of biodegradable waste fraction, i.e.24.29% of total generated waste and 45% of green waste fraction, i.e. 7.71% of total generated waste.

Treatment of Mixed Waste Bin

- Collected Mixed Waste from the mixed waste Bin processed to a Material Recovery Facility (MRF). Recovered materials such as Fe, Al, plastic, paper and glass can sold. Residues from MRF disposed in landfill. Mechanical Recovery Facility produces also RDF that can be used in cement kilns.

Treatment of Biodegradables sorted at source (Organic Waste Bin)

- Biological treatment (aerobic composting). The produced compost can be sold as a good quality compost.

Treatment of Green Waste

- Collected Green Waste will be directed to Biological Treatment Process together with the waste from the Organic Bin.

Table 3-90: Assumptions and calculations for scenario 2

		Scenario 2 **% Collection (Average 2018-2042)**
Green Points	A* A A A C*	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction Total collection: 1.59% of generated waste
Sorting at source of packaging waste (Collective Schemes)	A A C	21.45 % of packaging waste [9.04% (2018)-22.31% (2020-2042)] 4.59% of generated waste
Green Waste	A C	40% of green waste fraction 6.85% of generated waste
Organic waste bin (Sorting at Source of biodegradable waste)	A C	66.36% of biodegradable waste fraction and 45% of green waste fraction 32.00% of total generated waste
Packaging waste from MRF	A C	29.95% of packaging waste 6.42% of generated waste

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MRF (scenario 2) the following assumptions were made:

Recyclables	**Incoming quantities of recyclables in Mechanical treatment % (of generated waste)**	**Recovery % (Assumption)**	**Final Recovery %**	**Recovery of packaging fraction***
Paper	8.42	30	2.53	1.40
Plastic	11.79	40	4.72	4.42
Glass	2.01	20	0.40	0.28
Fe	0.47	70	0.33	0.23
Al	0.12	70	0.09	0.09
Total	22.81		**8.06**	**6.42**

**Paper packaging=100%Tetrapak+90%Cardboard+25%Paper=6.03% of generated waste or 55.24% of total paper fraction*

Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles=12.59% of generated waste or 93.68% of total plastic fraction
Glass packaging=70%Glass=2.15% of generated waste or 70% of total glass fraction
Fe metal packaging=70% Fe metal=0.44% of generated waste or 70% of total FE metal fraction
Al metal packaging=100% Al metal=0.19% of generated waste of 100% of total Al fraction

3.8.4.2 Achievement on national targets for Recycling and Biodegradables

The following tables are based on the detailed calculations included in Annex III. These tables presented the achievement of national targets for recycling and biodegradable waste for landfilling.

Packaging waste

Recycling of packaging waste % (2020)	Scenario 2	Achievement on recycling targets
Total % of recycling of packaging waste	55.26%	Yes
% glass packaging	63.31%	Yes
% plastic packaging (2018)	44.11%	Yes
% paper packaging	63.71%	Yes
% Fe packaging	88.66%	Yes
% Al packaging	81.89%	Yes

Biodegradable waste

Reduction of BMW	Scenario 2	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2020)*	71.38%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	69.83%	Yes

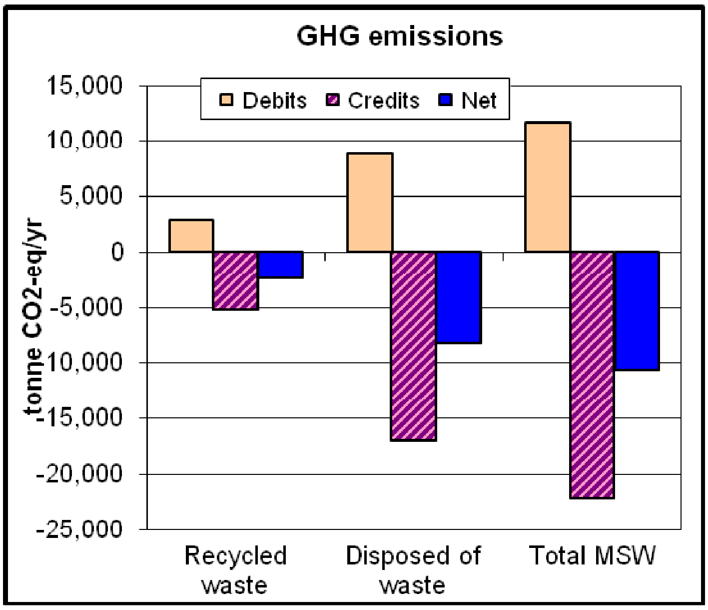
Biodegradable municipal waste in territory 1995=305,000 t (Rulebook LoWM Article 87)
Total population of country 2,062,294 (statistical office 2012)
East Region Population 178,551 (8.66% of territory)
*Biodegradable municipal waste in East Region 1995, 8.66%*305,000=26,413 t*

3.8.4.3 Greenhouse gas emissions

For calculation of greenhouse gas emission impact applied SWM-GHG Calculator, a tool for calculating greenhouse gases in solid waste management.

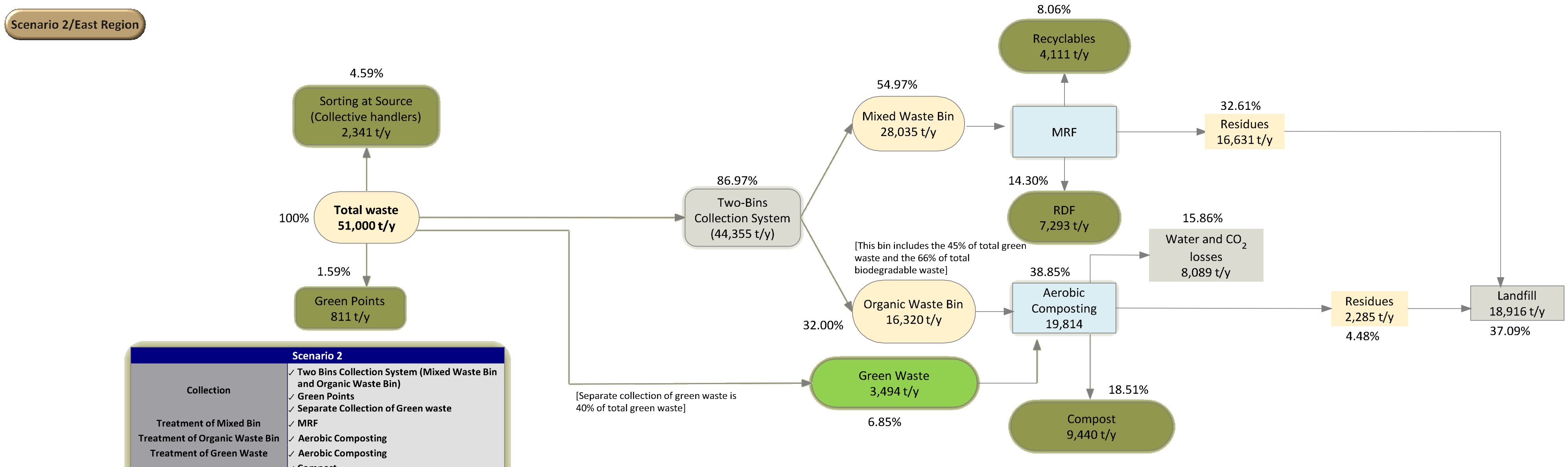
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e. difference between debits and credits

Scenario 2



t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	2,851	8,795	11,646
Credits	-5,208	-16,979	-22,188
Net	-2,357	-8,184	**-10,542**

3.8.4.4 Achievement on national targets for Recycling and Biodegradables



Scenario 2	
Collection	✓ Two Bins Collection System (Mixed Waste Bin and Organic Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Mixed Bin	✓ MRF
Treatment of Organic Waste Bin	✓ Aerobic Composting
Treatment of Green Waste	✓ Aerobic Composting
Products	✓ Compost ✓ Recyclables ✓ RDF
Landfill	✓ Residual from MRF Facility and Aerobic Composting Treatment

3.8.5 Scenario 3: Two bin collection system (Mixed Waste & Recyclable Waste)

3.8.5.1 Key Features

Scenario 3 is based in two bin collection system (mixed or residual waste and recyclable waste) and includes three sub-scenarios depends on the treatment technology selected to treat residual waste. Sub-scenario 3a, which dispose residual waste directly to landfill, sub-scenario 3b which includes MBS plant and sub-scenario 3c which includes incinerator. The key features of scenario 3 are:

Collection

- *Two Bin Collection system*. One *Recyclable waste bin* for separate collection of recyclables at source and one *Residual Waste Bin* for residual waste. According to calculations, the total number of residual waste bins (capacity 1.1 m^3) that required for scenario 3a/3b is 2048 and for scenario 3c is 5685. Also the total number of recyclable waste bins (capacity 1.1 m^3) is 1208 for scenario 3a/3b and 2591 for scenario 3c. However because there are already existing residual waste bins with capacity 1.1 m^3 in East Region, the necessary mixed waste bins that needed to be purchased in scenario 3a/3b are 211 and for scenario 3c are 2030. Regarding scenario 3a/3b, the amount of waste collected in residual waste bin is 35,761 t/y (70.12% of total generated waste) and the amount of waste collected in recyclable waste bin is 9,011 t/y (17.67% of total generated waste). Regarding scenario 3c, the amount of waste collected in residual waste bin is 83,228 t/y (74.98% of total generated waste) and the amount of waste collected in recyclable waste bin is 19,447 t/y (17.52% of total generated waste).
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials (Green Points)*. The following assumptions have been made: (i) Collection of 100% of electric and electronic waste fraction i.e. 0.07% of total generated waste (36 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0.25% of total generated waste (128 t/y), (iii) Collection of 30% of construction and demolition waste fraction, i.e. 0.42% of total generated waste (214 t/y) and (iv) Collection of 3% of recyclable materials until 2020, i.e. 0.85% of total generated waste (434 t/y). The total collection of waste in green points in East Region is 1.59% of total generated waste (811 t/y). All these assumptions are the same for scenario 3a, 3b and 3c but in scenario 3c the total collection of waste in green points is 1.82% due to difference in waste composition (unified waste composition for two regions).
- *Separate collection of Green Waste*. The assumption which has been done is that collected the 40% of green waste fraction, i.e. 6.85% of total generated waste (3,494 t/y). This assumption is common for scenario 1a and 1b.
- *Sorting at Source for recyclable waste*. The minimum requirements that needed to be achieved in year 2020 are: glass packaging 81.75%, plastic packaging 56.38% (25.06% 2018), paper packaging 72.45%, Fe packaging 57.45% and Al packaging 57.45% (all of these percentages are of generated recyclable waste).For the achievement of these percentages we assumed that sorting at source of recyclable waste will start from 2016 with smaller percentages and gradually will increase until 2020. The above assumptions are common for all sub-scenarios (3a, 3b and 3c).

Treatment of Residual Waste Bin

- Collected Residual Waste from residual waste Bin will disposed directly to landfill (3a) or can be treated with different processes [Mechanical Biological stabilization (3b) or Incineration (3c)]

Treatment of Recyclable Waste Bin

- Collected Recyclable Waste from the Recyclable waste bin treated to a Material Recovery Facility (MRF). Recovered materials are sold. Residues are disposed in landfill.

Treatment of Biodegradables sorted at source (Home Composting)

- Home Composting. For the estimation of quantities that will be directed to home composting process is assumed that the 20% of rural population will be served, ie 20%*35.2%=7%, and the fractions that can be used in this process are green waste, biodegradable waste and wood. According to calculations, the total number of waste bins (capacity 0.2 m^3) that needed for scenario 3a/3b for home composting process is 4100. Home composting process takes place only in scenario 3a/3b.

Treatment of Green Waste

- Collected Green Waste will be directed either to windrow composting process (scenario 3a/3b), or in the incineration plant (scenario 3c). Especially for scenario 3c collected green waste can also be directed to windrow composting process for the production of high quality compost.

Table 3-91: Assumptions and calculations for scenario 3a, 3b and 3c

		Scenario 3a % Collection (Average 2018-2042)	Scenario 3b % Collection (Average 2018-2042)	Scenario 3c % Collection (Average 2018-2042)
Green Points	A* A A A C*	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction <u>Total collection: 1.59% of generated waste</u>	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction <u>Total collection: 1.59% of generated waste</u>	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction <u>Total collection: 1.82% of generated waste</u>
Sorting at source of recyclable waste	A A C	62.57% of recyclable waste [22.78% (2018)-65.36% (2020-2042)] <u>17.67% of generated waste</u>	62.57% of recyclable waste [22.78% (2018)-65.36% (2020-2042)] <u>17.67% of generated waste</u>	62.09% of recyclable waste [22.82% (2018)-64.79% (2020-2042)] <u>17.52% of generated waste</u>
Green Waste	A C	40% of green waste fraction <u>6.85% of generated waste</u>	40% of green waste fraction <u>6.85% of generated waste</u>	40% of green waste fraction <u>5.68% of generated waste</u>
Home Composting	A C	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste+Wood <u>3.77% of generated waste</u>	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste+Wood <u>3.77% of generated waste</u>	-
Packaging waste Mechanical Treatment of MRF/Incineration	A C	51.40% of packaging waste [19.90% (2018)-53.44% (2020-2042)] <u>10.97% of generated waste</u>	51.40% of packaging waste [19.90% (2018)-53.44% (2020-2042)] <u>10.97% of generated waste</u>	51.33% of packaging waste [19.92% (2018)-53.31% (2020-2042)] <u>11.34% of generated waste</u>

**A: Assumption, C: Calculation*

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MRF (scenario 3a, 3b) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Recovery % (Assumption)	Final Recovery %	Recovery of packaging fraction*
Paper	7.55	80	6.04	3.34
Plastic	7.31	90	6.58	6.16
Glass	2.37	70	1.66	1.16
Fe	0.35	90	0.31	0.22
Al	0.10	90	0.09	0.09
Total	17.68		**14.68**	**10.97**

**Paper packaging=100%Tetrapak+90%Cardboard+25%Paper=6.03% of generated waste or 55.24% of total paper fraction*
**Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles=12.59% of generated waste or 93.68% of total plastic fraction*
**Glass packaging=70%Glass=2.15% of generated waste or 70% of total glass fraction*
**Fe metal packaging=70% Fe metal=0.44% of generated waste or 70% of total FE metal fraction*
**Al metal packaging=100% Al metal=0.19% of generated waste of 100% of total Al fraction*

Especially for scenario 3b also collected Fe metals and Al for Mechanical Biological Stabilization plant (MBS). For determine of these recyclable quantities and packaging materials the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment of MBS % (of generated waste)	Recovery %	Final Recovery %	Recovery of packaging fraction*
Fe	0.27	70	0.19	0.13
Al	0.08	70	0.06	0.06
Total	0.35		**0.25**	**0.19**

**Fe metal packaging=70% Fe metal=0.44% of generated waste or 70% of total FE metal fraction*
**Al metal packaging=100% Al metal=0.19% of generated waste of 100% of total Al fraction*

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MRF (scenario 3c) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Recovery %	Final Recovery %	Recovery of packaging fraction*
Paper	6.55	80	5.24	3.17
Plastic	7.88	90	7.09	6.53
Glass	2.58	70	1.81	1.27
Fe	0.33	90	0.30	0.21
Al	0.18	90	0.16	0.16
Total	17.52		**14.60**	**11.34**

**Paper packaging=100%Tetrapak+90%Cardboard+25%Paper=5.73% of generated waste or 60.55% of total paper fraction*
**Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles=13.34% of generated waste or 92.08% of total plastic fraction*
**Glass packaging=70%Glass=2.34% of generated waste or 70% of total glass fraction*
**Fe metal packaging=70% Fe metal=0.42% of generated waste or 70% of total FE metal fraction*
**Al metal packaging=100% Al metal=0.33% of generated waste of 100% of total Al fraction*

For determine of Fe metals and electric energy production from the incineration plant (scenario 1b) the following figures were used:

Parameter	Origin
60% recovery only of Fe metals (from Fe metals that inserts the incineration plant)	A*
Calorific value of incoming waste in incineration plant 9984KJ/kg	C*
Net electricity production = (incoming waste in WtE)*22%*9984/3600 (MWh/y)	C
Annual operational hours 7488	A
Net electric power = Net electricity production/7488 (MW)	C

**A: Assumption, C: Calculation*

3.8.5.2 Achievement on national targets for Recycling and Biodegradables

The following tables are based on the detailed calculations included in Annex III. These tables presented the achievement of national targets for recycling and biodegradable waste for landfilling.

Packaging waste

Recycling of packaging waste % (2020)	Scenario 3a	Achievement on recycling targets	Scenario 3b	Achievement on recycling targets	Scenario 3c	Achievement on recycling targets
Total % of recycling of packaging waste	56.44%	Yes	57.31%	Yes	56.31%	Yes
% glass packaging	60.10%	Yes	60.10%	Yes	60.10%	Yes
% plastic packaging (2018)	25.55%	Yes	25.55%	Yes	25.55%	Yes
% paper packaging	60.96%	Yes	60.96%	Yes	60.96%	Yes
% Fe packaging	54.70%	Yes	84.16%	Yes	54.70%	Yes
% Al packaging	54.70%	Yes	84.16%	Yes	54.70%	Yes

Biodegradable waste

Reduction of BMW	Scenario 3a	Achievement on targets of BDW	Scenario 3b	Achievement on targets of BDW	Scenario 3c	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2020)	15.43%	No	84.50%	Yes	97.44%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	10.84%	No	83.65%	Yes	97.25%	Yes

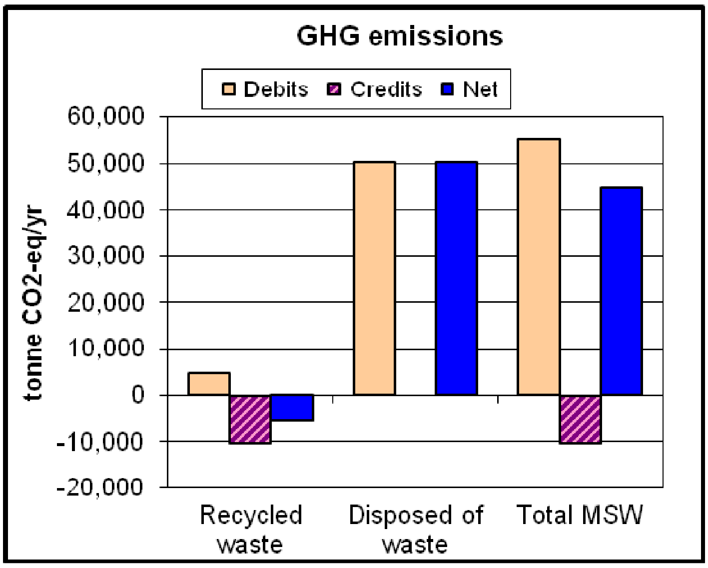
* *Biodegradable municipal waste in territory 1995=305,000 t (Rulebook LoWM Article 87)*
Total population of country 2,062,294 (statistical office 2012)
East Region Population 178,551 (8.66% of territory)
North-East Region Population 175,560 (8.51% of territory)
*Biodegradable municipal waste in East Region 1995, 8.66%*305,000=26,413 t*
*Biodegradable municipal waste in East and North-East Region 1995, 17.17%*305,000=52,369 t*

3.8.5.3 Greenhouse gas emissions

For calculation of greenhouse gas emission impact applied SWM-GHG Calculator, a tool for calculating greenhouse gases in solid waste management.

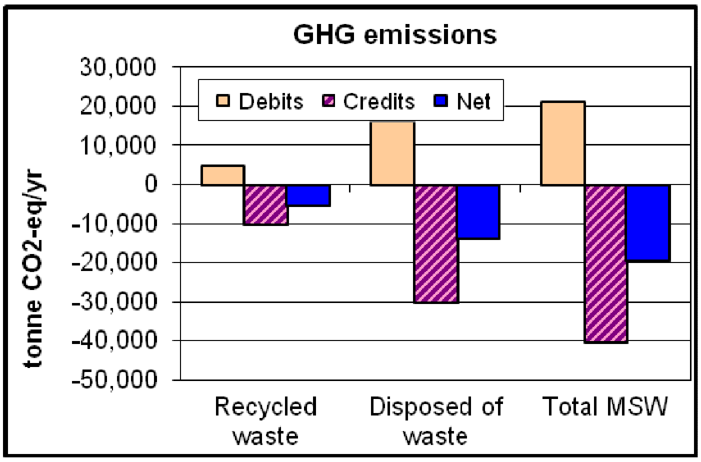
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e difference between debits and credits

Scenario 3a



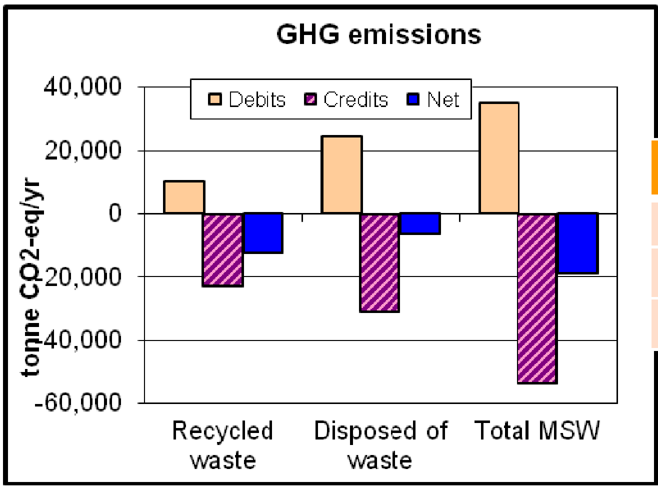
t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	4,752	50,399	55,151
Credits	-10,265	0	-10,265
Net	-5,513	50,399	**-44,885**

Scenario 3b



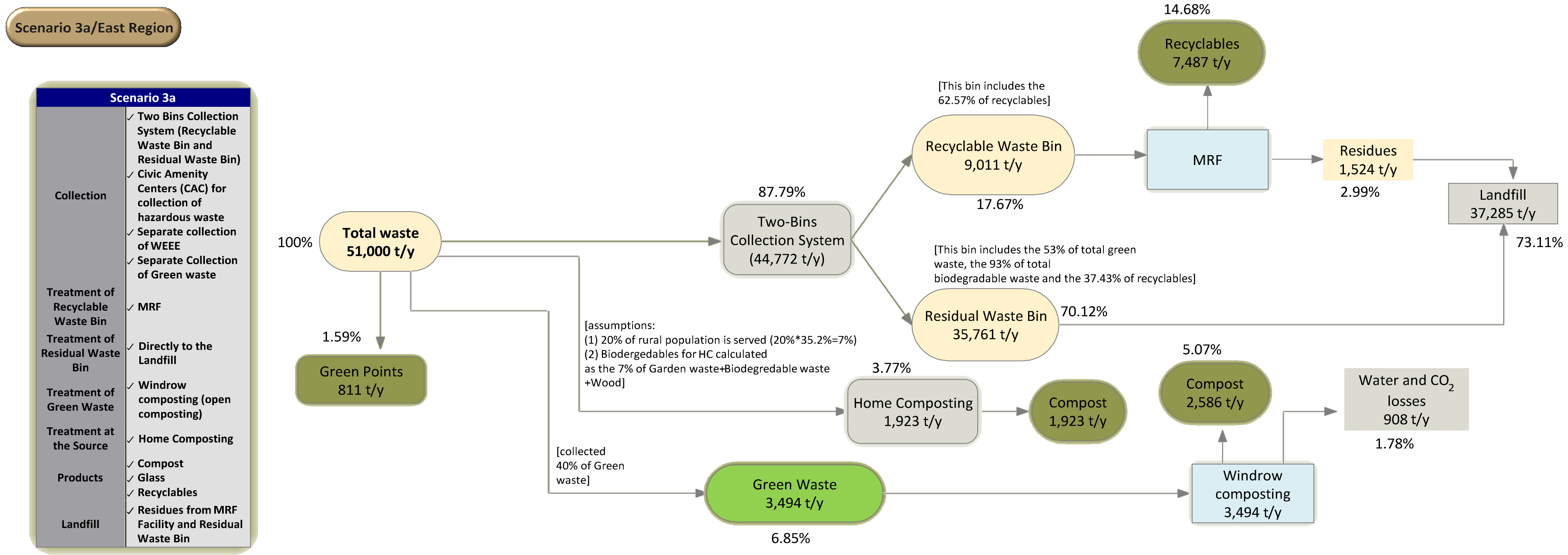
t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	4,752	16,283	21,036
Credits	-10,265	-30,260	-40,526
Net	-5,513	-13,977	**-19,490**

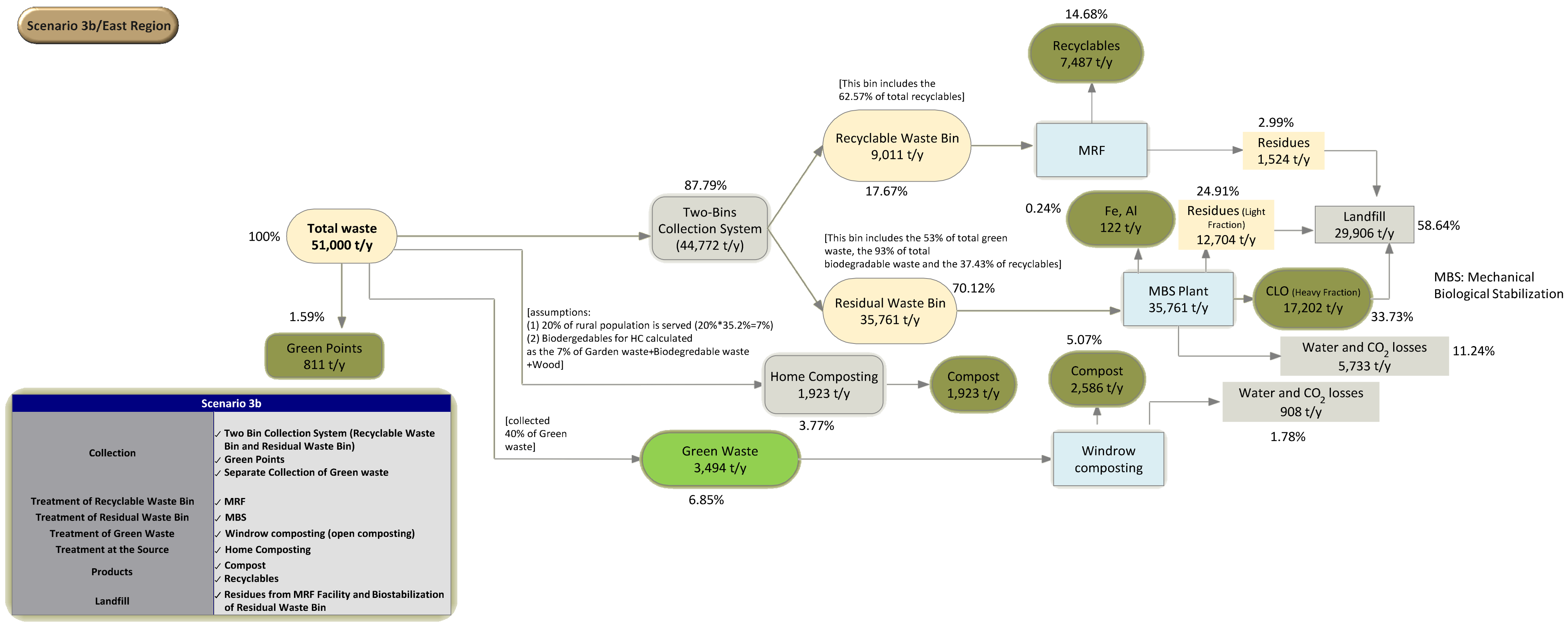
Scenario 3c

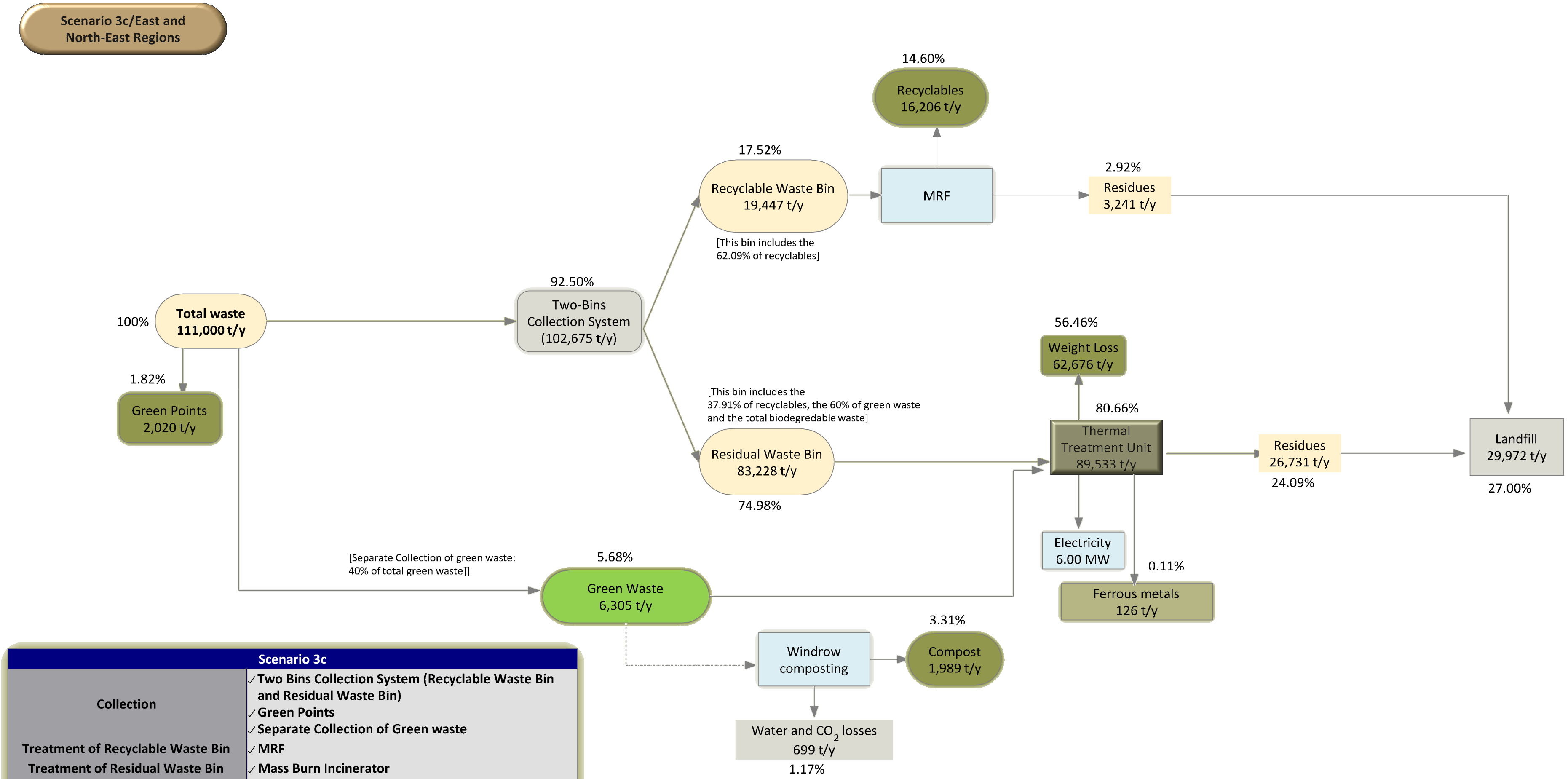


t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	10,377	24,458	34,834
Credits	-22,767	-30,724	-53,490
Net	-12,390	-6,266	**-18,656**

3.8.5.4 Detailed Flow Diagrammes







Scenario 3c	
Collection	✓Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓Green Points ✓Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓MRF
Treatment of Residual Waste Bin	✓Mass Burn Incinerator
Treatment of Green Waste	✓Incineration
Products	✓Compost ✓Recyclables
Landfill	✓Landfill for Residues of Incineration

3.8.6 Scenario 4: Three bin collection system (Mixed Waste, Recyclable Waste & Biodegradable waste)

3.8.6.1 Key Features

Scenario 4 is based in three bin collection system (mixed waste, biodegradable waste and recyclable waste) and does not include sub-scenarios. The key features of scenario 4 are:

Collection

- *Three Bin Collection system*. One *organic waste bin* for separate collection of biowaste at source, one *Recyclable waste Bin* for residual waste and one *Mixed Bin* for residual waste. According to calculations, the total number of residual waste bins (capacity 1.1 m^3) that needed for scenario 4 is 1223, the total number of organic waste bins (capacity 0.66 m^3) is 685 and the total number of recyclable waste bins, capacity 1.1 m^3 and 0.12 m^3 is 1208 and 5961 respectively. However because there are already existing residual waste bins with capacity 1.1 m^3 in East Region, the necessary residual/mixed waste bins that needed to be purchased in scenario 4 are 0. The amount of waste collected in residual waste bin is 21,3645 t/y (41.89% of total generated waste), the amount of waste collected in organic waste bin is 16,320 t/y (32% of total generated waste) and the amount of waste collected in recyclable waste bin in 9,011 t/y (17.67% of total generated waste).
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials (Green Points)*. The following assumptions have been made: (i) Collection of 100% of electric and electronic waste fraction i.e. 0.07% of total generated waste (36 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0.25% of total generated waste (128 t/y), (iii) Collection of 30% of construction and demolition waste fraction, i.e. 0.42% of total generated waste (214 t/y) and (iv) Collection of 3% of recyclable materials until 2020, i.e. 0.85% of total generated waste (434 t/y). The total collection of waste in green points in East Region is 1.59% of total generated waste (811 t/y).
- *Separate collection of Green Waste*. The assumption which has been done is that collected the 40% of green waste fraction, i.e. 6.85% of total generated waste (3,494 t/y). This assumption is common for scenario 1a and 1b.
- *Sorting at Source for recyclable waste*. The minimum requirements that needed to be achieved in year 2020 are: glass packaging 81.75%, plastic packaging 56.38% (25.06% 2018), paper packaging 72.45%, Fe packaging 57.45% and Al packaging 57.45% (all of these percentages are of generated recyclable waste).For the achievement of these percentages we assumed that sorting at source of recyclable waste will start from 2016 with smaller percentages and gradually will increase until 2020.
- *Sorting at Source for biodegradable waste (Organic waste bin)*. The minimum requirements that needed to be achieved in year 2020 and 2027 are: 66.36% collection of biodegradable waste fraction, i.e.24.29% of total generated waste and 45% of green waste fraction, i.e. 7.71% of total generated waste.

Treatment of Residual Waste Bin

- Collected Residual Waste from the residual waste Bin disposed directly to landfill.

Treatment of Biodegradables sorted at source (Organic Waste Bin)

- Biological treatment (aerobic composting). The produced compost can be sold as a good quality compost.

Treatment of Recyclable Waste Bin

- Collected Recyclable Waste from the Recyclable waste bin treated to a Material Recovery Facility (MRF). Recovered materials are sold. Resides are disposed in landfill.

Treatment of Green Waste

- Collected Green Waste will be directed to Biological Treatment Process together with the waste from the Organic Bin.

Table 3-92: Assumptions and calculations for scenario 4

		Scenario 4 % Collection (Average 2018-2042)
Green Points	A* A A A C*	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction Total collection: 1.59% of generated waste
Sorting at source of recyclable waste (Recyclable waste bin)	A A C	62.57% of recyclable waste [22.78% (2018)-65.36% (2020-2042)] 17.67% of generated waste
Green Waste	A C	40% of green waste fraction 6.85% of generated waste
Organic waste bin (Sorting at Source of biodegradable waste)	A C	66.36% of biodegradable waste fraction and 45% of green waste fraction 32.00% of total generated waste
Packaging waste from MRF	A C	51.40% of packaging waste [19.90% (2018)-53.44% (2020-2042)] 10.97% of generated waste

**A: Assumption, C: Calculation*

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MRF (scenario 4) the following assumptions were made:

Recyclables	**Incoming quantities of recyclables in Mechanical treatment % (of generated waste)**	**Recovery %**	**Final Recovery %**	**Recovery of packaging fraction***
Paper	7.55	80	6.04	3.34
Plastic	7.31	90	6.58	6.16
Glass	2.37	70	1.66	1.16
Fe	0.35	90	0.31	0.22
Al	0.10	90	0.09	0.09
Total	17.68		**14.68**	**10.97**

**Paper packaging=100%Tetrapak+90%Cardboard+25%Paper=6.03% of generated waste or 55.24% of total paper fraction*
**Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles=12.59% of generated waste or 93.68% of total plastic fraction*
**Glass packaging=70%Glass=2.15% of generated waste or 70% of total glass fraction*
**Fe metal packaging=70% Fe metal=0.44% of generated waste or 70% of total FE metal fraction*
**Al metal packaging=100% Al metal=0.19% of generated waste of 100% of total Al fraction*

3.8.6.2 Achievement on national legislation

The following tables are based on the detailed calculations included in Annex III. These tables presented the achievement of national targets for recycling and biodegradable waste for landfilling.

Packaging waste

Recycling of packaging waste % (2020)	Scenario 4	Achievement on recycling targets
Total % of recycling of packaging waste	56.44%	Yes
% glass packaging	60.10%	Yes
% plastic packaging (2018)	25.55%	Yes
% paper packaging	60.96%	Yes
% Fe packaging	54.70%	Yes
% Al packaging	54.70%	Yes

Biodegradable waste

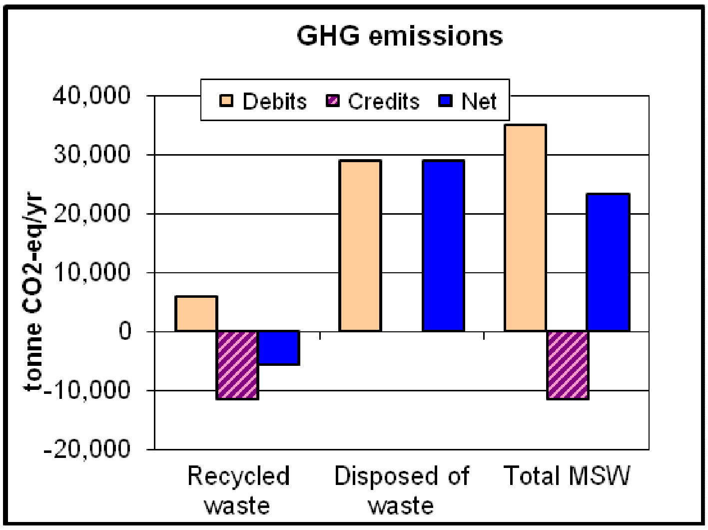
Reduction of BMW	Scenario 4	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2020)*	67.17%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	65.39%	Yes

**Biodegradable municipal waste in territory 1995=305,000 t (Rulebook LoWM Article 87)*
Total population of country 2,062,294 (statistical office 2012)
East Region Population 178,551 (8.66% of territory)
*Biodegradable municipal waste in East Region 1995, 8.66%*305,000=26,413 t*

3.8.6.3 Achievement on targets for Recycling and Biodegradables

For calculation of greenhouse gas emission impact applied SWM-GHG Calculator, a tool for calculating greenhouse gases in solid waste management.
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/dispo
Net: Net effect, i.e. difference between debits and credits

Scenario 4

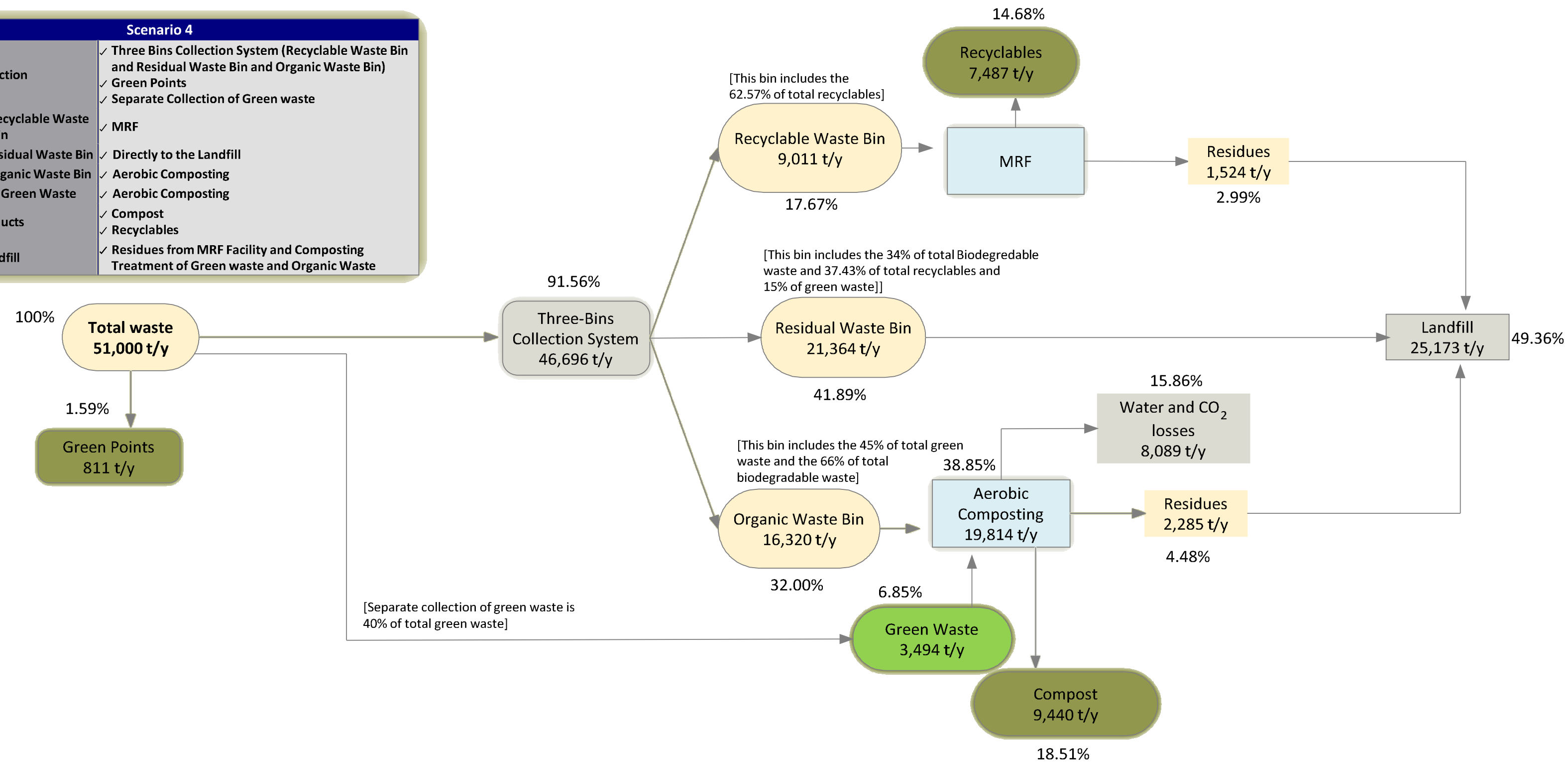


t CO2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	6,005	28,980	34,985
Credits	-11,633	0	-11,633
Net	-5,628	28,980	**23,352**

3.8.6.4 Achievement on targets for Recycling and Biodegradables

Scenario 4/East Region

Scenario 4	
Collection	✓ Three Bins Collection System (Recyclable Waste Bin and Residual Waste Bin and Organic Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓ MRF
Treatment of Residual Waste Bin	✓ Directly to the Landfill
Treatment of Organic Waste Bin	✓ Aerobic Composting
Treatment of Green Waste	✓ Aerobic Composting
Products	✓ Compost ✓ Recyclables
Landfill	✓ Residues from MRF Facility and Composting Treatment of Green waste and Organic Waste



3.8.7 Overview of Scenarios and Scenarios Performance

The table below presents a summary of the scenarios analyzed in the current chapter.

Table 3-93: Scenarios overview

	Scenario 1 (1 bin)		**Scenario 2 (2 bins) Mixed + Biowaste**	**Scenario 3 (2 bins) Mixed + Recyclables**			**Scenario 4 (3 bins) Mixed + Recyclables + Biowaste**
	1a (MBT)	**1b (Incineration)**	**2**	**3a (MRF+ Aerobic Composting)**	**3b (MRF + MBS + Aerobic Composting)**	**3c (MRF + Incineration)**	**4 (MBT)**
Waste Collection	One Bin collection system		Two Bin collection system (*Organic Waste Bin* and *Mixed Bin*)	Two Bin collection system (*Recyclable Waste Bin* and *Mixed Bin*)			Three Bin collection system
Green Points	√	√	√	√	√	√	√
Home Composting	√	-	-	√	√	-	-
Mixed Bin Treatment	Mechanical Biological Treatment (MBT) with Aerobic Composting	Incineration	Dirty MRF	Disposed to Landfill	MBS (Biostabilization)	Incineration	Disposed to Landfill
Recyclable waste bin treatment	-	-	-	MRF	MRF	MRF	MRF
Organic waste bin treatment	-	-	Aerobic Composting	-	-	-	Aerobic Composting
Green waste treatment	Aerobic Composting	Incineration	Aerobic Composting	Aerobic Composting	Aerobic Composting	Incineration	Aerobic Composting
Landfill	√	√	√	√	√	√	√

Table 3-94: Capacities of treatment facilities (t/y)

	1a (MBT)	1b	2	3a	3b	3c	4
Clean MRF				9,011	9,011	9,011	
Dirty MRF			28,035				
Aerobic Composting for Organic waste bin			19,814				19,814
MBT Plant for mixed waste bin	42,432						
MBS Plant for Residual waste bin					35,761		
Incineration						83,228	
Biological treatment for green waste (windrow composting)	3,494		3,494	3,494	3,494		3,494
Landfill (residues, m^2)	32,000	52,000	41,000	79,000	66,500	50,000	54,000

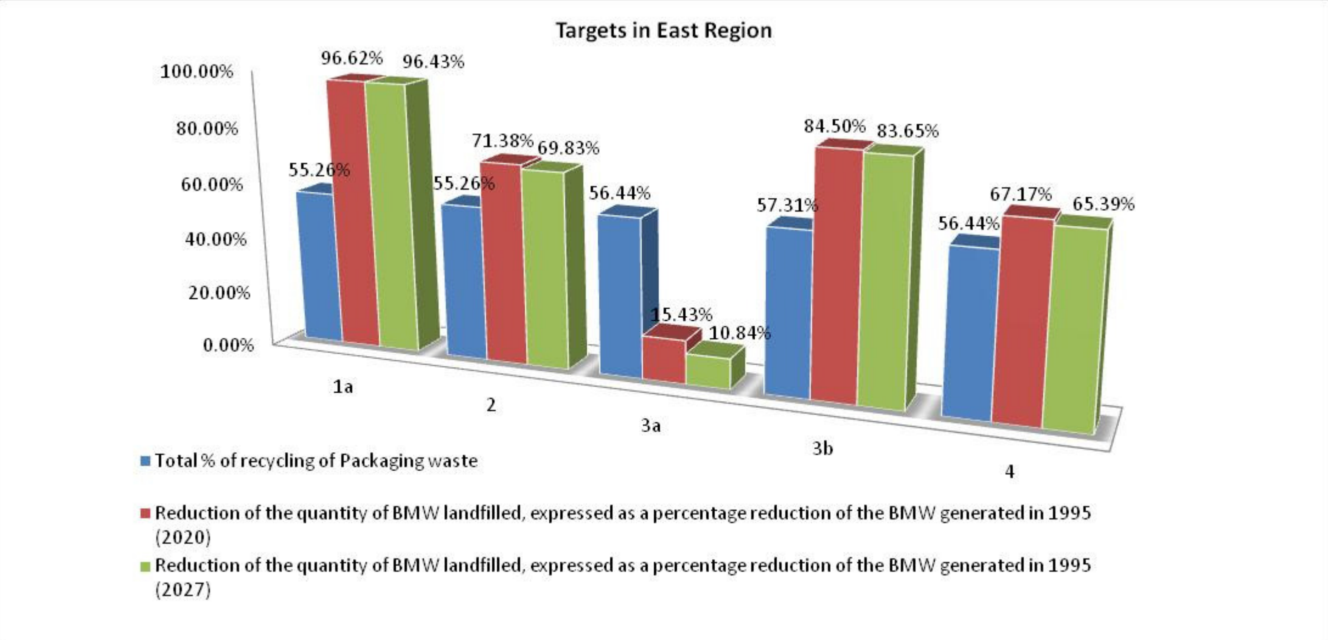
As it is aforementioned the discussed scenarios must achieve the minimum requirements based on national legislation according to the Law on management of packaging and packaging waste and to the Law in relation to reduction of the quantity of Biodegradable municipal waste landfilled. The table below presents the quantification of targets for all scenarios in East Region.

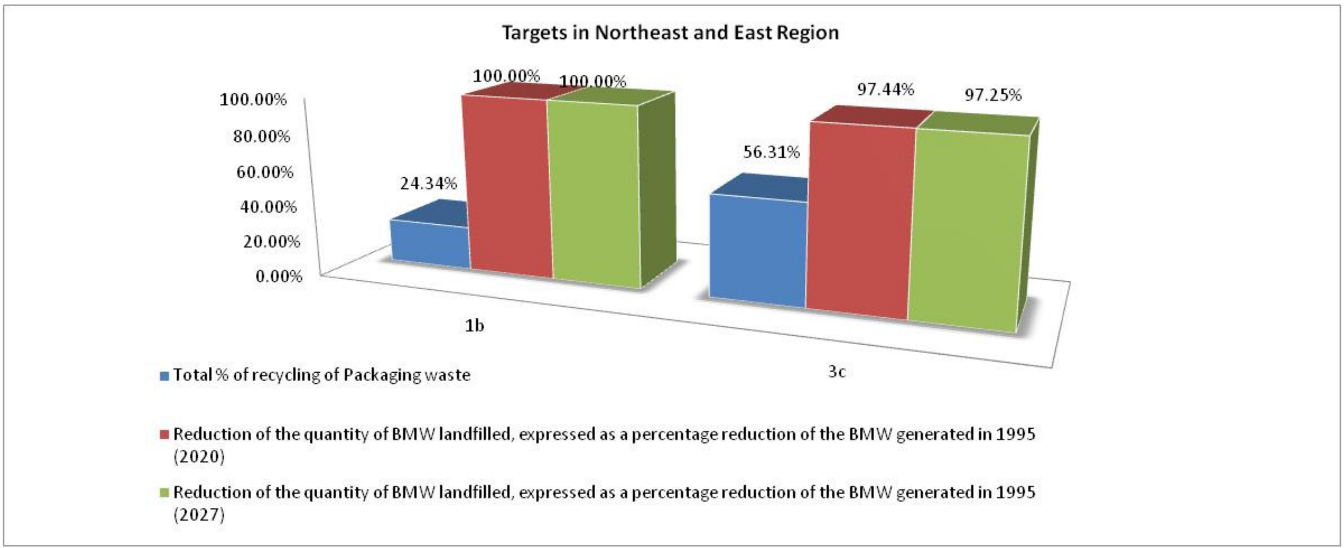
Table 3-95: Quantification of targets for all scenarios in East Region

Scenarios	Total percentage of recycling of packaging waste (2020)		Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995	
			2020	2027
1a	55.26%	Glass 63.31% Plastic (2018) 44.11% Paper 63.71% Fe 88.66% Al 81.89%	96.62%	96.43%
1b	24.34%	Glass 50.19% Plastic (2018) 9.02% Paper 40.58% Fe 18.01% Al 18.01%	100.00%	100.00%
2	55.26%	Glass 63.31% Plastic (2018) 44.11% Paper 63.71% Fe 88.66% Al 81.89%	71.38%	69.83%
3a	56.44%	Glass 60.10% Plastic (2018) 25.55% Paper 60.96% Fe 54.70% Al 54.70%	15.43%	10.84%
3b	57.31%	Glass 60.10% Plastic (2018) 25.55% Paper 60.96% Fe 84.16% Al 84.16%	84.50%	83.65%
3c	56.31%	Glass 60.10% Plastic (2018) 25.55% Paper 60.96% Fe 54.70% Al 54.70%	97.44%	97.25%

Scenarios	Total percentage of recycling of packaging waste (2020)		Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995	
			2020	2027
4	56.44%	Glass 60.10%	67.17%	65.39%
		Plastic (2018) 25.55%		
		Paper 60.96%		
		Fe 54.70%		
		Al 54.70%		

Summarized, only scenarios 3a and 1b does not achieve the targets for Biodegradable Municipal waste landfilled and for packaging and packaging waste respectively. All the other scenarios achieve the targets.





Regarding Greenhouse gases, the following table summarizes the results for GHG emissions recycling and disposal in t CO_2-eq/yr for each proposed scenario for East Region.

Scenario's	t CO_2-eq/yr Net emissions		
	Recycled Waste	Disposed Waste	Total MSW
1a	-2,242	-12,331	-14,574
1b	-4,244	-1,146	-5,389
2	-2,357	-8,184	-10,542
3a	-5,513	50,399	44,886
3b	-5,513	-13,977	-19,490
3c	-12,390	-6,266	-18,656
4	-5,628	28,980	23,352

The term of 'Recycling' of waste is consider the recycling rates of different waste fractions and additionally for the type of treatment in the case of organic waste

- recycling rates for dry materials,
- recycling rates for organic waste (food waste, garden and park waste),
- share of composting and/or digestion of recycled organic waste

The term of 'Disposal' of waste referred to different types of waste treatment and disposal in remaining waste amount after recycling. These include

- Unburned scattered waste
- Open burning of scattered waste
- Wild dumps/unmanaged disposal site
- Controlled dump/landfill without gas collection
- Sanitary landfill with gas collection
- Biological stabilization and landfill
- Mechanical Biological Treatment and landfill
- Mechanical Biological Stabilization and/or mechanical physical stabilization and co-processing cement kiln
- Incineration

3.9 FINANCIAL AND ECONOMIC ANALYSIS OF PROPOSAL SCENARIOS

3.9.1 Investment Cost

The cost of a waste treatment plant is one of the main evaluation criteria, which is affected by a number of parameters:

- the capacity of the unit
- the type and complexity of the technology
- the degree of automation of production processes
- the required infrastructure

A better cost approach will be carried in the feasibility study where the technical parameters and the location of the facilities have been selected and determined. Even at this stage, variations in technology offered by different suppliers can have a significant effect on the costs.

It is important to note that the objective is to estimate the cost of alternative scenarios for comparative evaluation purposes rather than the determination of the absolute cost. It should also be noted that systems that are in the same group of technologies (i.e. different aerobic digestion systems) can vary considerably in their investment costs depending on the know-how and performance.

Tables below provide a summary of the project investment costs – prices excluding contingencies and VAT.

3.9.1.1 Investment cost of Scenario 1a

Table 3-96: Investment Cost of Scenario 1a

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Mechanical Separation (t/y)	42.432	100	4.243.200	61,5327	261.095.553
Biological Treatment (t/y)	23.796	110	2.617.532		161.063.790
Landfill (residues) (m2)	32.054	90	2.884.875		177.514.174
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	1	500.000	500.000		30.766.350
Total Cost of MBT for mixed waste (i)	-	-	**10.745.607**		**661.206.216**

(ii) Green Waste

Aerobic Composting (Windrow Composting)

	Quantities (t/y)	Unit Cost (€/t)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Biological Treatment for Green Waste (Windrow Composting)(t/y)	3.494	80	279.520	61,5327	17.199.620
Total Cost of Aerobic Composting for Green Waste (ii)	-	-	**279.520**		**17.199.620**

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
(iii) Collection equipment					

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (bins)	593	220	130.460	61,5327	8.027.556
Collection equipment / mixed waste (waste collection vechiles)	7	110.000	770.000	61,5327	47.380.179
Collection equipment / home composting (bins)	4.100	50	205.000	61,5327	12.614.204
Collection equipment for Green Waste (trucks)	7	75.000	525.000	61,5327	32.304.668
Collection equipment for Sorting at Source (1,1m^3 bins)	314	160	50.240	61,5327	3.091.403
Collection equipment for Sorting at Source (0,12m^3 bins)	1.548	20	30.960	61,5327	1.905.052
Total Cost of Collection equipment (iii)			**1.711.660**		**105.323.061**
(iv) Green Points					

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	9	80.000	720.000	61,5327	44.303.544
Total Cost of Green Points (iv)			**720.000**		**44.303.544**

Total Cost of Scenario 1a/ East (i+ii+iii+iv)	-	-	**13.456.787**		**828.032.442**
(v) Intangible components					

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land					
	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	72.054	4	288.217	61,5327	17.734.751
Total Cost of Acquisition of land (vi)			**288.217**		**17.734.751**
Grand Total Cost of Scenario 1a/ East (i+ii+iii+iv+v+vi)	**-**	**-**	**15.645.004**		**962.679.323**

3.9.1.2 Investment cost of Scenario 1b

Table 3-97: Investment Cost of Scenario 1b

	Quantities	**Unit Cost (€/t) & (€/m2) for landfill**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Thermal Treatment Unit	103.952	750	77.964.000	61,5327	4.797.335.423
Landfill (residues) (m2)	51.782	150	7.767.262		477.940.625
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	2	500.000	1.000.000		61.532.700
i) Total Cost of Thermal Treatment	**-**	**-**	**87.231.262**		**5.367.575.097**

(iii) Collection equipment					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (bins)	1.904	220	418.880	61,5327	25.774.817
Collection equipment / mixed waste (waste collection vechiles)	26	110.000	2.860.000	61,5327	175.983.522
Collection equipment for Green Waste (trucks)	13	75.000	975.000	61,5327	59.994.383
Collection equipment for Sorting at Source (1,1m3bins)	670	160	107.200	61,5327	6.596.305
Collection equipment for Sorting at Source (0,12m3bins)	3.306	20	66.120	61,5327	4.068.542
Total Cost of Collection equipment (iii)			**4.427.200**		**272.417.569**

(iv) Green Points

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	16	80.000	1.280.000	61,5327	78.761.856
Total Cost of Green Points (iv)			**1.280.000**		**78.761.856**
Total Cost of Scenario 1b/ East (i+ii+iii+iv)	-	-	**92.938.462**		**5.718.754.523**

(v) Intangible components

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land

	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	71.782	4	287.127	61,5327	17.667.699
Total Cost of Acquisition of land (vi)			**287.127**		**17.667.699**
Grand Total Cost of Scenario 1b/ East (i+ii+iii+iv+v+vi)	-	-	**95.125.589**		**5.853.334.352**

3.9.1.3 Investment cost of Scenario 2

Table 3-98: Investment Cost of Scenario 2

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Mechanical Separation (t/y)	28.035	100	2.803.500	61,5327	172.506.924
Landfill (residues) (m2)	40.895	90	3.680.524		226.472.593
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	1	500.000	500.000		30.766.350
Total Cost of MBT for mixed waste (i)	**-**	**-**	**7.484.024**		**460.512.217**
(ii) Organic Waste and Green Waste -Aerobic Composting					
	Quantities (t/y)	**Unit Cost (€/t)**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Biological Treatment for Organic and Green Waste (t/y)	19.814	110	2.179.540	61,5327	134.112.981
Total Cost of Aerobic Composting for Green Waste (ii)	**-**	**-**	**2.179.540**		**134.112.981**
(iii) Collection equipment					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (1,1m^{3}bins)	0	220	0	61,5327	0
Collection equipment / mixed waste (waste collection vechiles)	8	110.000	880.000	61,5327	54.148.776
Collection equipment for Green Waste (trucks)	7	75.000	525.000	61,5327	32.304.668
Collection equipment for Sorting at Source (1,1m^{3}bins)	314	160	50.240	61,5327	3.091.403
Collection equipment for Sorting at Source (0,12 m^3 bins)	1.548	20	30.960	61,5327	1.905.052
Collection equipment for Organic Waste (0,6m^{3}bins)	701	120	84.120	61,5327	5.176.131
Total Cost of Collection equipment (iii)			**1.570.320**		**96.626.029**

(iv) Green Points					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	9	80.000	720.000	61,5327	44.303.544
Total Cost of Green Points (iv)			**720.000**		**44.303.544**
Total Cost of Scenario 2 East (i+ii+iii+iv)	**-**	**-**	**11.953.884**		**735.554.772**

(v) Intangible components					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land					
	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	80.895	4	323.579	61,5327	19.910.681
Total Cost of Acquisition of land (vi)			**323.579**		**19.910.681**
Grand Total Cost of Scenario 2/ East (i+ii+iii+iv+v+vi)	**-**	**-**	**14.177.463**		**872.377.582**

3.9.1.4 Investment cost of Scenario 3a

Table 3-99: Investment Cost of Scenario 3a

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Mechanical Separation (t/y)	9.011	100	901.100		55.447.116
Landfill (residues) (m2)	78.654	90	7.078.851	61,5327	435.580.816
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	1	500.000	500.000		30.766.350
Total Cost of MBT for mixed waste (i)	-	-	8.979.951		552.560.632
(ii) Organic Waste and Green Waste -Aerobic Composting					
Aerobic Composting for Organic and Green Waste					
	Quantities (t/y)	**Unit Cost (€/t)**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Biological Treatment for Organic and Green Waste (t/y)	3.494	80	279.520	61,5327	17.199.620
Total Cost of Aerobic Composting for Green Waste (ii)	**-**	**-**	**279.520**		**17.199.620**
(iii) Collection equipment					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (1,1m^{3}bins)	211	220	46.420	61,5327	2.856.348
Collection equipment / waste collection vechiles	9	110.000	990.000	61,5327	60.917.373
Collection equipment / home composting (0,2m3bins)	4.100	50	205.000	61,5327	12.614.204
Collection equipment for Green Waste (trucks)	7	75.000	525.000	61,5327	32.304.668
Collection equipment for Recyclables (0,12m^{3}bins)	5.961	20	119.220	61,5327	7.335.928
Collection equipment for Recyclables (1,1m^{3}bins)	1.208	160	193.280	61,5327	11.893.040
Total Cost of Collection equipment (iii)			**2.078.920**		**127.921.561**

(iv) Green Points					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	9	80.000	720.000	61,5327	44.303.544
Total Cost of Green Points (iv)			**720.000**		**44.303.544**

Total Cost of Scenario 3a East (i+ii+iii+iv)	-	-	**12.058.391**		**741.985.357**

(v) Intangible components					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land					
	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	118.654	4	474.616	61,5327	29.204.379
Total Cost of Acquisition of land (vi)			**474.616**		**29.204.379**

Grand Total Cost of Scenario 3a/ East (i+ii+iii+iv+v+vi)	-	-	**14.433.007**		**888.101.867**

3.9.1.5 Investment cost of Scenario 3b

Table 3-100: Investment Cost of Scenario 3b

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Mechanical Separation (t/y)	9.011	100	901.100		55.447.116
MBS Treatment (t/y)	35.761	120	4.291.320		264.056.506
Landfill (residues) (m2)	66.301	90	5.967.084	61,5327	367.170.791
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	1	500.000	500.000		30.766.350
Total Cost of MBT for mixed waste (i)	**-**	**-**	**12.159.504**		**748.207.113**

(ii) Organic Waste and Green Waste -Aerobic Composting

	Quantities (t/y)	**Unit Cost (€/t)**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Biological Treatment for Organic and Green Waste (t/y)	3.494	80	279.520	61,5327	17.199.620
Total Cost of Aerobic Composting for Green Waste (ii)	**-**	**-**	**279.520**		**17.199.620**

(iii) Collection equipment

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (1,1m^{3}bins)	211	220	46.420	61,5327	2.856.348
Collection equipment / mixed waste (waste collection vechiles)	9	110.000	990.000	61,5327	60.917.373
Collection equipment / home composting (0,2m3bins)	4.100	50	205.000	61,5327	12.614.204
Collection equipment for Green Waste (trucks)	7	75.000	525.000	61,5327	32.304.668
Collection equipment for Recyclables (0,12m^{3}bins)	5.961	20	119.220	61,5327	7.335.928
Collection equipment for Recyclables (1,1m^{3}bins)	1.208	160	193.280	61,5327	11.893.040
Total Cost of Collection equipment (iii)			**2.078.920**		**127.921.561**

(iv) Green Points

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	9	80.000	720.000	61,5327	44.303.544
Total Cost of Green Points (iv)			**720.000**		**44.303.544**

Total Cost of Scenario 3b East (i+ii+iii+iv)	**-**	**-**	**15.237.944**		**937.631.838**

(v) Intangible components

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land

	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	106.301	4	425.204	61,5327	26.163.934
Total Cost of Acquisition of land (vi)			**425.204**		**26.163.934**

Grand Total Cost of Scenario 3b/ East (i+ii+iii+iv+v+vi)	**-**	**-**	**17.563.148**		**1.080.707.902**

3.9.1.6 Investment cost of Scenario 3c

Table 3-101: Investment Cost of Scenario 3c

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Thermal Treatment Unit	89.533	800	71.626.400	61,5327	4.407.365.783
Mechanical Sorting	19.447	100	1.944.700		119.662.642
Landfill (residues) (m2)	50.267	150	7.539.990		463.955.949
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	2	500.000	1.000.000		61.532.700
i) Total Cost of Thermal Treatment	**-**	**-**	**82.611.090**		**5.083.283.424**

(iii) Collection equipment

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (bins)	2.030	220	446.600	61,5327	27.480.504
Collection equipment / mixed waste (waste collection vechiles)	29	110.000	3.190.000	61,5327	196.289.313
Collection equipment for Green Waste (trucks)	13	75.000	975.000	61,5327	59.994.383
Collection equipment for Sorting at Source (0,12bins)	12.787	20	255.740	61,5327	15.736.373
Collection equipment for Sorting at Source (1,1bins)	2.591	160	414.560	61,5327	25.508.996
Total Cost of Collection equipment (iii)			**5.281.900**		**325.009.568**

(iv) Green Points

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	16	80.000	1.280.000	61,5327	78.761.856
Total Cost of Green Points (iv)			**1.280.000**		**78.761.856**

Total Cost of Scenario 3c East (i+ii+iii+iv)	-	-	**89.172.990**		**5.487.054.848**

(v) Intangible components					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**
(vi) Acquisition of land					
	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	70.267	4	281.066	61,5327	17.294.775
Total Cost of Acquisition of land (vi)			**281.066**		**17.294.775**
Grand Total Cost of Scenario 3c/ East (i+ii+iii+iv+v+vi)	**-**	**-**	**91.354.056**		**5.621.261.752**

3.9.1.7 Investment cost of Scenario 4

Table 3-102: Investment Cost of Scenario 4

	Quantities	**Unit Cost (€/t) & (€/m2) for landfill**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Mechanical Separation for Recyclabe wastes(t/y)	9.011	100	901.100		55.447.116
Landfill (residues) (m2)	54.105	90	4.869.437	61,5327	299.629.603
Infrastructure works	-	-	500.000		30.766.350
Transfer Station	1	500.000	500.000		30.766.350
Total Cost of MBT for mixed waste (i)	**-**	**-**	**6.770.537**		**416.609.419**
(ii) Organic Waste and Green Waste -Aerobic Composting					
	Quantities (t/y)	**Unit Cost (€/t)**	**Total Cost (€)**	**Exchange rate MKD/EURO**	**Total Cost (MKD)**
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Biological Treatment for Organic and Green Waste (t/y)	19.814	110	2.179.540	61,5327	134.112.981
Total Cost of Aerobic Composting for Green Waste (ii)	**-**	**-**	**2.179.540**		**134.112.981**

(iii) Collection equipment					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Collection equipment / mixed waste (1,1m^{3}bins)	0	220	0	61,5327	0
Collection equipment / mixed waste (waste collection vechiles)	10	110.000	1.100.000	61,5327	67.685.970
Collection equipment organic waste (0,6m3bins)	701	120	84.120	61,5327	5.176.131
Collection equipment for Green Waste (trucks)	7	75.000	525.000	61,5327	32.304.668
Collection equipment for Recyclables (0,12m^{3}bins)	5.961	20	119.220	61,5327	7.335.928
Collection equipment for Recyclables (1,1m^{3}bins)	1.208	160	193.280	61,5327	11.893.040
Total Cost of Collection equipment (iii)			**2.021.620**		**124.395.737**

(iv) Green Points					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Green Points	9	80.000	720.000	61,5327	44.303.544
Total Cost of Green Points (iv)			**720.000**		**44.303.544**
Total Cost of Scenario 4 East (i+ii+iii+iv)	-	-	**11.691.697**		**719.421.681**

(v) Intangible components					
	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
TA & Supervision during implementation	-	1.500.000	1.500.000	61,5327	92.299.050
Publicity	-	100.000	100.000	61,5327	6.153.270
Public Utilities Works	-	300.000	300.000	61,5327	18.459.810
Total Cost of Intangible components (v)			**1.900.000**		**116.912.130**

(vi) Acquisition of land

	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Exchange rate MKD/EURO	Total Cost (MKD)
	(1)	(2)	(3)=(1)*(2)	(4)	(5)=(3)*(4)
Acquisition of land	94.105	4	376.419	61,5327	23.162.103
Total Cost of Acquisition of land (vi)			**376.419**		**23.162.103**

Grand Total Cost of Scenario 4/ East (i+ii+iii+iv+v+vi)	-	-	**13.968.116**		**859.495.914**

3.9.1.8 Overview of Investment Costs

The analytical data is presented in Annex V. In the following table, it is given the investment cost of each scenario.

Table 3-103: Investment Cost of each Scenario

	Cost of Treatment, Collection Transportation (€)	Cost of Intangible components (€)	Cost of Acquisition of land (€)	Grand Total (€)
Scenario 1a/East Region	13.456.787	1.900.000	288.217	15.645.004
Scenario1b/East & North East Regions	92.938.462	1.900.000	287.127	95.125.589
Scenario 2/East Region	11.953.884	1.900.000	323.579	14.177.463
Scenario 3a/East Region	12.058.391	1.900.000	474.616	14.433.007
Scenario 3b/East Region	15.237.944	1.900.000	425.204	17.563.148
Scenario 3c/East & North East Regions	89.172.990	1.900.000	281.066	91.354.056
Scenario 4/East Region	11.691.697	1.900.000	376.419	13.968.116

	Cost of Treatment, Collection Transportation (MKD)	Cost of Intangible components (MKD)	Cost of Acquisition of land (MKD)	Grand Total (MKD)
Scenario 1a/East Region	828.032.442	116.912.130	17.734.751	962.679.323
Scenario1b/East & North East Regions	5.718.754.523	116.912.130	17.667.699	5.853.334.352
Scenario 2/East Region	735.554.772	116.912.130	19.910.681	872.377.582
Scenario 3a/East Region	741.985.357	116.912.130	29.204.379	888.101.867
Scenario 3b/East Region	937.631.838	116.912.130	26.163.934	1.080.707.902
Scenerio 3c/East & North East Regions	5.487.054.848	116.912.130	17.294.775	5.621.261.752
Scenerio 4/East Region	719.421.681	116.912.130	23.162.103	859.495.914

3.9.1.9 Investment cost for landfills rehabilitation works

There are three (3) models of landfill remediation as mentioned in previous section. The unit costs for remediation activities per model are given below:

<u>Model "A" - Waste disposal by method "ex-situ" by cleaning the waste and its redisposal on the municipal landfill</u>

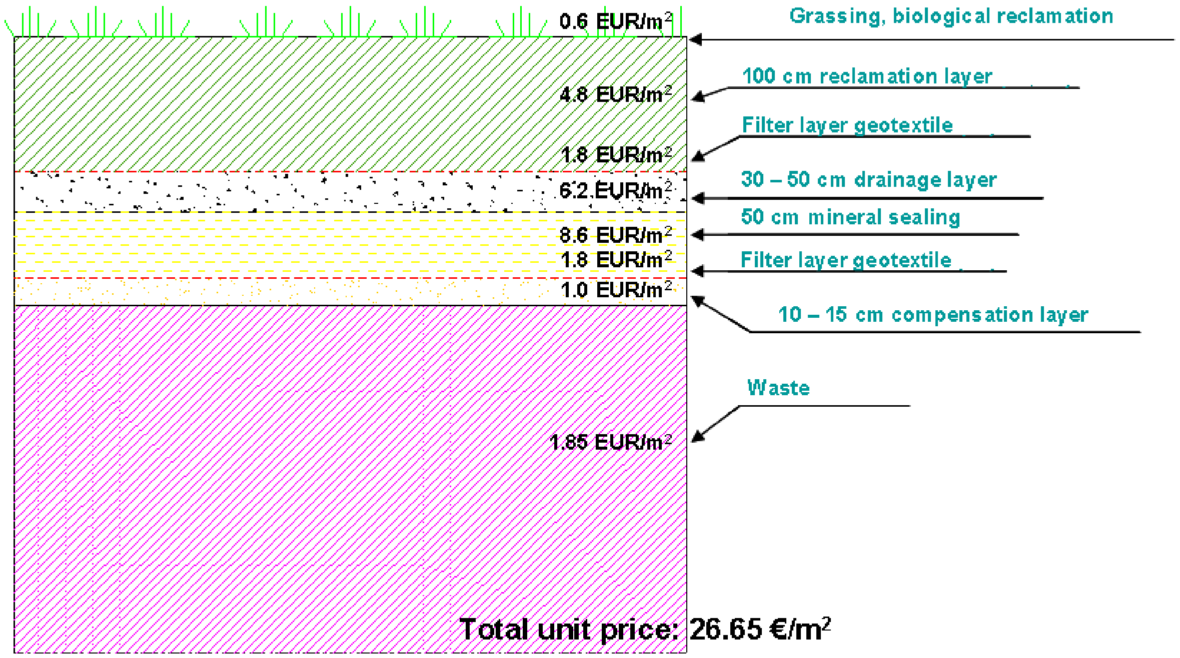
- Removal of disposed waste. According the present conditions, removal can be done with a bulldozer / front loader or excavator - at cost price of 1.5 €/m^3;
- Transport and redeposition of waste to the existing municipality landfill (distance to 100 km) at cost price 20 €/m^3;
- Compacting the waste with roller at cost price of 1.1 €/m^3, and;
- Bilogical recultivation (grass) on areas cleared of waste at cost price of 06 €/m^2.

The total cost for model "A" is 131,785 €. Analytical breakdown of cost is given in annex.

<u>Model "B" – Safe disposal "in-situ"</u>

- Profiling of waste deposited, spreading and leveling with a bulldozer at cost price of 1.85 €/m^2;
- Laying leveling layer of ground masses with thickness 0.1 – 0.15 m at cost prices of 1.0 €/m^2
- Laying the geo-textile separator (300 - 400 g/m^2) at cost price of 1.80 €/m^2;
- Construction of a mineral layer of compacted clays (0.5 m – 2 × 25 cm thick, k = 1×10^{-9} m/s) – at cost prices of 8.6 €/m^2) or hydro-geo-membrane (at cost price of 10.50 €/m^2);
- Laying drainage layer of washed river gravel fraction 12/35 for removal of infiltrated water with $k>10^{-4}$ m/s (0.5 m) at cost price 6.2 €/m^2;
- Laying geo-textile separator (300 - 400 g/m^2) at a cost price of 1.80 €/m^2;
- Construction of remediation layer with thickness of 1 m at cost price of 4.80 €/m^3;
- Landfill monitoring (for landfills with volume of deposited waste above 15,000 m^3), and;
- Biological remediation of landfill - grass (at cost price of 0.6 €/m^2 with cultivation activities), construction of protective belts (at cost prices of 1.2 €/m^2).

Figure 3-106: Section of remediated landfill after model "B"



The total cost for model "B" is 1,529,177 €. Analytical breakdown of cost is given in Annex.

Model "C" - Safe disposal "in-situ"

- Profiling of deposited waste, spreading and leveling with a bulldozer at cost price 1.85 €/m^2;
- Laying leveling layer of ground masses with thickness of 0.1 – 0.15 m with cost price of 1.0 €/m^2;
- Construction of gas drainage system (drainage blanket of gravel) at cost price of 6.00 €/m^3;
- Construction of gas drainage and gas venting system for flaring of the captured gas emissions from landfill (model C1 - used for landfills with volume of deposited waste from 100,000 to 500,000 m^3) – 120 €/m;
- Construction of gas drainage and gas venting system for utilization of landfill gas emissions (model C2 - used for landfill volume of waste disposed of over 500,000 m^3) at cost price of 60,000 €;
- Laying of geotextile separator (300 - 400 g/m^2) at cost price of 1.80 €/m^2);
- Construction of a mineral layer of compacted clays (0.5 m – 2 × 25 cm thickness, $k=1\times10^{-9}$ m/s) – at cost price of 8.6 €/m^2) or hydro-geo-membrane (at cost price of 10.50 €/m^2);
- Laying drainage layer of washed river gravel fraction 12/35 for removal of infiltrated water with $k>10^{-4}$ m/s (0.5 m) at cost price 6.2 €/m^2;
- Laying of geo-textile separator (300 - 400 g/m^2) at cost price of 1.80 €/m^2);
- Construction of remediation layer with thickness of 1 m at cost price of 4.80 €/m^3;
- Biological remediation of landfill - grass (at cost price of 0.6 €/m^2 with cultivation activities), construction of protective belts (at cost prices of 1.2 €/m^2);
- Landfill monitoring (for landfills with volume of deposited waste above 15,000 m^3).

Figure 3-107: Section of remediated landfill after model "C1" (100,000 – 500,000 m³)

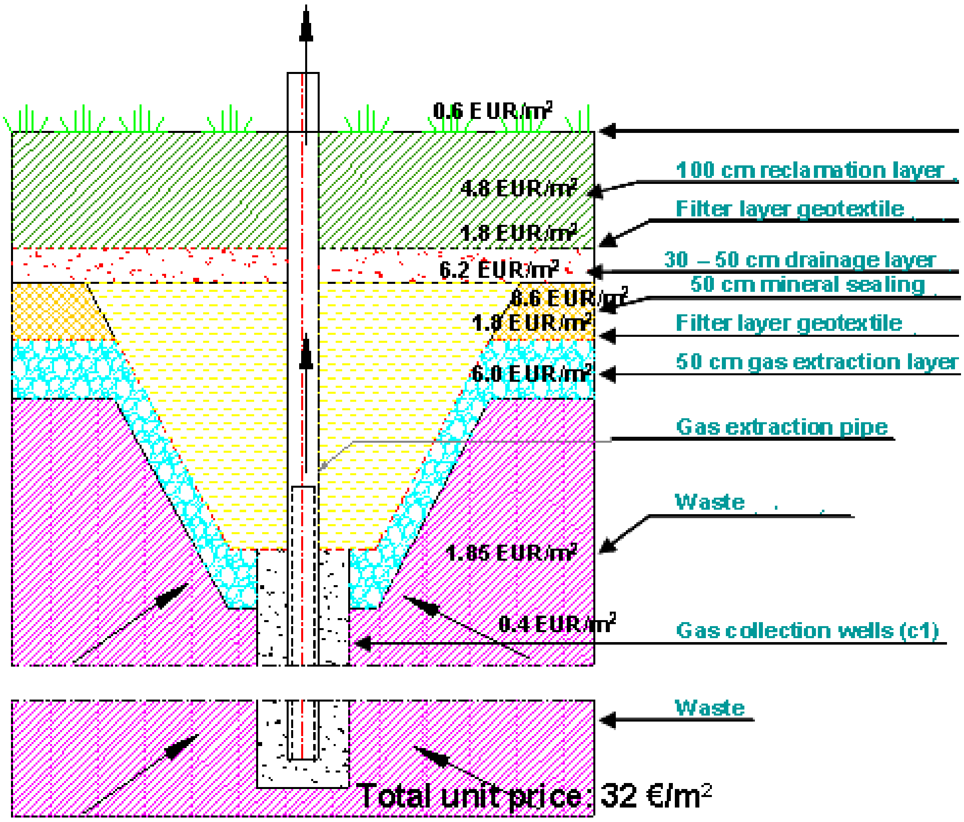
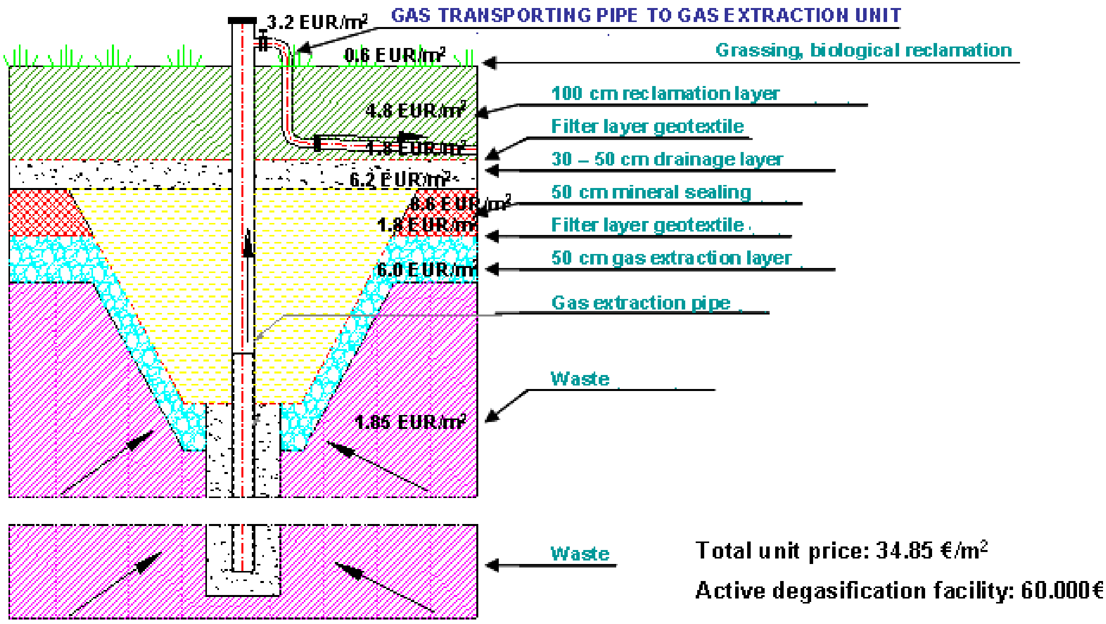


Figure 3-108: Section of remediated landfill after model "C2" (above 500,000 m³)



The total cost for model "C" is 2,810,560 €. Analytical breakdown of cost is given in Annex.

A summary of the costs for implementing the remediation activities is given in the table below:

Table 3-104: Costs (in €) for implementing the planned activities

Municipality	Model "A" (in €)	Model "B" (in €)	Model "C" (in €)	Total (in €)
Berovo	11,454	279,825	-	291,279
Shtip	8,256	436,527	-	444,783
Chesinovo-Obleshevo	45,183	213,200	-	258,383
Karbinci	17,764	-	-	17,764
Probishtop	-	66,625	1,120,000	1,186,625
Delchevo	12,389	133,250	768,000	913,639
Kochani	28,728	-	672,000	700,728
Pehchevo	5,692	399,750	-	405,442
Vinica	2,320	-	250,560	252,880
Total East Region	**131,785**	**1,529,177**	**2,810,560**	**4,471,522**

All costs are indicative and are not taken into account in the financial analysis of the present report.

3.9.2 Operating Cost

3.9.2.1 Operating Cost for Collection & Transportation

Assessment of needs for transportation trucks

For the development of the transportation service in East region it is necessary to replace and expand the existing fleet. The present report outlines the respective calculations as well as the unit prices for the equipment. The following assumptions are adopted:

- Waste generation, projections and existing collection - transportation means are according to the previous chapters.
- The assumed the density of municipal waste and biowaste is about 450 kg/m^3
- The assumed the density of recyclable waste is about 300 kg/m^3.
- The assumed frequency of collection is twice per week on average with one-shift operation, 312 d per year.
- Collection is done with press-pack rear loading RCV, capacity of 16 m^3 and payload of approx. 8 tonnes/RCV. The new trucks will serve the whole region, in order to optimise costs.
- Collection of green waste will be done in open trucks
- Transport trucks which were purchased in 2000 or before are considered to be too old and have reached their useful life and therefore have to be replaced.

The existing trucks were taken from the waste questionnaires. The calculations for the required number of new trucks and the associated investment are shown in the following Table, indicatively for scenario 1a. Calculations for all scenarios are given in Annex V

Table 3-105: Required number of 16 m3 trucks in East region

Waste			
Total Quantity mixed waste		tons/a	42.432
Daily Quantity mixed waste		tons/d	136
Transportation trucks			
Capacity of trucks		m3	16
Average waste density in truck		t/m3	0,45
MW Container load		tons	7,2
Utilization		of capacity	85%
Average trips of MW transport trucks per day			
Average time for loading		hours	2,00
Average distance to disposal site and back		km	80
Average speed when travelling		km/h	50
Total time loading/driving/unloading		hours	3,5
Possible number of trips per truck per day		trips/day	2,0
Required trips per day		trips/day	23,0
No trucks required		#	12,0
Equipment			
No extra trucks required		#	7,0
Additional Investments for direct transport			
Investment for waste collection trucks	110.000	€	770.000

The respective collection and transportation cost is shown underneath, where a typical distance of 40 km to the landfill was adopted for illustrative reasons:

Table 3-106: Collection and transportation cost

Operating and maintenance costs				
Drivers (1+1 per truck)			number	24
Costs of drivers	12.000	€/a	€	288.000
Assistants (2+1 per truck)			number	36
Costs of assistants	7.200	€/a	€	259.200
(a) Total staff costs			€	**547.200**
(b) Fuel				
Truck-engine				
Average transporting per day			km/day	1840
Average transporting per year			km/year	574.080
Use of fuel/km			l/km	0,30
Consumption			l/a	172.224
Use of fuel/t waste collected			l/t	2
Consumption			l/a	84.864
Fuel of truck	1,30	€/l	€	334.214
Total fuel costs			€	**334.214**
(c) Other consumables, taxes, MOT	5%	of fuel	€	**16.711**
(d) Maintenance				
Maintenance of Trucks	5%	on invest.	€	66.000
Average driving			km/year	574.080
Number of tyre-sets required	60.000	km/set	Number	9,57
Number of tyres of vehicle	8			
Tyres	4.000	€ per set	€	38.272

Total maintenance costs			€	**104.272**
Total (a to d)			€	1.002.397
(e) Administration - Overheads	15%			150.360
(f) Insurance - Security	2,5%	on invest.	**€**	26.400
Total costs			**€**	**1.179.157**
Total costs per t waste			**€/t**	**27,8**

Calculations for collection cost of green waste are similar. It is calculated that:

- 7 open trucks are needed for green waste collection at a cost of 55.000 € each, 385.000 € in total
- Due to the lower quantities of green waste, collection cost amounts to 78,3 €/t

The operating cost for collection and transportation of each scenario are presented in the following table:

Table 3-107: Collection and transportation cost

	Collection Transportation (€) /year)	**Collection Transportation (MKD/year)**
Scenario 1a/East Region	**1.391.663**	**85.632.800**
Scenario1b/East & North East Regions	**2.484.488**	**152.877.273**
Scenario 2/East Region	**1.467.091**	**90.274.047**
Scenario 3a/East Region	**1.525.934**	**93.894.869**
Scenario 3b/East Region	**1.525.934**	**93.894.869**
Scenario 3c/East & North East Regions	**3.601.003**	**221.579.441**
Scenario 4/East Region	**1.567.347**	**96.443.080**

3.9.2.2 Operating Cost for Treatment

The operating cost of each scenario is projected by waste component: i.e. waste transfer and transportation, waste sorting, waste biological treatment, waste thermal treatment and disposal.

For the calculation of the operating costs of various waste management facilities considered the following cost categories.

Maintenance cost: The annual maintenance costs for all facilities are calculated based on a certain percentage of the investment cost, which is assumed:

- 4% for mechanical sorting and biological treatment.
- 2,5% for thermal treatment
- 1.5% for landfills and
- 1% for infrastructure

Labour Costs: The labor cost is calculated based on typical salaries for different categories of staff, including the various insurances, taxes, employer contributions, etc.

Table 3-108: Assumption for labour cost

	WORKER UNSKILLED	WORKER SKILLED	ENGINEERS/ CHEMISTS/ SUPERVISORS
Scenario 1a/East Region	18	10	2
Scenario1b/East & North East Regions	18	15	4
Scenario 2/ East Region	14	6	2
Scenario 3a/ East Region	13	7	1
Scenario 3b/East Region	14	10	2
Scenario 3c/East & North East Regions	30	17	5
Scenario 4/ East Region	12	8	2

Administrative costs: Administrative costs are calculated as a percentage of labor costs, ie to 20% of labor costs.

Energy – Fuel: Electricity and fuel necessary for the operation of the landfill, mechanical sorting, and biological treatment. It is assumed that in scenarios in which we will be producing energy for own consumption to meet energy needs. The consumption values per tn incoming waste for every unit are the following:

Table 3-109: Energy and fuel consumption

	Energy	Fuel
	(KWh/t) @ (0,07EUR/KWh)	(l/t) @ (1,12EUR/l)
Mechanical Sorting	30	3
Biological Plant	10	3
Windrow Composting	5	2
Landfill	5	5
Thermal Treatment	0	0

Monitoring: For the necessary environmental monitoring (noise, dust, odors, etc.) at work / perimeter of the site and ensuring product quality are adopted following annual costs:

Table 3-110: Cost for Monitoring

	EUR/y	MKD/y
Mechanical Sorting	25.000	1.538.318
Biological Plant	15.000	922.991
Windrow Composting	5.000	307.664
Landfill	20.000	1.230.654
Thermal Treatment	90.000	5.537.943

Within each waste component, the cost is split into fixed and variable costs in order to allow better projection and differentiation of growth rates. The fixed cost comprises labour (skilled/unskilled workers, drivers, handlers, supervisors, technicians, and chief engineers), maintenance, administrative cost, insurance, control and monitoring. Variable costs vary depending on the waste quantities (t) i.e. fuel cost, energy, other (water, leachate treatment, etc.). The analytical data is presented in Annex V.

Regarding scenarios 1b and 3c for the portion of the thermal treatment to be carried out with PPP, it was calculated the gate fee for the thermal treatment of waste. For the calculation of the gate fee at cash flows, it was taken into consideration at:
- the outflows: the operating costs of the unit and the loan
- the inflows: the revenues from the sale of energy.

The gate fee for the thermal processing units is presented below:

Table 3-111: LGate Fee for thermal treatment of residual waste

Scenario	Gate Fee for WTE (EUR/year)	Gate Fee for WTE (MKD/year)
Scenario1b/East & North East Regions	83	5.109
Scenario3c/East & North East Regions	95	5.842

The operating cost for the treatment of each scenario is presented below:

Table 3-112: Operating cost for treatment

	Operating Cost for treatment	Operating Cost for treatment
	(€)	(MKD)
Scenario 1a/East Region	1.082.478	66.607.809
Scenario1b/East & North East Regions	8.016.856	493.298.819
Scenario 2/East Region	932.140	57.357.114
Scenario 3a/East Region	700.415	43.098.455
Scenario 3b/East Region	1.016.738	62.562.620
Scenario 3c/East & North East Regions	8.166.937	502.533.687
Scenario 4/East Region	772.085	47.508.503

In the following table, it is given the grant operating cost of each scenario.

Table 3-113: Operating Cost of each Scenario (for the 1st year of operation)

Scenario	Operating Cost (EUR/year)	Operating Cost (MKD/year)
Scenario 1a/East Region	2.474.142	152.240.609
Scenario1b/East & North East Regions	10.501.344	646.176.074
Scenario 2/East Region	2.399.231	147.631.161
Scenario 3a/East Region	2.226.350	136.993.325
Scenario 3b/East Region	2.542.672	156.457.490
Scenario 3c/East & North East Regions	11.767.940	724.113.124
Scenario 4/East Region	2.339.432	143.951.583

The cost of thermal treatment is included in scenarios 1b and 3c

3.9.2.3 Revenues

Revenues from recyclables

Each technology produces recyclable materials and / or energy, which have market value and can be sold. The value of recyclables is provided in the table below.

Table 3-114: Values of recyclables in €/t

Process Outputs	Unit	Values for recyclables from MBT	Values for recyclables from MRF
Glass	€/tonne	2	3
Paper & cardboard	€/tonne	30	50
Al	€/tonne	650	650
Fe	€/tonne	150	150
Plastics	€/tonne	60	90
RDF / SRF	€/tonne	0	
Compost from green waste (and / of presorted organic waste)	€/tonne	5	
CLO	€/tonne	0	
Revenues from collective shcemes	€/tonne	15	30

Revenues from energy

The thermal-treatment plant produces electricity and thermal energy. The price of electricity for the thermal treatment of biomass is 0,150 €/kWh. For the thermal treatment unit, based on the biomass quantities, the selling price to the national grid will be 0,71 €/kWh (for scenario 1b) and 0,81 €/kWh (scenario 3c).

Table 3-115: Revenues of Scenario 1b and 3c for PPP (for the 1st year of operation)

Scenario	Revenues (EUR/year)	Revenues (MKD/year)
Scenario1b/East & North East Regions	4.131.791	254.240.256
Scenario 3c/East & North East Regions	3.400.521	209.243.239

The analytical data for the revenues for each scenario for the 1st year of operation is presented in the following table.

Table 3-116: Revenues of each Scenario (for the 1st year of operation)

Scenario	Revenues (EUR/year)	Revenues (MKD/year)
Scenario 1a/East Region	288.007	17.721.844
Scenario 2/East Region	305.764	18.814.459
Scenario 3a/East Region	700.567	43.107.797
Scenario 3b/East Region	732.864	45.095.129
Scenario 4/East Region	718.324	44.200.412

3.9.3 Dynamic Price Cost (DPC) and Affortabillity

3.9.3.1 Dynamic Price Cost (DPC) calculations

The index of Dynamic Prime Cost, or commonly also known as Net Present Value, is an index of cost-effectiveness and it is widely used in environmental projects as a best proxy of a long run average cost (for the present case it would be equivalent to the gate fee, €/ t of waste). This index has a similar structure like the Cost-Benefit Ratio, i.e. it is a ratio between discounted costs and discounted benefits. It takes into account: operation and maintenance costs, a lifetime of an investment and profile of an ecological effect.

The following calculations are based on the data (investment, operation, etc) given in the above chapters. The formula is given below:

$$DPC = \frac{\sum_{t=0}^{t=n} \frac{KI_t + KE_t}{(1+i)^t}}{\sum_{t=0}^{t=n} \frac{EE_t}{(1+i)^t}}.$$

Where:

DPC -- Dynamic Prime Cost, €/t
KIt -- investment expenditures in year t,
KEt -- O&M costs in year t,
EEt -- waste delivered to RWMC in year t,
I -- the disscount rate, 5%
n -- a lifetime of an investment.

Taking into account the categories of operating costs and revenues (described in previous paragraphs) and the generated waste quantities for the period 2013-2042, then it is determined the Dynamic Prime Cost (DPC) for each scenario (analytical calculations in Annex V). An overview of DPC results are presented in the following table.

Table 3-117: DPC of each Scenario

Scenario	DPC (€/t)	DPC (MKD/t)
Scenario 1a/East Region	75	4.596
Scenario1b/East & North East Regions	115	7.088
Scenario 2/East Region	70	4.304
Scenario 3a/East Region	61	3.726
Scenario 3b/East Region	72	4.448
Scenario 3c/East & North East Regions	116	7.116
Scenario 4/East Region	62	3.797

3.9.3.2 Affortability calculations

The Polluter Pays Principle (PPP) is one of the principles of Community environmental policy and applies throughout the European Union. According to Art. 14§1 of Directive 2008/98/EC on waste, the costs of waste management shall be borne by the original waste producer or by the current or previous waste holders.

The simplest way to implement PPP is to introduce a full cost recovery waste tariff, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system.

However, according to the "Guidance on the methodology for carrying out Cost-Benefit Analysis" Working Document No. 4, when the affordability of tariffs is considered, stakeholder may artificially cap the level of charges to avoid a disproportionate financing burden for the users, thus ensuring that the service or good is affordable also for the most disadvantaged groups. The minimum requirement is that tariffs should at least cover operating and maintenance costs as well as a significant part of the assets' depreciation. An adequate tariff structure should attempt to maximise the project's revenues before public subsidies, while taking affordability into account.

Taking into account the aforementioned for the present project, the tariffs to the users of the project are proposed to be as follows:

i. The tariffs for commercial activities are considered from the first year of operation to be equal to the Dynamic Unit Cost.
ii. The tariffs for residential users are taken so as to cover the net operating costs of the project

The proposed tariffs for households are given in Annex V – Financial Analysis.

The tariffs of each scenario are presented in the following table:

Table 3-118: Tariffs of each Scenario

	Residential users	Economic units
Scenario 1a/East Region	38	75
Scenario1b/East & North East Regions	102	115
Scenario 2/East Region	37	70
Scenario 3a/East Region	24	61
Scenario 3b/East Region	29	72
Scenario 3c/East & North East Regions	99	116
Scenario 4/East Region	27	62

Tariffs of each scenario for residential users have been calculated as follows:

Table 3-119: Tariffs of each Scenario for residential users

	Tariffs per tonne		Tariffs per capita		Tariffs per HH	
	(€/t)	(MKD/t)	(€/cap)	(MKD/cap)	(€/HH)	(MKD/HH)
Scenario 1a/ East Region	38	2.338	8	501	25	1.554
Scenario1b/East & North East Regions	102	6.276	22	1.332	67	4.130
Scenario 2/ East Region	37	2.277	8	486	24	1.505
Scenario 3a/ East Region	24	1.477	5	321	16	994
Scenario 3b/East Region	29	1.784	6	379	19	1.174
Scenario 3c/East & North East Regions	99	6.092	21	1.292	65	4.005
Scenario 4/East Region	27	1.661	6	350	18	1.084

For the residential tariffs plan are calculated the value of affordability for each scenario:

- as % of the average annual income
- as % of the lowest decile income

According to the statistical data, the average annual income per household in the country for 2012 is 328.444 MKD. As data for income in the region is not provided, an average annual income per household for the East Region is estimated, considering GDP per capita in East region. GDP per capita for the East Region is 93% of the average country GDP. Based on this assumption, the average annual income per household for East Region is calculated at 305.460MKD (4.964,07 €) and the lowest decile income is calculated at 64.666,62MKD/y (1.050,93€/y).

The value of affordability as % of the average annual income for the 1st year and as % of the lowest decile income is for the 1st year is presented in the following table:

Table 3-120: Affordability of each Scenario

	Waste tariff as a % of lowest decile HH income	**Waste tariff as a % of average HH income**
Scenario 1a/East Region	2,20%	0,47%
Scenario1b/East & North East Regions	5,84%	1,24%

	Waste tariff as a % of lowest decile HH income	Waste tariff as a % of average HH income
Scenario 2/East Region	2,13%	0,45%
Scenario 3a/East Region	1,41%	0,30%
Scenario 3b/East Region	1,66%	0,35%
Scenario 3c/East & North East Regions	5,66%	1,20%
Scenario 4/East Region	1,53%	0,32%

It can be argued that the calculation of affordability ratio shall be based on average household income, rather than to the average household income of the lowest decile. Indeed the former gives more representative results for waste management investments.

For part of population (pensioners, farmers etc) that live on poverty limits, even the current waste tariffs that practically cover collection service only, are not bearable.

For these people, will pose an additionally burden. It has to be seriously considered that municipalities grant exemptions or subsidies to the more vulnerable group of citizens, at the expense of having modernized waste management that covers the sanitation standards of EU, yet being affordable to the majority of population.

3.10 EVALUATION OF ALTERNATIVE SCENARIOS BY USING THE METHOD OF MULTICRITERIA ANALYSIS – FINAL PROPOSED REGIONAL WASTE MANAGEMENT SYSTEM

3.10.1 Introduction

Finding the best way to address a management problem is a very complex process, because of the need to evaluate different options / scenarios, which, in many cases, are apparently equivalent.

In order to achieve an evaluation of all the different suggested solutions, it is not sufficient to compare only one critical parameter, but it is needed the analysis and rating of a number of different criteria. These criteria are common to all suggested scenarios and their importance for solving the problem is characterized by a weighting factor.

The selection of appropriate criteria is particularly important for the export of the optimal conclusions. The kind of criteria depends:
(A) directly from the type of problem to be solved and its particular characteristics and
(B) indirectly as the problem is affected or affects the attitude of various stakeholder groups.

The simultaneous analysis of the characteristics of various alternative scenarios through the evaluation and rating of all the different criteria, for the extraction of the optimal solution, is the Multi – Criteria Analysis.

3.10.2 Multicriteria Analysis and Environmental Management

The decisions taking process regarding the management of environmental problems, is a very complicated and difficult process. The various environmental problems are related (affecting or affected) directly or indirectly with a large number of factors, the severity of which is a key factor in choosing the best solution for every problem.

The use of a single criterion (e.g. the applied technology performance or operational costs) for the comparison evaluation between scenarios may not lead to a result which ensures optimal solution of the problem as well as the taking of appropriate decisions / actions. Therefore, the need to implement a data multi-criteria evaluation system, which are connected with an environmental management problem is conspicuous.

The methodology followed for the implementation of the Multi – Criteria Analysis (MCA) includes:

- determination of the problem and selection of possible alternative scenarios
- selecting the appropriate model
- selection and classification of criteria
- mathematical description of the criteria
- assessing the weighting of each criterion in relation to the problem to be solved
- an evaluation matrix
- fixing various restrictive parameters depending on the subject of the assessed problem

- final classification of the evaluated scenarios based on the special characteristics of the of the selected model.

3.10.3 The concept of MCA

In order to be compare the different scenarios with each other, it is required the composition of their performance in relation to all the various evaluation criteria, in a manner that in could take place an hierarchy of the evaluated scenarios, in order of preference, or a classification of them in groups / categories of preference (high, medium and low). Except, in the case where all the criteria are measured in financial terms, in all other cases, it is required the application of appropriate performance composition technics.

In many countries as well as in Greece, it has been widely used and continues to be used, the simple technique of "weighted performance" (or "weighted average"). The performance of alternative scenarios, regarding the evaluation criteria, is usually expressed in different measurement units e.g. million €, tons of pollutant-binding acres of land, etc.

According to the previous mentioned technique, as a reference point for each evaluation criterion, it is selected the performance of an alternative scenario and then the performance of the other scenarios are normalized according to the previously set reference performance. In that way all expressed performances are expressed in the form of performance ratios. In continuance to the previous step, in each criterion is assigned a weighting factor. The overall performance of each scenario is derived as the sum of the relative multiplications of the weighting factors, of each criterion, in relation to the corresponding (normalized) performance of the scenario according to the selected criterion.

This technique presents a number of serious methodological problems:

- The performance scale of the evaluation criteria is formulated mechanistically (simply through normalization) and without assessing the significance of the differences between criteria to the decision maker. The formulation process of the performance scale implies that the decision maker's preference is linear, something that rarely applies in reality.

- The selection of the best or worst performance as a performance reference point, in combination to the performance normalization, it is possibly affecting the resulting hierarchy.

- The value of weights is usually defined arbitrarily by analysts, without being connected with the actual or possible performance per criterion, which characterized as "... the most usual extremely serious error" (Keeney 1992) in the field of MCA expertise.

Therefore, the composition of the derived impacts should be done with mathematical trial techniques. These techniques - characterized as multi-criteria - are divided into two major categories, those of the "utility function" and those of "dominance relations".

In the first category of techniques (utility theory) takes place the assumption that in the mind of each decision maker exists a particular structure of preferences, which compose the utility function that characterizes his/her thinking and decisions. The aim of the method is to "reveal" this function through appropriate questions to the decision maker on the basis of the performance of alternative scenarios / solutions. In other words, the application of these techniques it is based to the certainty that both the decision maker can answer all questions relating to the way of thinking that characterizes him and secondly that this method is completely rational. In each scenario / solution turns out to yield a total utility and based on these values, the scenarios are ranked in preference order. Typical techniques of this theory are MACBETH (Bana e Costa and Vansnick 1994) and AHP (Saaty 1980, Saaty 2005),

In the second category of techniques (analysis of prevalence relations) is not intended to develop a total utility function that measures the overall attractiveness of an alternative solution, but take place the analysis of the comparison results between alternatives solutions in each criterion. In these techniques it is possible two options not to be comparable to each other (for example if their performance is diametrically opposite).

The result of the comparisons taking place may be:

- the selection of a subset of solutions,
- the prioritization of solutions or
- the ranking of solutions in classes (groups) of preference.

The most popular techniques of this theory are the methods ELECTRE (Roy 1985, Roy 1990) and PROMETHEE (Brans and Vincke 1985).

Techniques based on utility theory are generally easy handling by the most decision-makers regarding their results. In the meantime has been developed and a number of technique variations in order to address real problems in decision making such as, the inability to quantify the decision maker's preferences. However, main implementation difficulty, is the requirement for a significant interaction with decision makers, which require analysts with vast experience and skills in both the analysis of the problem and communicating with the decision makers. On the other hand, analysis of prevalence relations techniques demand significantly less time to be spent in order to conclude in a decision, but often the results are obscure. For many years the main advantage of prevalence relations analysis techniques was the ability to integrate and use of uncertainty in the preferences of decision-makers. Nowadays some techniques based on utility theory have begun to incorporate such features.

In any case, the basic goal of the analysts at the stages of problem identification, performance evaluation – weighting factors, and synthesis of the effects (if done through methods MCA) should be to allow the direct and meaningful interaction with decision-makers (i.e. through the creation of a special working group which will join the analysts in a particular - not large - number of decision sessions). The sessions are decision technique applied effectively in international level, in a variety of problems such as problems infrastructure sitting, environmental protection, optimal allocation of resources, evaluation of suppliers, etc. (Bana e Costa and al. 2006, Bana e Costa and al. 2002, Philips and Bana e Costa 2005, Quaddus and Siddique 2001).

Finally, the multi-criteria analysis is a decision making tool/method developed to reduce the confusion caused in problems involving many and different criteria concerning of specific options. Essentially, through this method is achieved the synthesis and analysis of a large volume of information while taking into account the objectives and preferences of the decision - making process. Finally, the use of such methods is the political compromise among all stakeholders, adjusting where necessary and proportionate to the objectives set, the weight that everyone carries to the final decision. Towards this direction several multi-criteria methods have been applied to solve environmental problems and in particular regarding the management of solid waste or wastewater (Avarossis et al., 2001).

3.10.4 The MCA model ELECTRE III

In the problems of Solid Waste Management take place of significant importance the applications of Hokkanen and Saminen (Aravossis et al., 2001), who applied the methods ELECTRE II and ELECTRE III respectively. Specifically, in a study conducted in Oulu (northern Finland) (Hokkanen & Saminen, 1997) the ELECTRE III method, as a multi – criteria analysis decision support tool, has proven particularly useful in addressing environmental problems, in a case where the decision-making process included many stakeholders and the results of various alternatives solutions where, to an extensive point, uncertain. The aim of the research was to use all landfills that were available in the studied area, as well as the energy potential of waste that could be used by 2010. The conducted assessments of a solid waste management system led to the selection of a series of techniques: interim landfilling, composting and incineration – RDF.

Another model based on the principles of multi criteria analysis and simulation is developed by Karterakis and Gidarakos (2005). The main objective of the research is to develop a reliable and useful methodology for selecting the optimal scenario of urban waste management in the Region of Crete through the help of the mathematical software Matlab. The three scenarios selected to be used for the comparison evaluation should be representative and discrete referring to the methods and their goals.

In the case of design management and waste treatment projects, the methodologies, the most appropriate practice are prevalence relations between the alternative scenarios. This conclusion comes up from the adaptability that these methods exhibiting in such applications. These methods also provide high processing capabilities of parameters and analysis of the structure of the problem. Alongside address successfully any imperfections of the imported data, by modeling uncertainty that is usually characterizing such decision problems. One of them is the ELECTRE III, which is used in the present study.

The ELECTRE (ELimination Et Coix Traduisant la REalite) is a whole category of methods for MCA, which is based on the theory of prevalence relations. According to this theory originally is defined a function between two alternative scenarios and then by the use of an index is developed a prevalence relation over all the alternative scenarios. The preference index represents the preference intensity of the decision-maker for an alternative scenario comparing to another. It is separated into different methods (ELECTRE I, II, III, IV and TRI), out of which, in our case, it is chosen to apply the ELECTRE III, due to the successful implementation in other relative evaluations of waste management plans and the accurate adjustment to the data of our study.

The ELECTRE methods are not characterized by a high degree of substitution between the criteria, i.e. the unsatisfactory rating a criterion is not balanced by the good rating of another criterion.

These methods present an important advantage, which is the use of preference thresholds as well as the use of indifference thresholds which are an often obstacle while using inaccurate data.
The methodology used in this analysis is comprehensive and easy to follow up by decision-makers, even if they are unfamiliar with similar techniques. It is also offering substantial and accurate ranking of the evaluated alternative scenarios. Below are presented the basic theoretical principles of the method.

We consider a finite number of selection criteria gj, where j = 1,2, ... r and a total of alternative scenarios A. Between two scenarios a, b is possible to exist the following relationships as well as the opposites of them:
• aPb, a is strongly preferred compared to b, where g (a)-g (b)> p
• aQb, a is slightly preferable compared to b, when q <g (a)-g (b) ≤ p
• aIb, indifference between a and b, when │g (a)-g (b)│≤ q
where p refers to the preference threshold and q to the indifference threshold, whose values are set by the analyst and/or decision makers.

For implementing the method ELECTRE III it is introduced the function S = P ∩ I using the notation aSb, indicating that a scenario is at least as good as b. In order to examine the statement aSb are introduced the following principles:

- Agreement Principle: aSb is valid for the majority of criteria.
- Principle of non-discrepancy: all the criteria, by which is not accepted the declaration, contains no criteria based on which the declaration is strongly rejected.

The symbol aSjb indicates that a scenario is at least as good as b in respect to criterion j. To be considered the criterion j in agreement with the statement aSb, aSjb must be valid, i.e. gj (a) ≥ gj (b)-qj. Similarly, the criterion j is at discrepancy with the statement aSb, when bPja is valid, i.e. when gj (b) ≥ gj (a)-pj.
In general, the goal of the method as defined, is the classification of alternative scenarios taking into account (Roy 1985):

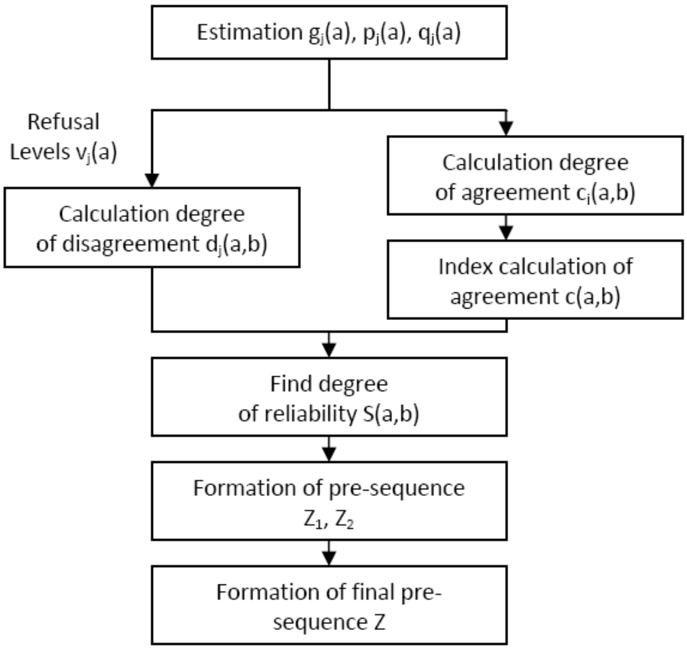
- The indifference and preference thresholds for each criterion
- The importance rates of criteria
- The difficulties that may arise after comparing two scenarios, where the first is significantly better than the second with respect to a subtotal of criteria, but inferior in relation to all the criteria.

Having defined the theoretical framework of the method, we present the methodology for verification or rejection of the declaration aSb.
The scenarios are compared in pairs and the concordance measures are calculated cj (a, b), expressing the superiority of scenario a than b. In more details:

$$c_j(a,b) = \begin{cases} 1 & g_j(b) - g_j(a) \leq q_j \\ 0 & g_j(b) - g_j(a) \geq p_j \\ \dfrac{p_j + g_j(a) - g_j(b)}{p_j - q_j} & q_j \leq g_j(b) - g_j(a) \leq p_j \end{cases}$$

where gj (a) and gj (b) are the ratings of the alternative scenarios a and b respectively, according to the criterion j and pj, qj the corresponding limits of preference and indifference.

Figure 3-109: Schematic Illustration of ELECTRE III Methodology



In the next step are calculated the concordance indices C (a, b), following function:

$$C(a,b) = \frac{1}{\sum_{j=1}^{r} k_j} \sum_{j=1}^{r} k_j c_j(a,b)$$

where kj significance coefficient of criterion j.

The concordance indexes are used in setting up the concordance matrix which has the following form:

Table 3-121: Concordance matrix of multicriteria method ELECTRE III.

	Σ1	Σ2	…	Σn
Scenario 1	1	C(1,2)		C(1,n)
Scenario 2	C(2,1)	1		C(2,n)
:			1	
:				
Scenario n	C(n,1)	C(n,2)		1

From these concordance indices may be calculated the net flows by using the following function:

$$C(a) = \sum_{a \neq b} \left[c(a,b) - c(b,a) \right] / (n-1)$$

Where *n* the number of criteria

In a similar way are calculated the discrepancy indices dj (a, b) and it is required the introduction of an additional threshold, the veto threshold vj. The veto threshold of a criterion j is defined as the smaller value of difference between the scores of the two scenarios over which is accepted that the statement ***aSjb*** is not valid.

$$d_j(a,b) = \begin{cases} 0 & g_j(b) - g_j(a) \leq p_j \\ 1 & g_j(b) - g_j(a) \geq v_j \\ \dfrac{g_j(b) - g_j(a) - p_j}{v_j - p_j} & p_j \leq g_j(b) - g_j(a) \leq v_j \end{cases}$$

The use of mismatch indices limits down the compensation of criteria scoring. In the case that dj (a, b) = 1 for each j, then the alternative scenario a is rejected and not included in the subsequent assessment. Unlike to concordance indices, during the identification of discrepancy indices the weighting factors are not taken into consideration.

Following the next step and based on the concordance and discrepancy indices, is identified the credibility degree for each pair of scenarios, according to the function:

$$S(a,b) = \begin{cases} C(a,b) & d_j(a,b) \leq C(a,b) \ \forall j \\ C(a,b) \cdot \prod_{j \in J(a,b)} \dfrac{1 - d_j(a,b)}{1 - C(a,b)} & d_j(a,b) \geq C(a,b) \\ & J(a,b) : d_j(a,b) > C(a,b) \end{cases}$$

where J (a, b) is the total of criteria. By the use of the last function is resulted the exported Assurance Matrix which is similar to Concordance Matrix.

The next step is the ranking of scenarios according to Reliability Matrix. Initially there are two ranking lists Z1 and Z2, an ascending preference and a descending preference one respectively and by their combination we end up in the final scenario ranking Z = Z1 $\cap$Z2.

At this point is inserted the constant k, which refers to the largest value of reliability:

$$\lambda = \max_{a,b \in A} S(a,b)$$

and is defined as the value of reliability s (λ), such that in the next steps of the process to remain only the values S (a, b) which are greater than λ-s (λ). The reliability value, as well as the limits pj, qj, vj mentioned above, are determined by the decision maker.

$$T(a,b) = \begin{cases} 1 & S(a,b) > \lambda - s(\lambda) \\ 0 & S(a,b) < \lambda - s(\lambda) \end{cases}$$

Out of the use of the last function derives the final matrix based on which will take place the scenario ranking.

The methodology followed in order to extract the classification of the final ranking table is as follows:

First calculate the sums of rows and columns. The sum of the columns is deducted out of the corresponding lines. The scenario with the largest resulted difference is placed first in the ranking table. The scenarios are sorted from left to right. The process is repeated by skipping the row and column of the scenario that was classified. The final outcome of the above process, is the total preorder Z1. To export ranking table Z2 the first in the classification is placed the scenario with the smallest difference and the scenarios are sorted from right to left. In case there are several scenarios with the same difference value, the constant s(λ) is modified, thus changing the final table and differences.

As mentioned above, the final partial preorder derives from the intersection of total preorders Z1 and Z2.

The criteria are essential components of multi criteria analysis, since they are the basis for the assessment of alternative scenarios. Unfortunately, their selection is not based on some well defined methodology. However, there are certain techniques that contribute to an improved selection. Roy (1985) studied the various opinions describing the determination of factors, in order to highlight after extensive analysis, the ranking from minor to increased significance. Keeney, Raiffa (1976), Keeney (1988) and Saaty (1980) approached the subject as for an hierarchical manner of setting up the different criteria of reverse ranking set by Roy, through the synthesis of different views in the sub-elements that constitute them, until the appropriate approach is achieved. In Greek literature is observed a tendency to evaluate the evaluation criteria so as to cover the widest possible satisfaction range of targets.

The selection should be the product of a participatory process, while the maintenance of criteria technical characteristics (restrictions) are work of the scientific team working on each assessed issue. Furthermore, all the criteria should agree with the following assumptions:

- *Completeness*: Should be covered all the key points of the problem
- *Functionality:* Must be able to attribute numerical values
- *Absence of unnecessary criteria either* a criterion to be contained within another criterion

- The characteristics of each assessed problem should be unchanged in a minimum level
  J.P. Brans (1996) proposes four different kinds of selection criteria for multi-criteria evaluation of alternatives options concerning of development projects:
    - Finances
    - Technical
    - Social
    - Environmental

3.10.5 Setting up of criteria and evaluation of alternative scenarios

In this case, during the criteria selection process, was attempted to include all the affected areas, focusing on the environment, but in the same time by implementing the requirements of European and National Legislation. Based on the general categories were defined also the sub criteria set to evaluate alternative scenarios. The final synthesis and analysis of evaluation criteria is as follows:

Table 3-122: Evaluation Criteria

	EVALUATION CRITERIA	ANALYSIS CRITERIA
A	**LEGISLATIVE CRITERIA**	
A.1	Compatibility with European legislation and the objectives of the applicable Solid Waste Legislation	Assess the compatibility of each method with the requirements and objectives of EU legislation concerning the Solid Waste Management and in particular with the fulfillment of targets for recycling and recovery of materials, with emphasis on reducing the quantities of biodegradable waste which are led to landfill
A.2	Compatibility with National Strategy regarding the Solid Waste Management	Assess the ability of each method to fulfill the requirements of national strategic plans and objectives relating to the Solid Waste Management
A.3	Compatibility with tendering procedures under the rules of the EU	Assess the existence or not of a sufficient number (at least 4) of specific suppliers for each technology in order to compete at international level the project tendering
B	**ENVIRONMENTAL CRITERIA**	
B.1	Air Pollution. Emissions of gaseous pollutants, within EU limits	The possible emission of gaseous pollutants, dust and the overall burden of the atmosphere from the application of each technology
B.2	Pollution of soil, groundwater and surface water. Emissions within EU limits	Assess the impacts on soil, surface and groundwater from the construction and operation of the facilities of the various technologies
B.3	Odours	The possible odours from the application of each technology and whether it does not exceed the permissible limits of the legislative predefined limits

	EVALUATION CRITERIA	ANALYSIS CRITERIA
B.4	Noise	Assesses whether the level of noise generated by the operation of facilities are within the permitted limits of the applicable legislation
B.5	Ability to identify appropriate locations for the sitting of facilities – Aesthetics	Assess the need and the ease of finding sites for the location of facilities and furthermore is evaluated the degradation of the natural environment and the impression created to the neighbouring communities by the image of the facilities
B.6	Mitigation measures in the environment	Collectively assesses the measures that should be implemented to address the impact likely to have arisen from the above criteria, both in terms of applicability and economically
C	**TECHNOLOGICAL CRITERIA**	
C.1	Adaptability of the process towards the future volume fluctuation and quality of waste	Assess the possibility of adapting the process towards the changes and future variations of waste (qualitative and quantitative)
C.2	Proven technology – guarantee of operational excellence for representative quantities and capacities of waste management facilities	Assess the existence of proven technology with application to units of similar size and not in pilot scale units. Taken in consideration any proven operational problems arising during operation.
C.3	Need of skilled personnel for implementation / operation of the selected technology	Assess whether there is the necessity and the presence of skilled personnel for the proper operation of the process.
C.4	Existence of a market for the use of the finished product	Assess whether the final main products (compost, recyclables, biogas, electricity, thermal, etc.) from the application of each technology is usable and available in the existing market. Moreover evaluate whether these products meet, out of qualitative and quantitative point of view, the current required standards, in order to be considered usable. Finally evaluate the possibility of alternative markets in case of change of the existing legislative framework or the needs of the market, in order to ensure the viability of the technology
C.5	Exploitation – Energy efficiency	Evaluated the energy efficiency (energy efficiency)
C.6	Management of by-products	Assess whether the resulting by-products can be managed with appropriate and economical methods. Moreover, it should be taken into consideration that a product applying the current conditions is considered final, may be converted into by-product resulting an expensive cost of exploitation
C.7	Employment of local population	Assess the employment opportunities of personnel, especially concerning of the population of the neighbouring area to the installations. It is an important factor especially as a compensatory benefit to him who undertakes to accept the waste produced by others.

	EVALUATION CRITERIA	ANALYSIS CRITERIA
D	ECONOMIC CRITERIA	
D.1	Construction cost – Investment cost	Assess the cost of land acquisition, project and facilities construction etc. As well as are taken into consideration the economic factors required before the operational phase for implementation of each technology
D.2	Net operational cost	Assess the operational cost and maintenance cost of facilities
D.3	Economic sustainability of the technology	Assess the economic viability of the process, taking into account construction costs, operating costs, as well as revenues and expenses of products management.

The previously mentioned criteria are combined in order to calculate an overall rating of the alternative waste management scenarios. Regarding the importance of criteria, many decision problems, it is found that the criteria do not contribute equally to the satisfaction of the basic objective, or that from decision – maker point of view, the selection criteria have variable factors of importance. The relative importance of the criteria is determined by a separate analysis matrixes, and applied as a percentage of importance during the rating process. The table below presents the format of the objective, the units as well as the importance of individual criteria, which has emerged as the importance of each criterion and their contribution to the final evaluation.

Table 3-123: Final statement of evaluation criteria

	EVALUATION CRITERIA	OBJECTIVE	UNIT	IMPORTANCE FACTOR (%)
A	LEGISLATIVE CRITERIA			100
A.1	Compatibility with European legislation and the objectives of the applicable Solid Waste Legislation	max	0-10	40
A.2	Compatibility with National Strategy regarding the Solid Waste Management	max	0-10	40
A.3	Compatibility with procurement procedures under the rules of the EU	max	0-10	20
B	ENVIRONMENTAL CRITERIA			100
B.1	Air Pollution. Emissions of gaseous pollutants within EU limits	min	0-10	40
B.2	Pollution of soil, groundwater and surface water. Emissions within EU limits	min	0-10	10
B.3	Odours	min	0-10	10
B.4	Noise	min	0-10	10
B.5	Ability to identify appropriate locations for the sitting of facilities – Aesthetics	max	0-10	10
B.6	Mitigation measures in the environment	max	0-10	20
C	TECHNOLOGICAL CRITERIA			100
C.1	Adaptability of the process towards the future volume fluctuation and quality of waste	max	0-10	10
C.2	Proven technology – guarantee of operational excellence for representative quantities and capacities of waste management facilities	max	0-10	25
C.3	Need of skilled personnel for implementation / operation of the selected technology	min	0-10	10
C.4	Existence of a market for the use of the finished product	max	0-10	20
C.5	Exploitation – Energy efficiency	max	0-10	10

	EVALUATION CRITERIA	OBJECTIVE	UNIT	IMPORTANCE FACTOR (%)
C.6	Management of by-products	max	0-10	10
C.7	Employment of local population	max	0-10	15
D	**ECONOMIC CRITERIA**			**100**
D.1	Construction cost – Investment cost	min	0-10	30
D.2	Net operational cost	min	0-10	30
D.3	Economic sustainability of the technology	min	0-10	40

The comparative evaluation of the alternative scenarios will be examined from various points of view, depending on what priorities are set each time. For this purpose and in order to determine the sensitivity of the results on the criteria importance, can be set up different evaluating scenarios, with different importance factors of evaluation criteria sub-groups. In the present study is selected to take place three times the importance analysis of the main criteria, by using the configuration of the following three scenarios:

Table 3-124: Calibration of evaluation criteria – alternative scenarios

	EVALUATION CRITERIA	EVALUATION SCENARIO A (EQUAL VALUE OF ALL GROUPS OF CRITERIA)	EVALUATION SCENARIO B (EMPHASIS ON ECONOMIC - TECHNOLOGICAL CRITERIA)	EVALUATION SCENARIO C (LEGISLATIVE FOCUS - ENVIRONMENTAL CRITERIA)
A.	**LEGISLATIVE CRITERIA**	**0,250**	**0,200**	**0,300**
A.1	Compatibility with European legislation and the objectives of the applicable Solid Waste Legislation	0,100	0,080	0,120
A.2	Compatibility with National Strategy regarding the Solid Waste Management	0,100	0,080	0,120
A.3	Compatibility with procurement procedures under the rules of the EU	0,050	0,040	0,060
B.	**ENVIRONMENTAL CRITERIA**	**0,250**	**0,200**	**0,300**
B.1	Air Pollution. Emissions of gaseous pollutants within EU limits	0,100	0,080	0,120
B.2	Pollution of soil, groundwater and surface water. Emissions within EU limits	0,025	0,020	0,030
B.3	Odours	0,025	0,020	0,030
B.4	Noise	0,025	0,020	0,030
B.5	Ability to identify appropriate locations for the sitting of facilities – Aesthetics	0,025	0,020	0,030
B.6	Mitigation measures in the environment	0,05	0,040	0,060
C.	**TECHNOLOGICAL CRITERIA**	**0,250**	**0,300**	**0,200**
C.1	Adaptability of the process towards the future volume fluctuation and quality of waste	0,025	0,030	0,020
C.2	Proven technology – guarantee of operational excellence for representative quantities and capacities of waste management facilities	0,063	0,075	0,050

	EVALUATION CRITERIA	EVALUATION SCENARIO A (EQUAL VALUE OF ALL GROUPS OF CRITERIA)	EVALUATION SCENARIO B (EMPHASIS ON ECONOMIC - TECHNOLOGICAL CRITERIA)	EVALUATION SCENARIO C (LEGISLATIVE FOCUS - ENVIRONMENTAL CRITERIA)
C.3	Need of skilled personnel for implementation / operation of the selected technology	0,025	0,030	0,020
C.4	Existence of a market for the use of the finished product	0,005	0,060	0,040
C.5	Exploitation – Energy efficiency	0,025	0,030	0,020
C.6	Management of by-products	0,025	0,030	0,020
C.7	Employment of local population	0,037	0,045	0,030
D.	**ECONOMIC CRITERIA**	**0,250**	**0,300**	**0,200**
D.1	Construction cost – Investment cost	0,075	0,090	0,060
D.2	Net operational cost	0,075	0,090	0,060
D.3	Economic sustainability of the technology	0,100	0,120	0,080
	TOTAL	**1,000**	**1,000**	**1,000**

The Evaluation Matrix contains the scores g_j (a) of each scenario (table rows) in relation to all the criteria j (table columns). The factors per evaluated scenarios are resulting from calculations, literature review and other data. Basic requirement for the design of waste management systems is the cost estimation. The main sub – systems of an integrated MSW management are treatment facilities, construction costs, operation – maintenance cost, as well as the revenue and expenditure for the management of produced products possess a key role in assessing the total cost of waste management projects included in each alternative scenario.

One of the basic methods of estimating the cost of these facilities is the *statistical method* which is used when data are available in publications. These data correlate the initial expenditures and / or operating costs with planning capacity or the actual incoming flow waste. The relative costs are affected by factors such as treatment technology, the factor of human resources involvement, legislation, etc. The details of cost - benefit and effectiveness of the evaluated scenarios are listed in the relevant chapters of the present study.

Regarding the technological and environmental characteristics of the scenarios and the legislative framework for waste management projects are presented in detail in the relevant chapters of the present study**.**

3.10.6 Rating Of Alternative Waste Management Scenarios

Considering all the above, as well as the key characteristics of the selected technologies in each waste management scenario, took place the rating of each criterion. The evaluated scenarios of this study were presented in § 3.8:
The main elements which are evaluated, compared and rated are the alternative treatment methods as well as the disposal site which according to treatment procedures differ mainly as to the required area.

The evaluation matrix introduced in ELECTRE III, as follows:

Table 3-125: LEvaluation Matrix – Rating Of Alternative Waste Management Scenarios

	EVALUATION CRITERIA	OBJECTIVE	UNIT	Scenario 1a	Scenario 1b	Scenario 2	Scenario 3a	Scenario 3b	Scenario 3c	Scenario 4
A.	**LEGISLATIVE CRITERIA**									
A.1	Compatibility with European legislation and the objectives of the applicable Solid Waste Legislation	max	0-10	9	5	9	5	9	9	8.5
A.2	Compatibility with National Strategy regarding the Solid Waste Management	max	0-10	9	5	9	5	9	9	8.5
A.3	Compatibility with procurement procedures under the rules of the EU	max	0-10	9	7	10	10	10	7	10
B.	**ENVIRONMENTAL CRITERIA**									
B.1	Air Pollution. Emissions of gaseous pollutants, dust within EU limits	min	0-10	8	7	7.5	4	8.5	8.5	4.5
B.2	Pollution of soil, groundwater and surface water. Emissions within EU limits	min	0-10	8	6	8	6	8	6	8
B.3	Odours	min	0-10	7	8	7	5	7	7.5	6
B.4	Noise	min	0-10	6	6	6	6	6	6	6
B.5	Ability to identify appropriate locations for the sitting of facilities – Aesthetics	max	0-10	8.5	8.5	7.5	6	6.5	8.5	7
B.6	Mitigation measures in the environment			8	8	8	8	8	8	8
C.	**TECHNOLOGICAL CRITERIA**									
C.1	Adaptability of the process towards the future volume fluctuation and quality of waste	max	0-10	8	9	7	7	7	9	6

	EVALUATION CRITERIA	OBJECTIVE	UNIT	Scenario 1a	Scenario 1b	Scenario 2	Scenario 3a	Scenario 3b	Scenario 3c	Scenario 4
C.2	Proven technology – guarantee of operational excellence for representative quantities and capacities of waste management facilities	max	0-10	10	9	8	10	10	9	8
C.3	Need of skilled personnel for implementation / operation of the selected technology	min	0-10	8	6	8	8	8	6	8
C.4	Existence of a market for the use of the finished product	max	0-10	8.5	9	9	9	9	8.5	9
C.5	Exploitation – Energy efficiency	max	0-10	5	8.5	5	5	5	8	5
C.6	Management of by-products	max	0-10	7.5	5	8	8	6	5	8
C.7	Employment of local population	max	0-10	10	8	10	10	10	8	10
D.	**ECONOMIC CRITERIA**									
D.1	Construction cost – Investment cost	min	0-10	8.5	5	9	9	8.5	5	9
D.2	Net operational cost & Maintenance cost	min	0-10	8.5	5	8.5	9	9	5	9
D.3	Economic sustainability of the technology	min	0-10	8	5	8	9	8	5	9

3.10.7 Rating Justification By Criterion Of Alternative Waste Management Scenarios

Based on the methodology discussed above, all alternative waste management scenarios for East Region where rated, as shown in the previous table. Subsequently is presented the comparative advantages – disadvantages of each of the evaluated scenarios, which justifies the rating of each criterion.

Legislative criteria

For the rating of alternative scenarios concerning of the legislative criteria, namely the compatibility of projects with European and National Legislation and the fulfillment of the objectives set, as well as the compatibility of projects with the procurement procedures under the rules of EU (at least four different competitors) have been taken into consideration all the detailed calculations to achieve the objectives (recycling, recovery, reducing the volume of landfilled waste.

These calculations have been made taking into account the requirements of the Framework Directive on Waste. It has been taken into consideration and the necessity to meet the requirements of Directive 94/62/EC on packages and packaging waste.

Also, according to the Framework Directive 2008/98/EC on waste and the thematic strategy on the prevention and recycling of waste, the future priorities of EU regarding waste management are summarized in the following points:

- Reduction of environmental impacts derived from waste
- Reduction of waste production
- Separation of organic waste at the source
- Increase of recycling
- Energy Recovery

Regarding the diversion of Biodegradable Municipal Wastes (Directive 99/31/EC) to landfilling, exist many bibliographic data to enable comparison between the alternative scenarios from a qualitative point of view. In particular:

- The residues from mechanical sorting municipal solid waste (MSW) as well as from refining compost like materials, contain up to a certain percentage biodegradable components. Bibliographic references concerning of mainly German installations which meet the strict legislative targets of Germany, report a decrease in oxygen consumption (index AT4) at a rate of 80 – 90%, and 20 l/kg d.s. of biogas production potential in contrast with 280 l/kg d.s. (200 l/kg w.s.) characterizing the untreated MSW. Leikam & Stegmann report a significant decrease of 90% in COD, BOD and total nitrogen in the leachate produced by Residuals Waste Landfill Sites compared to the "classic" leachate of Waste Landfills, which proves that a very significant amount of biodegradable ingredients of wastes is diverted through the application Mechanical and Biological Waste Treatment methods.
- The legal requirements concerning of the quality of incineration residues (Directive 2000/76/EC *"Incineration of waste"*), set the following requirements for slag and bottom ash (Article 6.1 of Directive 2000/76/EC: "to ensure a level of incineration such that the content of slag and bottom ashes total organic carbon (TOC) is less than 3% or their loss on ignition (loss of ignition) is less than 5% by weight of dry material "). In modern installations is achieved TOC less than 1% of wet weight. Related studies of bottom ash deposited in separate cells (ash monofils), presented a very large reduction of COD in the produced leachate, the COD concentration in leachate does not exceed 400 mg/l, while the TOC and total Kjeldah nitrogen varies between 100 and 20 mg/l, respectively, with the maximum TOC concentration to reach 400 mg/l. The production potential of biogas by such waste is expected to be negligible in the range of 2,5-3,0 l/kg d.s. It is therefore an evident that through incineration we achieve great reduction in biodegradability of waste, while, in practice, someone would say that the material is biologically inert. However in the legislative criteria is assessed the overall behaviour of each scenario according to the requirements of EU legislation.

The key objectives (waste collection system, recycle materials and reduction of the fraction of Biodegradable which will be routed to landfill), for each alternative scenario, shown at the above table:

Table 3-126: Achievement of targets

a/a	S1a	S1b	S2	S3a	S3b	S3c	S4
Directive 94/62/EC (on packages and packaging waste)	Yes	No	Yes	Yes	Yes	Yes	Yes
(Directive 99/31/EC (diversion of Biodegradable Municipal Wastes)	Yes	Yes	Yes	No	Yes	Yes	Yes
Collection System	One bin collection		Two bin collection				Three bin collection

Based on the above data, resulting the following conclusions:

- The goal of recycling achieved for all scenarios, except scenario S1b.
- All scenarios, except S3a, achieve the objective of Directive 1999/31 concerning the percentage of the Biodegradable Municipal Waste which will be diverted from landfill, with scenarios that include incineration to have the best performance.
- Scenarios S1a and S1b have only one bin collection system, comparative to all other scenarios, with two or three bin collection system.

Considering all the above, and considering that meet the requirements of European legislation, ensures the satisfaction of the objectives of national laws by legislative criteria apply:

A.1. and A.2. Regarding compliance with the requirements and objectives set by the European and National Legislation and Strategy on the management of the MSW: Scenarios, S1a, S2, S3b and S3c will receive the maximum score because it can archiving all targets. Scenario S4 will receive a little lower score compared with the above mentioned scenarios, because of landfilling residual waste, Finally the scenarios S1b and S3a will be receive the lowest score because of not achieving all targets.

A.3. Regarding compatibility scripts for the auction procedures under EU rules and foremost that at least four different suppliers: Scenarios S2, S3a, S3b and S4 followed by S1a are in total compliance with procurement procedures under the rules of EU. For this reason, in this test that scenarios receive the same high score. Scenarios S1b and S3c (incineration scenarios) will receive a lower score because, although they are in compliance with procurement procedures under the rules of EU, it is difficult to get finance.

Environmental criteria

For the scoring of alternative scenarios for the environmental criteria are taken into account all data presented in detail in relevant chapters of the study, which lists the characteristics of various processing technologies, landfills and the environmental impact of resulting from their operation. Based on these data, per environmental criteria is applied:

B.1. This criterion evaluated comparatively the test scenarios for their contribution to greenhouse gases. The carbon dioxide (CO_2), the concentration of which plays a crucial role, in the atmosphere, in the absorption of thermal and thus global warming provides great contribution to the greenhouse effect.

It is important to note that the recovery of recyclable materials helps to reduce greenhouse gases if the recycling process has fewer emissions than the production of the new products. Studies have shown that in general, through recycling is achieved a small reduction of greenhouse gases, especially in cases where the use of a new product requires the use of vehicles, which emit much larger quantities of greenhouse gases.

In summary the calculations of greenhouse gas emission impact for each scenario(1. Debits: Represents the GHG emissions caused by recycling, 2. Credits: Represents the GHG emissions savings by recycling, 3.Net: Net effect, i.e difference between debits and credits), shown in total in Chapter 3.6.2.3.1 , and especially the indicator Net, given in the bellow table:

Table 3-127: GHG emissions - Net effect

a/a	S1a	S1b	S2	S3a	S3b	S3c	S4
Net effect (t CO2-eq/yr)	-14,574	-5,389	-10,542	+44,885	-19,490	-18,656	+23,352

Considering all the above, the lowest performance on criterion B1 shows scenario S3a, followed by scenario S4. Better performance showed scenario S1b followed by scenario S2 and then scenario S1a. Scenarios S3b and S3c, taking into account all the processes considered to have the best performance on this criterion, ie causing the lowest charge in the atmosphere.

B.2. For the pollution of soil, groundwater and surface water of the alternative proposed scenarios are considered foremost the generated solid waste and wastewater produced from the various sub-processes.

Regarding the generated solid waste, in the scenarios where is taking place mechanical sorting and composting, include:

- Solid Residues derived from Mechanical Sorting Process
- Impurities, pieces of plastic, metal and glass, stones, etc. during the phase of refining of the raw organic fraction

The solid residues derived from the separation and refining processes, and they are mainly those materials that are not usable either for energy recovery or biological treatment. These residues are materials that can be placed in Residuals Sanitary Landfill and do not require special treatment. From the mechanical point of view, products are not produced for immediate use or soil application.

In mechanical and biological treatment plants, a possible effect on the soil may result indirectly from the use of Compost Like Material (CLO). The possible presence of pathogens in such materials is a major public health threat that affects the usability of this materials and therefore all EU countries have included pathogens sanitary quality criteria for both humans, animals and plants. Of course, composting, as it is a thermophilic process, leads to thermal destruction of most pathogens, while it seems that other destruction mechanisms operate (competitive relationships, antibiotic production by the microflora of compost, stabilization of organic waste, etc.).

Regarding the legislative requirements, the quality criteria referred to the product, in the process or both.

Regarding the scenarios having thermal treatment, all categories of residue from incineration can potentially have a "negative" behaviour when disposed at landfill. The effect on landfill is dependant on the leachability of the various components and on the "environmental conditions" within the deposits.

Now, as for the produced wastewater during the mechanical treatment and separation of mixed waste characterized by a high content of biodegradable, can be produced leachate quantities. In this case, there should be provision for the collection and processing the produced leachate. In some MBT technologies is taking place waste separation in the liquid phase, after the addition of water. These technologies produce larger leachate quantities, which can be used in anaerobic digestion reactor usually present in this type of MBT plants.

The produced wastewater from mechanical and biological treatment plants include:

- Due to the existence of containers having liquid residues are generated small amounts of wastewater in the reception areas
- During composting, is taking place the production of wastewater which is mostly recycled to maintain the moisture of the composted pile
- Wastewater produced from anaerobic digestion
- Wastewater produced during gas treatment in biofilters
- During the cleaning process is generated wastewater after washing spaces
- The effluent from the staff employed in the installation

There is a choice of condensation the water vapor resulting from the evaporation of moisture during the drying of the waste. In that case the amounts of wastewater produced are considered significant.

Now, regarding the wastewater produced during thermal treatment units, water is used in waste incineration for various reasons. The wet gas cleaning systems produce wastewater, but on the other hand semi-dry and dry systems generally do not produce any amounts of wastewater. In some cases the wastewater from the wet scrubber is evaporated while in other cases is treated and after that released or recycled. Finally the wastewater from the treatment of waste gases usually contain heavy metals such as Pb, Cd, Cu, Hg, Zn, As, etc.

Considering all the above, the lowest performance on criterion B2 shows scenarios S1b and S3c and S3a. Scenarios S1a, S2, S3b and S4 have the optimal performance because they cause less burden on the ground and in ground and surface waters.

B.3. Odors. In general aerobic treatment plants produce odors and biogas emissions treated satisfactorily because of closed systems and the general processing. Odors produced from incinerating gaseous pollutants include many inorganic and organic compounds, which are of course treated with modern pollution control technologies and are subject to very strict emission limits.

Considering all the above and the requirement area of landfill, the lowest performance on criterion B3 shows scenario S3a, followed by scenario S4 and then scenarios S1a, S2, S3b and S3c. Scenario S1b have the optimal performance because it cause the least impact on the creation odors.

B.4. As far as the noise from the operation of all the units comprising each of the alternative scenarios, based on the technical characteristics of the units, all other scenarios, have the same performance.

B.5. The possibility now identifying suitable sites for the location of waste management facilities and the effects caused to the aesthetics of the landscape of the region is a very important factor since such projects are generally viewed with suspicion by the public. This criterion will assess the various scenarios, depending on the area requirements for the sitting of facilities, calculating the required main area of landfills, which collect the more negative characteristics because of their direct contact with natural environment and in particular the ground. In the following table, it is presented the required area per scenario.

Table 3-128: Required area

	S1a	S1b	S2	S3a	S3b	S3c	S4
Landfill area (m2)	32,000	52,000	41,000	79,000	66,500	50,000	54,000
Area for treatment plant (m2)	40,000	20,000	40,000	40,000	40,000	20,000	40,000
Total area (m2)	**72,000**	**72,000**	**81,000**	**119,000**	**106,500**	**70,000**	**94,000**

Considering all the above and based on the treatment method and the required area, the worst performance on the criterion B5, shows scenarios S3a followed by scenario S3b, S4 and S2. The remaining scenarios S1a, S1b and S3c have the same performance.

B.6. Finally, as regards the measures to be taken whether to reduce environmental impacts: From all the above all scenarios have both positive and negative environmental characteristics. However, since all technologies today are quite widespread, and there are all possible measures and projects that can be made to minimize the negative environmental impact to this criterion all scenarios are rated by the same score.

Technological criteria

For the rating of the alternative scenarios concerning of the technological criteria, have taken into consideration everything presented in the relevant chapters oh the study which sets out a technical description of the various treatment technologies and sanitary landfilling. Based on these data, by technological criteria are the following:

C.1. As to the adaptability of different scenarios to future fluctuations in the quantity and quality of the incoming waste, is examined both the flexibility of the various units in the fluctuations of the quantities of waste treatment, and the change in body composition such as the possibility of receiving other waste streams.

Regarding the flexibility of technologies in future legislative trends shaped by EU, on increasing recycling of recyclables and organic materials, through sorting at source and to variations of incoming MSW quantities, that may be due to social or other reasons, factors that lead to quantitative and qualitative changes of the waste, the following shall apply:

Aerobic biological treatment presents great flexibility, as the operation of mechanical processing can be adapted to the incoming quantities by reducing or increasing the operating time of each line and ultimately works in one or more shifts. The composting system configuration also allows easy adaptation to fluctuating quantities or future application in pre-sorted organic system, in the case that source separation is extended in the future. In the thermal processing units, the quantity of incoming material should be kept constant, so that the combustion takes place with high efficiency. Reduction of input quantities will have a direct impact on the production of electricity and hence the viability of the unit.

As far as the possibility of receiving other waste streams, the methods of thermal treatments have greater flexibility with regard to admission of other waste streams such as sewage sludge, tires, commercial industrial waste or high calorific waste such as agricultural and livestock wastes. In addition to this, having the possibility of receiving other waste streams can result in a possible reduction in the MSW quantities, based on which the dimensions of the units was made. The mechanical and biological methods can treat as agricultural and livestock wastes in the biological part of the process and possible dry commercial industrial waste in the mechanical part of the process. However this capability may require re-adjustment of the units .

Considering all the above and also considering the potential host and other waste streams, and the collection system (one, two, or three bins) scenarios S1b, S3c have the best performance, followed by scenario S1a, and then scenarios S2, S3a and S3b, while the S4 has the lowest performance (because of the three bins collection systems).

C.2. Regarding whether all technologies which are presented in alternative scenarios are tested and there is experience and reliability of the application to other plants with similar characteristics, today can be said that all scenarios have been installed and currently are operational.

In particular it is commonly accepted that the increased commercial installed capacity of a technology, is a sign of reliability. However, the reduced installed capacity does not mean quite low reliability as some technologies are developed in the recent years and still have not been clarified all the operating parameters which is also reflected in the available literature. Aerobic treatment is a combination of mechanical and aerobic biological treatment of two proven techniques with a high degree of reliability. Nowadays, the methods of thermal treatment are applicable in many countries.

Considering all the above criterion C2 can be seen that all technologies is now proven and reliable (S1a, S3a, S3b), while the thermal treatment methods follow closely behind (Scenarios S1b and S3c). Finally scenarios S2 and S4 has the lowest performance because of the separate collection of the organic stream, witch having difficulties.

C.3. The need for skilled personnel for plant operation is included in each of the scenarios and depends on whether these methods are known, the number of qualified personnel required for the proper operation of the plants, as well as on the complexity of the units. In any case it is considered that during the operation of such facilities, the presence of qualified personnel is necessary.

Taking also into account the results of criterion C2, and the required number of qualified staff given at the annexes of the study the greatest need for skilled personnel have scenarios S1b and S3c (lowest performance at that criterion), followed by scenarios S1a, S2, S3a, S3b, S4 (best performance at that criterion).

C.4. As to the existence of a market for the trading of products produced by various individual units (Recyclables, compost, electric or thermal energy, etc.), there is now enough demand for all products. Some difficulty may be presented as to the disposal of the compost,(when it in not first quality product), which must meet certain specifications. Nowadays the ability to sell electricity is very high. Is noted that the production of electricity especially by utilizing biogas, but also by the utilization of biomass is also considered as a renewable energy source.

Considering all the above, the lowest performance on criterion C3 shows scenarios S1a and S3c. Scenarios S1b, S2, S3a, S3b and S4 are having the optimal performance.

C.5. In this criterion is considered the possibility of energy exploitation and utilization i.e. the energy efficiency of each scenario, based on the technologies of the individual units comprising each scenario. From the balance of scenarios, such as those listed in relevant chapters oh the study greater energy efficiency will scenario S3c that produces the largest amount of electric energy and then scenario S1b.. Then comes all the other scenarios (S1a, S2, S3a, S3b, S4) because of the technology included have no energy efficiency ..

C.6. Regarding the possibility of by products management potential resulting from the different treatment processes (compost, CLO, ashes), the lowest performance have scenarios S1b and S3c (incineration scenarios), followed by scenarios S3b and S1a (because of the production of CLO). all other scenarios having the best performance (S2, S3a, S4).

C.7. Finally, regarding the employability of the local workforce and creating new jobs is directly influenced by the degree of automation of an installation. Scenarios S1a, S2, S3a, S3b and S4, because of the many different technologies which include having the same opportunities to create new jobs. Then comes the thermal treatment scenarios (S1b, S3c)

Economic criteria

For the rating of the alternative scenarios based on economic criteria are taken into account the detailed estimations of construction, operation and maintenance cost, and the potential Dynamic Prime Cost, (DPC), which is an index between reduced costs and reduced benefits, measured in €/tn of the available waste for processing. The index takes into account and addresses the following elements: construction, operation and maintenance cost, the life of an investment, projected revenue and the environmental benefit (in this case study tn waste to be processed).

The lowest prices of DPC concerning of the least expensive and correspondingly higher prices the more expensive option. In this way indicated the most cost-effective management solution, which achieves environmental benefits (quantity of waste management) with the lowest cost. Based on these data as further set out in the relevant chapters oh the study, per criterion the following apply:

D.1. Regarding the cost of construction all projects based on estimates of the present study, the scenarios are sorted from cheapest to the most expensive in the following order: S4, S2, and S3a with similar construction costs, S1a and S3b with similar construction costs, and finally scenarios S3c and S1b as the most expensive scenarios with large price difference from the rest.

Table 3-129: Scenarios Sorting Based on net operating cost

ALTERNATIVE SCENARIOS	INVESTMENT COST (€)
Scenerio 4	13.968.116
Scenario 2	14.177.463
Scenario 3a	14.433.007
Scenario 1a	15.645.004
Scenario 3b	17.563.148
Scenario 3c	91.354.056
Scenario1b	95.125.589

D.2. Referring to the operating costs all projects, which included both the operating costs of the facilities, and revenue - expenses from the disposal of products (net operating cost), scenarios are sorted from cheapest to the most expensive in the following order: S3a, S4 and S3b with similar net operating cost, S2 and S1a with similar operating cost, and finally scenarios S1b and S3c as the most expensive scenarios with large price difference from the rest.

Table 3-130: Scenarios shorting based on net operating cost

ALTERNATIVE SCENARIOS	NET OPERATING COST (€/tn)
Scenario 3a	32
Scenerio 4	33
Scenario 3b	38
Scenario 2	42
Scenario 1a	44
Scenario 3c	102
Scenario1b	105

D.3. The economic viability of each scenario is a combination of all the above financial figures, and as mentioned above in the context of this study is represented by the indicator DPC. The lowest prices DPC concerning the least expensive and correspondingly higher prices the more expensive option. In this way indicated the most cost-effective management solution, which achieves environmental benefits (quantity of waste management) with the lowest cost. Based on this indicator scenarios are ranked from the best in the following order: S3a and S4, S2 , S3b and S1a. Finally scenarios S1b and S3c as the most expensive scenarios with large price difference from the rest.

Table 3-131: Scenarios Sorting Based On DPC

ALTERNATIVE SCENARIOS	DPC (€/tn)
Scenerio 3a	61
Scenario 4	62
Scenario 2	70
Scenario 3b	72
Scenario 1a	75
Scenario 1b	115
Scenario3c	116

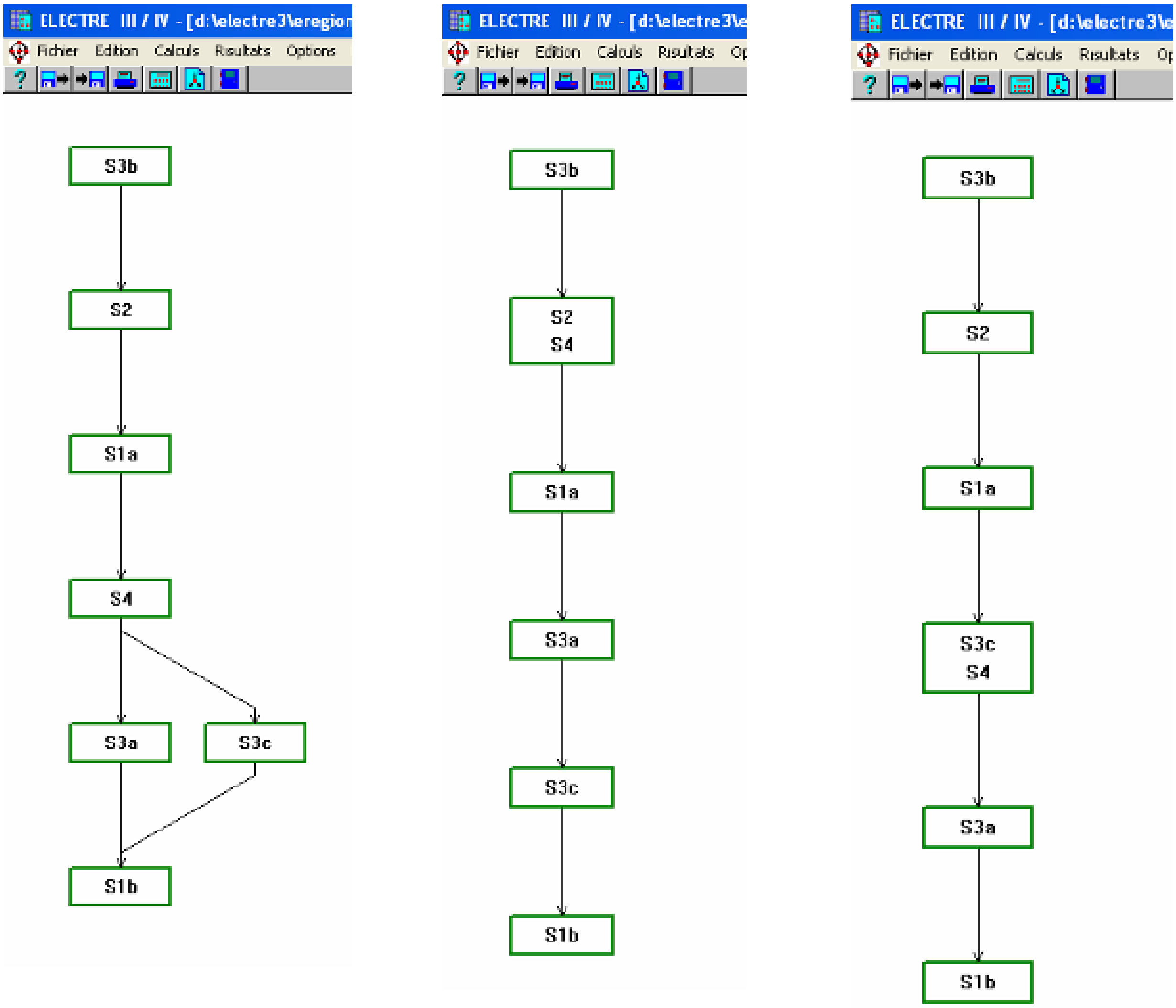
3.10.8 Results of Comparative Evaluation Of Alternative Waste Management Scenarios

The operation/use of the model requires the determination of the values of three thresholds: the bordered preference (p), indifference (q) and veto (v). The existence of these thresholds, allows the decision process to take into account the uncertainty of the performance during the evaluation of the alternative scenarios.

The thresholds p and q occur are based on the maximum and minimum difference in the rating of the scenarios in each criterion. Because some criteria are not quantitatively estimated, it results that the threshold for refusal should be zero, in order to avoid false results.

Below is presented the comparative assessment of the alternative scenarios, for each of the three calibrations, as occurred after the application of the method ELECTRE III, as well as the final ranking of the scenarios.

Figure 3-110: Results of ELECTRE III model



<u>A Scenario Evaluation:</u>
Equal value of all the groups of criteria

<u>Evaluation Scenario B:</u> Focus on the technological-economic criteria

<u>Evaluation Scenario C:</u>
Focus-legislative environmental criteria

From the above schematic representation of the comparative evaluation results, of alternative scenarios, is calculated by applying the method of multi-criteria analysis using the ELECTRE III model, resulting following conclusions:

- In all evaluation scenarios in the first position of preference seems to rank Scenario S3b, which includes, two bin collection system, Home Composting Process, mechanical biological stabilization and materials recovery facility, and windrow composting of green waste.
- As a second option seems to rank scenario S2 which includes, two bin collection system, materials recovery facility and aerobic composting of organic and green waste.
- As a third option seems to rank a scenario S1a and scenario S4.
- In last place always ranks scenarios S1b which includes mass burn incineration.
- In particular the assessment scenario A, where all sets of criteria have the same weight, the ranking is as follows:
  - 1st: Sscenario S3b
  - 2nd: Scenario S2
  - 3rd: Scenario S1a
  - 4th Scenario S4
  - 5th: Scenarios S3a and S3c
  - 6th: Scenario S1b
- In the assessment scenario B, where prevailing economic and technological criteria, the ranking is similar to scenario A and is as follows:
  - 1st: Sscenario S3b
  - 2nd: Scenarios S2 and S4
  - 3rd: Scenario S1a
  - 4th Scenario S3a
  - 5th: Scenario S3c
  - 6th: Scenario S1b
- In the assessment scenario C, where the prevailing legislative and environmental criteria, the ranking is as follows:
  - 1st: Sscenario S3b
  - 2nd: Scenario S2
  - 3rd: Scenario S1a
  - 4th Scenarios S3c and S4
  - 5th: Scenarios S3a
  - 6th: Scenario S1b

The final evaluation of the scenarios, as shown by the model, is similar for all calibrations and in this table compare the best and the worst scenarios. So in this case the comparison is made between scenarios S3b as better in all three evaluation scenarios and S1b as worst..

Figure 3-111: Final evaluation matrix scenarios S3b and S1b (matrice du preorde final)

Fichier Edition Calculs Résultats Options Fenêtre

	S1a	S1b	S2	S3a	S3b	S3c	S4
S1a	I	P	P-	P	P-	P	P-
S1b	P-	I	P-	P-	P-	P-	P-
S2	P	P	I	P	P-	P	I
S3a	P-	P	P-	I	P-	P	P-
S3b	P	P	P	P	I	P	P
S3c	P-	P	P-	P-	P-	I	P-
S4	P	P	I	P	P-	P	I

Prêt

Where:
P: Strong preference
P-: Delay
I: "Indifference" (equivalent scenarios)

In the above table the results are presented in pairs, for example horizontal line / Scenario S3b, vertical column / Scenario S1b, gives effect P, ie strong preference scenario S3b compared with Scenario S1b. Obviously, the diagonal of the tables shows the value I, since the diagonal each scenario compared with 'himself'.

3.10.9 Recommended System For East Region's Waste Management

Considering all the elements which have been presented in various chapters of this study namely:

- Requirements of the European and National Legislation regarding waste management and the achievement of targets for prevention and reduction of waste production and recycling in all scenarios
- The characteristics of the treatment and disposal methods
- The detailed presentation and design of projects and alternative management scenarios
- The financial details of alternative management scenarios
- Benchmarking and rating of alternative scenarios

The recommended Waste Management System for East Region is Scenario S3b, including:

Scenario 3b	
Collection	✓ Two Bin Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓ MRF
Treatment of Residual Waste Bin	✓ MBS
Treatment of Green Waste	✓ Windrow composting (open composting)
Treatment at the Source	✓ Home Composting
Products	✓ Compost ✓ Recyclables
Landfill	✓ Residues from MRF Facility and Biostabilization of Residual Waste Bin

The proposed scenario is perfectly applicable, workable and complete in terms of technological options and proposals. The processes included, result in a rational and environmentally sound waste management and the production of high-quality products (recyclables, compost, etc.). These features give it an advantage and promote it as first choice. Regarding the scenario's economic characteristics, the investment cost could be considered high due to the completeness of the proposed technological options, but it is advantageous in terms of operating costs.

As a second option seems to be scenario S2 which includes:

Scenario 2	
Collection	✓ Two Bins Collection System (Mixed Waste Bin and Organic Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Mixed Bin	✓ MRF
Treatment of Organic Waste Bin	✓ Aerobic Composting
Treatment of Green Waste	✓ Aerobic Composting
Products	✓ Compost ✓ Recyclables ✓ RDF
Landfill	✓ Residual from MRF Facility and Aerobic Composting Treatment

This scenario is applicable and complete in terms of technological options and proposals. The processes result, as in scenario 3b, in a rational and environmentally sound waste management. However, those processes produce lesser-quality products and have higher operational cost, despite the fact that they have lower investment cost in relation to S3b. Therefore, scenario S2 is ranked as the second option.

As a third option seems to be scenario (S1a) which includes:

Scenario 1a	
Collection	✓ One Bin Collection System ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Mixed Bin	✓ Aerobic Composting
Treatment of Green Waste	✓ Aerobic Composting
Treatment at source	✓ Home Composting
Products	✓ Compost ✓ CLO ✓ Recyclables ✓ RDF
Landfill	✓ Residual from mechanical separation and composting

3.11 PROPOSED SCENARIO AND ACTION PLAN

3.11.1Synopsis of proposed scenario

The proposed Waste Management System for East Region is Scenario S3b, including:

Scenario 3b	
Collection	✓ Two Bin Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓ Green Points ✓ Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓ MRF
Treatment of Residual Waste Bin	✓ MBS
Treatment of Green Waste	✓ Windrow composting (open composting)
Treatment at the Source	✓ Home Composting
Products	✓ Compost ✓ Recyclables
Landfill	✓ Residues from MRF Facility and Biostabilization of Residual Waste Bin

The proposed scenario is perfectly applicable, workable and complete in terms of technological options and proposals. The processes included, result in a rational and environmentally sound waste management and the production of high-quality products (recyclables, compost, etc.). These features give it an advantage and promote it as first choice. Regarding the scenario's economic characteristics, the investment cost could be considered high due to the completeness of the proposed technological options, but it is advantageous in terms of operating costs.

3.11.2 Types and cost estimation

3.11.2.1 Investment costs

The investment costs for the waste treamtnent and disposal plants of of the recommended scenario 3b are presented below.

Table 3-132: Investment Cost

	Quantities	Unit Cost (€/t) & (€/m2) for landfill	Total Cost (€)	Total Cost (MKD)
MRF plant (t/y)	9.011	100	901.100	55.447.116
MBS plant (t/y)	35.761	120	4.291.320	264.056.506
Landfill (residues) (m2)	66.301	90	5.967.084	367.170.791
Infrastructure works	-	-	500.000	30.766.350
Transfer Station	1	500.000	500.000	30.766.350
Total Cost for waste treatment-disposal plants (i)	-	-	**12.159.504**	**748.207.113**

(ii) Organic Waste and Green Waste -Aerobic Composting

	Quantities (t/y)	Unit Cost (€/t)	Total Cost (€)	Total Cost (MKD)
Biological Treatment for Organic and Green Waste (t/y)	3.494	80	279.520	17.199.620
Total Cost of Aerobic Composting for Green Waste (ii)	**-**	**-**	**279.520**	**17.199.620**

(iii) Collection equipment

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Total Cost (MKD)
Collection equipment / mixed waste (1,1m^{3}bins)	211	220	46.420	2.856.348
Collection equipment / mixed waste (waste collection vechiles)	9	110.000	990.000	60.917.373
Collection equipment / home composting (0,2m3bins)	4.100	50	205.000	12.614.204
Collection equipment for Green Waste (trucks)	7	75.000	525.000	32.304.668
Collection equipment for Recyclables (0,12m^{3}bins)	5.961	20	119.220	7.335.928
Collection equipment for Recyclables (1,1m^{3}bins)	1.208	160	193.280	11.893.040
Total Cost of Collection equipment (iii)			**2.078.920**	**127.921.561**

(iv) Green Points

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Total Cost (MKD)
Green Points	9	80.000	720.000	44.303.544
Total Cost of Green Points (iv)			**720.000**	**44.303.544**

Total Cost of Scenario 3b East (i+ii+iii+iv)	**-**	**-**	**15.237.944**	**937.631.838**

(v) Intangible components

	Quantities (no)	Unit Cost (€/no)	Total Cost (€)	Total Cost (MKD)
TA & Supervision during implementation	-	1.500.000	1.500.000	92.299.050
Publicity	-	100.000	100.000	6.153.270
Public Utilities Works	-	300.000	300.000	18.459.810

Total Cost of Intangible components (v)			**1.900.000**	**116.912.130**

(vi) Acquisition of land				
	Quantities (m2)	Unit Cost (€m2)	Total Cost (€)	Total Cost (MKD)
Acquisition of land	106.301	4	425.204	26.163.934
Total Cost of Acquisition of land (vi)			**425.204**	**26.163.934**

Grand Total Cost of Scenario 3b/ East (i+ii+iii+iv+v+vi)	-	-	**17.563.148**	**1.080.707.902**

3.11.2.2 Operating and maintenance costs

The cost of operation and maintenance concerns the full costs to operate all plants the components of the integrated waste management system, namely the mechanical sorting (MRF), MBS plant, windrow composting, landfill, infrastructure, waste collection & transportation and waste transfer station. Within each waste component, the operating cost of the project is divided into two categories: fixed cost (remains constant throughout the analysis period) and variable costs (dependent on the amount of waste and changes during the reference period) to allow for a better view of diversification and growth rates.

Fixed costs: The fixed costs include labor costs, maintenance, administrative costs, insurance and environmental monitoring. The staff for each section of the project is estimated as follows:

Table 3-133: Total staff

CATEGORY	€ / y	MRF plant	MBS plant	WINDROW COMPOSTING	LANDFILL	INFRASTRUCTURE WORKS
SPECIALTY		**ESTIMATED PERSONNEL - NUMBER**				
Unskilled Workers	2.356	10	1	1	1	1
Skilled Workers	3.250	3	3	1	3	-
Engineers / Chemists / Supervisors	4.063	1	1	-	-	-

General administrative expenses are calculated as a percentage of labor costs, i.e. as 20% of labor costs.

The annual maintenance costs for all facilities are calculated based on a certain percentage of the investment cost, which is assumed to be 4% for the Mechanical sorting unit, MBS and Windrow Composting. The maintenance costs are considered 1.5% and 1% of the total investment costs for landfills and for infrastructure respectively.

Variable costs vary depending on the waste quantities (t) i.e. fuel cost and energy.

Table 3-134: Fuel and energy

Type	Fuel l / ton waste	Energy kWh / ton of waste
MRF plant	3	30
MBS plant	3	10
Landfill	2	5
Windrow Composting	2	5

The following table is a summary of the operating costs of the project:.

Table 3-135: Operating cost summary

1. MECHANICAL SORTING PLANT		
LABOUR		Unit cost
CATEGORY	NO	EURO/y
WORKER UNSKILLED	10	2.356
WORKER SKILLED	3	3.250
ENGINEERS/ CHEMISTS/ SUPERVISORS	1	4.063
MAINTENANCE	36.044	EURO/YEAR
MONITORING	25.000	EURO/YEAR
ENERGY	30,00	KWh/t @ 0.07 EUR
FUEL	3,00	l/t @ 1.12 EUR
INSURANCE	6.308	EURO/YEAR
ADMINISTRATIVE COST	7.476	EURO/YEAR
Calculation of annual costs in Euro in 2018		
Cost category (fixed/variable)		**EURO/year**
Labour (fixed)		37.378
Maintenance (fixed)		36.044
Energy for … t/year sorted waste (variable)	8.414	17.148
= EU per t	2,04	
Fuel for … t/year sorted waste (variable)	8.414	28.306
= EU per t	3,36	
Administrative cost (fixed)		7.476
Monitoring (fixed)		25.000
Aftercare/insurance (fixed)		6.308
Total:		**157.660**
Total EU per t:		**18,7**

2.MBS PLANT (AEROBIC)		
LABOUR		Unit cost
CATEGORY	NO	EURO/y
WORKER UNSKILLED	1	2.356
WORKER SKILLED	3	3.250
ENGINEERS/ CHEMISTS/ SUPERVISORS	1	4.063
MAINTENANCE	171.653	EURO/YEAR
MONITORING	15.000	EURO/YEAR
ENERGY	10,00	KWh/t @ 0.07 EUR
FUEL	3,00	l/t @ 1.12 EUR
INSURANCE	30.039	EURO/YEAR
ADMINISTRATIVE COST	3.234	EURO/YEAR
Calculation of annual costs in Euro in 2018		
Cost category (fixed/variable)		**EURO/year**
Labour (fixed)		16.170
Maintenance (fixed)		171.653
Energy for … t/year compoted waste (variable)	33.380	22.675
= EU per t	0,68	
Fuel for … t/year composted waste (variable)	33.380	112.292
= EU per t	3,36	
Administrative cost (fixed)		3.234
Monitoring (fixed)		15.000
Aftercare/insurance (fixed)		30.039
Total:		**371.064**
Total EU per t:		**11,1**

3. WINDROW COMPOSTING		
LABOUR		Unit cost
CATEGORY	NO	EURO/y
WORKER UNSKILLED	1	2.356
WORKER SKILLED	1	3.250
ENGINEERS/ CHEMISTS/ SUPERVISORS		4.063
MAINTENANCE	11.181	EURO/YEAR
MONITORING	5.000	EURO/YEAR
ENERGY	5,00	KWh/t @ 0.07 EUR
FUEL	2,00	l/t @ 1.12 EUR
INSURANCE	1.957	EURO/YEAR
ADMINISTRATIVE COST	1.121	EURO/YEAR
Calculation of annual costs in Euro in 2018		
Cost category (fixed/variable)		**EURO/year**
Labour (fixed)		5.607
Maintenance (fixed)		11.181
Energy for … t/year composted waste (variable)	3.262	1.108
= EU per t	0,34	
Fuel for … t/year composted waste (variable)	3.262	7.315
= EU per t	2,24	
Administrative cost (fixed)		1.121
Monitoring (fixed)		5.000
Aftercare/insurance (fixed)		1.957
Total:		**33.289**
Total EU per t:		**10,2**

4. LANDFILL		
LABOUR		Unit cost
CATEGORY	NO	EURO/y
WORKER UNSKILLED	1	2.356
WORKER SKILLED	3	3.250
ENGINEERS/ CHEMISTS/ SUPERVISORS		4.063
MAINTENANCE	89.506	EURO/YEAR
MONITORING	20.000	EURO/YEAR
ENERGY	5,00	KWh/t @ 0.07 EUR
FUEL	5,00	l/t @ 1.12 EUR
INSURANCE	29.835	EURO/YEAR
ADMINISTRATIVE COST	2.421	EURO/YEAR
Calculation of annual costs in Euro in 2018		
Cost category (fixed/variable)		**EU/year**
Labour (fixed)		12.107
Maintenance (fixed)		89.506
Energy for … t/year landfilled waste (variable)	29.340	9.965
= EU per t	0,34	
Fuel for … t/year landfilled waste (variable)	29.340	164.501
= EU per t	5,61	
Administrative cost (fixed)		2.421
Monitoring (fixed)		20.000
Aftercare/insurance (fixed)		29.835
Total:		**328.337**
Total EU per t:		**11,2**

5. INFRASTRUCTURE WORKS		
LABOUR		Unit cost
CATEGORY	NO	EURO/y
WORKER UNSKILLED	1	2.356
WORKER SKILLED	0	3.250
ENGINEERS/ CHEMISTS/ SUPERVISORS	0	4.063
MAINTENANCE	5.000	EURO/YEAR
	1,0%	
ENERGY	80.000	KWh/t @ 0.07 EUR
FUEL	5.000	l/t @ 1.12 EUR
CHEMICALS	5.000	EURO/YEAR
ADMINISTRATIVE COST	471	EURO/YEAR
Calculation of annual costs in Euro in 2018		
Cost category (fixed/variable)		**EU/year**
Labour (fixed)		2.356
Maintenance (fixed)		5.000
Energy (fixed)		5.435
Fuel (fixed)		5.607
Administrative cost (fixed)		471
Chemicals (fixed)		5.000
Aftercare/insurance (fixed)		5.000
Total:		**28.869**
Total EU per t:		**0,9**

3.11.2.3 Revenues

The total annual revenues from the sale of project products during the 25 years of operation is estimated as follows.

Analytical calculations are given in Annex V of the current study.

Table 3-136: Revenues of recommended scenario

Year	TOTALS REVENUES (€/year)	TOTALS REVENUES (MKD/year)
2018	732.864	45.095.129
2019	738.911	45.467.180
2020	745.014	45.842.702
2021	751.173	46.221.730
2022	757.391	46.604.299
2023	763.666	46.990.446
2024	770.000	47.380.205
2025	776.394	47.773.613
2026	782.847	48.170.707
2027	785.453	48.331.071
2028	788.075	48.492.390
2029	790.712	48.654.669
2030	793.365	48.817.915
2031	796.034	48.982.133
2032	798.719	49.147.328
2033	801.420	49.313.506
2034	804.136	49.480.673
2035	806.869	49.648.835
2036	809.618	49.817.996
2037	812.384	49.988.164
2038	815.166	50.159.344
2039	817.964	50.331.542
2040	820.779	50.504.764
2041	823.611	50.679.015
2042	826.460	50.854.303

3.11.2.4 Operating Cost

The total annual operating cost from the sale of project products during the 25 years of operation is estimated as follows.

Analytical calculations are given in Annex V of the current study.

Table 3-137: Operating cost of the recommended scenario

Year	TOTALS OPEX (€/year)	TOTALS OPEX (MKD/year)
2018	2.542.672	156.457.490
2019	2.559.064	157.466.105
2020	2.575.608	158.484.129
2021	2.592.307	159.511.658
2022	2.609.162	160.548.788
2023	2.626.175	161.595.614
2024	2.643.346	162.652.234
2025	2.660.679	163.718.747
2026	2.678.174	164.795.252
2027	2.685.239	165.229.992
2028	2.692.346	165.667.321
2029	2.699.496	166.107.254
2030	2.706.688	166.549.807
2031	2.713.923	166.994.994
2032	2.721.201	167.442.831
2033	2.728.522	167.893.333
2034	2.735.887	168.346.516
2035	2.743.296	168.802.395
2036	2.750.749	169.260.986
2037	2.758.246	169.722.304
2038	2.765.787	170.186.366
2039	2.773.374	170.653.187
2040	2.781.006	171.122.784
2041	2.788.683	171.595.172
2042	2.796.405	172.070.368

3.11.2.5 Projections of cash flow

The cash flows of the project are presented below:

all values in constant EUR

Year	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035	2040	2041	2042
Calculation of DPC (total)														
Total civil construction	0	0	0	3.203.635	3.059.635	0	0	0	0	0	0	0	0	0
Total plant & machinery	0	0	0	3.735.877	5.238.797	0	0	0	0	0	0	0	0	0
Total contingencies (during implementation)	0	0	0	693.951	829.843	0	0	0	0	0	0	0	0	0
Total intangible components (during implementation)	0	0	0	1.175.204	1.150.000	0	0	0	0	0	0	0	0	0
Total inv. & reinvest. Costs + residual value	**0**	**0**	**0**	**8.808.667**	**10.278.275**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
PV of investment cost @ 5% p.a.	**20.267.587**													
Operation costs														
Operating costs - collection (mixed waste)	0	0	0	0	0	1.270.542	1.281.024	1.291.604	1.346.007	1.375.430	1.398.841	1.422.956	1.427.866	1.432.805
Operating costs - collection (green waste)	0	0	0	0	0	255.393	257.500	259.627	270.562	276.477	281.182	286.030	287.017	288.010
Operating costs - Mechanical Sorting	0	0	0	0	0	157.660	158.035	158.414	160.360	161.412	162.250	163.113	163.288	163.465
Operating costs - MBS Plant	0	0	0	0	0	371.064	372.177	373.301	379.080	382.206	384.693	387.254	387.776	388.301
Operating costs - Aerobic Composting	0	0	0	0	0	33.289	33.358	33.428	33.789	33.984	34.139	34.299	34.332	34.364
Operating costs - Infrastructure	0	0	0	0	0	28.869	28.869	28.869	28.869	28.869	28.869	28.869	28.869	28.869
Operating costs - landfilling	0	0	0	0	0	328.337	329.776	331.229	338.700	342.740	345.955	349.266	349.940	350.618
Operating costs - Transfer Station	0	0	0	0	0	97.520	98.324	99.136	103.312	105.570	107.367	109.218	109.595	109.974
Total operating costs, in EUR	**0**	**0**	**0**	**0**	**0**	**2.542.672**	**2.559.064**	**2.575.608**	**2.660.679**	**2.706.688**	**2.743.296**	**2.781.006**	**2.788.683**	**2.796.405**
PV of operating cost & 5% p.a.	**30.933.170**													
Total revenues from sales of recyclables and other	**0**	**0**	**0**	**0**	**0**	**732.864**	**738.911**	**745.014**	**776.394**	**793.365**	**806.869**	**820.779**	**823.611**	**826.460**
PV of revenues @ 5% p.a.	**9.032.731**													
Total all costs, in EUR	**0**	**0**	**0**	**8.808.667**	**10.278.275**	**1.809.808**	**1.820.153**	**1.830.595**	**1.884.285**	**1.913.322**	**1.936.427**	**1.960.226**	**1.965.072**	**1.969.946**
PV of all costs @ 5% p.a.	**42.168.026**													
Waste collected, in tons	**0**	**0**	**0**	**0**	**0**	**47.213**	**47.602**	**47.995**	**50.015**	**51.360**	**52.232**	**53.130**	**53.313**	**53.497**
Discounted residual waste collected @ 5% p.a.	**583.346**													
Dynamic Prime Cost Investment @ 5% p.a., EUR/t	35	2.138												
Dynamic Prime Cost Operation @ 5% p.a., EUR/t	53	3.263												
Dynamic Prime Cost Net Operation @ 5% p.a., EUR/t	38	2.310												
Dynamic Prime Cost Total @ 5% p.a., EUR/t	72	4.448	in MK											
Total revenues from tarrifs of economic units	**0**	**0**	**0**	**0**	**0**	**722.614**	**728.576**	**734.593**	**765.534**	**782.269**	**795.583**	**809.299**	**812.091**	**814.900**
PV of revenues @ 5% p.a.	**8.906.390**													
	0	**0**	**0**	**0**	**0**	**1.087.194**	**1.091.577**	**1.096.001**	**1.118.750**	**1.131.054**	**1.140.843**	**1.150.927**	**1.152.980**	**1.155.045**
Waste collected from HH, in tons	**0**	**0**	**0**	**0**	**0**	**37.606**	**37.916**	**38.229**	**39.840**	**40.710**	**41.403**	**42.117**	**42.263**	**42.409**
Tarrif for residential user per year, EUR/t						29	29	29	28	28	28	27	27	27

3.11.2.6 Possible sources of funding

The main possible financial sources will be the following:

- European Union contribution (under IPA)
- National Investment Plan
- Local Contribution or
- Loans from EIB

The amount of the European Contribution will be determined in the Cost Benefit Analysis.

At this stage, taking into account the affordability, the funding gap will be 100%.For co-financing rate of the priority axis equals to 85% of the community contribution and concerns only 85% of the eligible cost. The rest of the costs will be covered from:

- National Investment Plan
- Local Contribution or
- Loans from EIB

3.11.2.7 Tariff Plan

The Polluter Pays Principle (PPP) is one of the principles of Community environmental policy and applies throughout the European Union. According to Art. 14§1 of Directive 2008/98/EC on waste, the costs of waste management shall be borne by the original waste producer or by the current or previous waste holders.

The simplest way to implement PPP is to introduce a full cost recovery waste tariff, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system. However, according to the “Guidance on the methodology for carrying out Cost-Benefit Analysis” Working Document No. 4, when the affordability of tariffs is considered, stakeholder may artificially cap the level of charges to avoid a disproportionate financing burden for the users, thus ensuring that the service or good is affordable also for the most disadvantaged groups. The minimum requirement is that tariffs should at least cover operating and maintenance costs as well as a significant part of the assets’ depreciation. An adequate tariff structure should attempt to maximise the project’s revenues before public subsidies, while taking affordability into account.

Taking into account the aforementioned for the present project, the tariffs to the users of the project are proposed to be as follows:

iii. The tariffs for commercial activities are considered from the first year of operation to be equal to the Dynamic Unit Cost 72€/t (4.448 MKD/t).
iv. The tariffs for households are taken so as to cover the net operating costs of the project 29€/t (1.779MKD/t)

The proposed tariffs for households are given in Annex V – Financial Analysis.

According to the statistical data, the average annual income per household in the country for 2012 is 328.444 MKD. As data for income in the region is not provided, an average annual income per household for the East Region is estimated, considering GDP per capita in East region. GDP per capita for the East Region is 93% of the average country GDP. Based on this assumption, the average annual income per household for East Region is calculated at 305.460MKD (4.964,07 €) and the lowest decile income is calculated at 64.666,62MKD/y (1.050,93€/y).
The value of affordability as % of the average annual income for the 1st year is equal to 0,35% and as % of the lowest decile income is for the 1st year is equal to 1.66%.

It can be argued that calculation of affordability ratio shall be based on average household income, rather than to the average household income of the lowest decile. Indeed, the former gives more representative results for waste management investments. For part of the population (pensioners, farmers, etc) that live on the poverty limits, even the current waste tariffs that practically cover collection service only, are not bearable. For these people, will pose an additional burden. It has to be seriously considered that the municipalities grant exemptions or subsidies to the more vulnerable group of citizens, at the expense of having a modernized waste management that covers the sanitation standards of EU, yet being affordable to the majority of population.

3.11.3 Proposed Action Plan

3.11.3.1 Brief Overview

As mentioned in previous chapters, Article 4 of the revised EU Waste Framework Directive sets out 5 steps for dealing with waste, ranked according to environmental impact - the 'waste hierarchy'. Driving waste management up the waste hierarchy is central to the development of sustainable waste management and the ambition of a Zero Waste society.The waste hierarchy gives top priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal.

The following measures and waste management options deliver the best overall environmental outcome. The proposed scenario is based on national objectives and targets and recent national waste management legislation. The minimum requirements set by the national waste management legislation for packaging and packaging waste are covered. Also, the set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills are achieved.

Table 3-138: Inter-relation in waste management hierarchy and actions-measures / waste management options connected/linked with the Scenario 3b

Stages	Actions-Measures taken
Prevention:	**Definition:** using less material in design and manufacture, keeping products for longer, re-use, using less hazardous materials **Proposed actions:** ✓ Waste prevention awareness activities (targeted to households, as well as specific target groups, i.e. businesses, municipalities, hospitals, etc). ✓ Funding and implementation of re-use based projects and services in the municipalities of the Region. ✓ Support and enable community and voluntary sector, i.e. food banks, feed the poor initiatives, etc. ✓ Preparation and elaboration of various waste prevention guidelines ✓ Research and development ✓ Food waste prevention, reduction of paper use, reduction of glass containers
Preparing for re-use:	**Definition:** checking, cleaning, repairing, refurbishing, whole items or spare parts **Proposed actions**: ✓ Promote remanufacture and repair (public awareness campaigns, etc.). ✓ Presentation of good practice (benefits) and training of the targeted groups. ✓ Promotion and establishment of remanufacture/repair/reuse centers.
Recycling:	**Definition**: turning waste into a new substance or product, includes composting if it meets quality protocols (The products of the measure are compost and recyclables) **Proposed actions:** ✓ Implementation of two- bin collection system (recyclable waste bin and residual waste bin) and subsequent treatment of the contents of the recyclable waste bin in a Material Recovery Facility (MRF). • Biostabilisation of residual waste bin (MBS) • Separate Collection of green waste and windrow composting of the separately collected green waste ✓ Home composting (20% of rural population) Strengthening of the public and private waste management sector in the Region to introduce and practice two-bin collection system (training, preparation of guides, technical equipment-hardware and software etc). ✓ Public awareness (focused to the main target groups) for practicing of two-bin collection system. ✓ Public awareness campaigns, transfer of knowledge, presentation of good practice and preparation of practical guides. ✓ Construction and operation of Green points
Other recovery:	**Definition:** includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste, some backfilling **Proposed actions:**

Stages	Actions-Measures taken
	Waste management options that fall under the category of „Other recovery", as specified in the Waste Framework Directive, were not proposed.
Disposal:	**Definition:** landfill and incineration without energy recovery **Proposed actions:** ✓ Landfilling of residues from MRF and Mechanical Biological Stabilisation of residual waste bins (MBS). ✓ Identification of the location for the Regional landfill. ✓ Providing technical documentation and consent for building.

The proposed measures for each stage of the waste hierarchy are presented analytically in the following paragraphs.

The following table presents an overview of the relevant targets and the timeframe for their achievement.

Table 3-139: Overview of qualitative waste management targets

Scenario 3b/East Region	% Collection 2018		% Collection 2020		% Collection 2027	% Collection 2042
Green Points	100% of WEEE fraction 100% of Hazardous material fraction 30% of C&D material fraction 3% of recyclable materials fraction Total collection: 1.59% of generated waste	811 t/y	The same as 2018		The same as 2018	The same as 2018
Sorting at source of recyclable waste	22.78% of recyclable waste 6.44% of generated waste	3,284 t/y	65.36% of recyclable waste 18.46% of generated waste	9,415 t/y	The same as 2020	The same as 2020
Green Waste	40% of green waste fraction 6.85% of generated waste	3,494 t/y	The same as 2018		The same as 2018	The same as 2018
Home Composting	Served the 20% of rural population (7% of total population) 7% of Green waste +Biodegredable waste+Wood 3.77% of generated waste	1,923 t/y	The same as 2018		The same as 2018	The same as 2018
Packaging waste Mechanical Treatment of MRF	19.90% of packaging waste 4.26% of generated waste	2,173 t/y	53.44% of packaging waste 11.44% of generated waste	5,834 t/y	The same as 2020	The same as 2020

3.11.3.2 Stage 1 – Waste Prevention

In order to progress towards a zero waste economy, actions and measures have been set to:

- making it easier for people and businesses to find out how to reduce their waste, to use products for longer and enable reuse of items by others,
- help businesses recognise and act upon potential savings through better resource efficiency and preventing waste, to realise opportunities for growth; and
- support action by local government, businesses and civil society
- decouple waste generation from economic growth.

When establishing measures and actions in the Regional Waste Management Plan, it is important to take into consideration the capabilities of the local authorities and understand that there are limitations. This is very important, taking into account the absence of a National Waste Prevention Program, which would direct, enhance, support and fund these measures and actions.

There are inherent difficulties at taking measures in the market and the production of consumer goods only at a regional level. Furthermore, the action would have an impact on free competition and would distort the market.

Moreover, there are a number of areas where there is lack of experience or where initiatives have not been implemented even in more central areas, like the city of Skopje. As a consequence, tools and working methods are not developed yet.

The goals are unquantified. The extent to which waste reduction is actually attributable to waste prevention efforts must also be considered. A decrease in waste production may be linked to numerous structural or economic factors. For example, fluctuations in the economy have a significant impact on construction waste volumes. Similar considerations also apply to other statistical time series in the waste management sector. By defining unquantified waste prevention goals, we can retain a high degree of flexibility with our choice of waste prevention tools. The aim must always be to develop and implement those waste prevention measures which promise the greatest success, based on an ex ante view of the reduction of environmental impacts[56].

<u>Horizontal Measures</u>

Horizontal measure 1. Waste prevention awareness activities in the Region

Drawing public attention to waste prevention is a fundamental first step in stimulating behavioural change. Recycling has been readily adopted as a daily habit, and is accompanied by a feel-good factor associated with doing something green. Waste preventing actions are in fact much more environmentally beneficial, but often not as obvious[57]. There are a number of barriers to waste prevention for household waste, which impact on both the householders' values, as well as time and convenience. Additionally, waste prevention is a very personal behaviour, as it is driven by deeply held beliefs and attitudes rather than social norms[58]. These barriers should be taken into consideration when considering actions needed to engage the public in waste prevention initiatives

[56] http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/abfallvermeidung_en_bf.pdf
[57] http://ec.europa.eu/environment/waste/prevention/guidelines.htm
[58] WRAP (2009). Introduction to behavioural change

An example of waste prevention awareness activity targeted mainly at households can be the organization of eco-week by the municipalities, where various waste prevention related events can be organized, in collaboration with non-governmental organisations. Also, award schemes and competitions can be organized, where areas within a municipality or business groups can compete based on a rage of environmental aspects. A waste prevention web platform can be establisded, where households, businesses and other target groups can acquire or exchange information.
The promotion of waste prevention awareness campaigns in schools can be proved effective, together with the adaptation of awards schemes.

Horizontal measure 2. Funding and implementation of re-use based projects and services in the Region

Bulky items and WEEE selectively collected could be fit to be reused directly or following preparation for re-use. Due to their high prevention protential, it is necessary to facilitate the reutilization of those items through web-platforms for exchange and donate items. Also, the items could be donated via the municipal social services and NGOs.

Example of an online reuse service which was initiated at a regional level (Dublin Region in Ireland) is FreeTrade.ie, which was funded by the Authorities and delivered real results with over 8,300 items reused in 2009. Due to the success of the service it has been expanded to a national platform in July 2010[59], through http://www.freetradeireland.ie/, with Local Authorities across the country now promoting the FreeTrade Ireland Service. The online initiative encourages the reuse of unwanted items by facilitating the free advertising of items for members. The on-line platform was funded by "Be-green", the EPA's National Waste Prevention Program.
The following picture presents a snapsot of the website.

59 http://www.sdcc.ie/sites/default/files/dublin-waste-plan-annual-progress-report-2010.pdf

Horizontal measure 3. Support and enable community and voluntary sector, i.e. food banks, feed the poor initiatives.

Principally, foodbanks provide instantaneous support to people in crisis, helping people meet immediate need. A wide range of organisations, statutory and voluntary, can refer people to foodbanks, and they are located on a very local basis, within community locations and settings, such as community centres and places of worship, helping to make access as easy as possible. Indicative example of existing food bank in FYR of Macedonia is "Food for all"[60] , founded in 2011 in Skopje, associate member of the European Federation of Food Banks. Examples of food banks and NGOs in Greece, is the non-profit organization "BOROUME- WE CAN – SAVING FOOD – SAVING LIVES"[61], which aims to coordinate the collection of food from catering companies, corporations, hotels, bakeries, grocery stores, bakeries etc. and distribute it to a network of 450 institutes throughout Greece. Also, "Food Bank – Institute for fighting against hunger"[62], supports 215 institutes and 27,000 people. It was founded in 1995. The idea of the Food Bank was developed by John Van Hengel in 1967 in Phoenix, Arizona (USA). The idea spread to America as well as Europe. The Greek "Food Bank" is a charitable, non-profit institution (private legal entity) and is dedicated to the fight against hunger and reducing wastage.

The measure can be expanded to other products, such as medicines, clothes, etc.

Horizontal measure 4. Elaboration of various waste prevention guidelines.

Sector specific guidelines can be produced for various waste streams (i.e. guides to improve environmental performance in businesses, for running green meetings and events, for saving food waste at home or catering businesses, for waste prevention in farming, etc.). Examples of guides and toolkits for various occasions, elaborated by local authorities can be found on the website of the Local Authority Prevention Network (LAPN). It is is a cooperative programme between the Environmental Protection Agency's National Waste Prevention Programme and local authorities in Ireland. LAPN aims to build capacity in local authorities for promoting waste prevention at a local level for the benefit of their regions[63].

Horizontal measure 5. Research and development

After the construction and one-year operation of the proposed waste management system, the consumption and waste generation pattern in each municipality will be clear. Research and development studies on specific aspects of waste prevention at municipal and regional level can be elaborated.

<u>Specific measures</u>

Food waste prevention

A significant part of food waste could be avoided by simply using good practices when shopping, preparing and storing food, making households a major source of prevention of organic matter. At domestic level, the prevention of food waste can be addressed first of all by raising public awareness of the quantities of usable food discarded, the financial losses this represents, and the environmental impact of collecting and treating this waste. Constructive information on waste prevention techniques can help households better plan their food purchases, keep food supplies fresher for longer periods, make better use of leftovers and can make a noticeable difference to

[60] http://www.bankazahrana.org
[61] http://www.boroume.gr/
[62] http://www.traptrof.gr/
[63] http://localprevention.ie/

household expenses. The Love Food Hate Waste Campaign (www.lovefoodhatewaste.com) in UK, selected as a best practice in the prevention of biodegradable waste, can be taken as a model here of the range of guidance that can be provided. Effective awareness campaigns on the prevention of food waste will integrate waste preventing habits into individual behaviour so that actions at home, in the workplace and at leisure are consistent. Good practices are often linked to specific situations and are often abandoned when they become less convenient[64].

Actions which can be taken:

- Promote responsible food purchasing and consumption
- Set-up or improve existing circuits to take advantage of surplus foodstuffs.

These actions can be coordinated with the respective horizontal measures.

Reduction of paper use

It is proposed to reduce the amount of paper fraction generated by reducing consumption, in particular in offices and, in the Municipalities and various facilities. At the same time, the reuse of textbooks and other books will be promoted together with the prevention of waste from general advertising as these also cause a visible impact with regard to the amounts generated and its municipal management and cleaning.

Actions which can be taken:

- Promotion of reduction in paper consumption and dematerialization of the information using ICT (Information and Communication Technologies), through waste prevention awareness activities targeted at the Local Authorities, businesses, offices, households, etc. An example is the No Junk Mail sign produced by Limerick Kerry Clare Regional Waste Management Office in Ireland for households and offices[65]. Objectives may be the number of households that opt not to receive unaddressed mail or that attach a 'No junk mail' sticker to their post box,

- Promotion of re-use of books. Book exchange points can be set up
- Prevent unnecessary advertising.

Reduction of glass containers

- Promotion of re-usable glass containers in hospitality, restaurants and catering sector,
- Promotion of re-utilisation of cava bottles

3.11.3.3 Stage 2 – Preparing for re-use

Measures can be taken to promote remanufacture and repair activities, such as:

- **Public awareness campaigns to promote repair activities, together with**
- **Promotion of repair/re-use centres establishment.**

The quantity of bulky items, WEEE and textiles in municipal waste can be reduced and the reutilization and prolongation of their useful life can be promoted by means of preparing them for

[64] http://ec.europa.eu/environment/waste/prevention/guidelines.htm
[65] http://www.repository.localprevention.ie/sites/default/files/sticker_pauline_sample_2.pdf

reutilisation, the creation of municipal repair facilities for citizens and the promotion of economic activities related with the restoration of such items.
Representatives from repair/reuse center could also be present in the green points or the repair centers could be established within the green points. Citizens may bring items, especially WEEE but also furniture and textiles, normally because they are not functioning or torn, but also because they do not want it anymore or they have replaced it with a newer one. The condition of these items is afterwards checked, being fully reusable, needing slight or significant repair, or needing disposal. In the latter case, some spare parts may be in working condition. The citizens may collect the electrical appliance after repair. If it is unwanted or for furniture/ textiles, the reuse centers function as second-hand shops.

The idea is to develop and offer repair, reuse and recycling initiatives of materials in one central hub. Reuse and repair centres already exist in more than 10 EU Member States, as independent facilities or in regional or national networks. They provide a crucial service by extending the life of a wide range of consumer products and have significant potential in diverting consumer waste from landfill. Often they are operated by social integration enterprises working with disadvantaged groups such as the long-term unemployed, who are trained in technical repair skills, thus also serving a social function. Organised networks of repair and reuse centres can play an integral role in local waste management systems run by public authorities, whether they are operated on a local, regional or national level.
Effective promotion of reuse and repair is strengthened by the provision of early access to the waste streams for reuse centres, as well as appropriate handling and storage conditions. This is part of 'preparing for reuse' in the waste hierarchy and supports the overall aims of waste prevention.
Networks of reuse centres exist at national level in France (3 national networks), the Netherlands (1 national network), Spain (1 national network), Austria (1 national network), Ireland (Ballymun Regeneration Ltd (BRL) was set up by Dublin City Council in 1997) and the UK (7 national or regional networks), at regional level in Belgium (2 regional networks), Finland, Germany and British Columbia, with strong examples at local level in Strasbourg, Vienna, Frankfurt, Bilbao, Bristol, Dublin, Brussels and Rome[66]. Indicative factsheets can be found at the following links: http://ec.europa.eu/environment/waste/prevention/pdf/Kringloop%20Reuse%20Centres_Factsheet.pdf , http://www.prewaste.eu/index.php?option=com_k2&view=item&id=272&Itemid=101
An example of a social enterprise is presented in the following box.

Box: Oxfordshire County Council – Bicester Green reuse centre
Working in partnership with Sobell House Hospice Charity, Cherwell District Council, Oxfordshire Waste Partnership, Resource Futures, Sanctuary Housing and Grassroots Bicester (a local community group) Oxfordshire County Council set up a new social enterprise, Bicester Green. Bicester Green is a centre for 'skills, sustainability and second-hand stuff'. Opening in 2013, Bicester Green aimed to divert waste from landfill. The centre also brings together volunteers from across the community to provide them with practical work experience and the opportunity to learn new skills as well as functioning as a sustainability hub for the area, hosting events and meetings. During its first six months of operation, 1.3 tonnes of furniture, nearly a tonne of bikes and more than 300kg of electrical items were prevented from becoming waste.[67]

[66] http://ec.europa.eu/environment/waste/prevention/guidelines.htm
[67] http://www.local.gov.uk/documents/10180/5854661/LGA+Routes+to+Reuse+FINAL+FINAL.PDF/5edd19ba-7c13-47c5-b019-97a352846863

3.11.3.4 Stage 3 – Recyling

The Regional Waste Management Plan sets out a number of measures in order to boost recycling. Source separation is a critical precondition for generating high-quality secondary raw material from waste and to facilitate re-use of material. The separation of specific fractions of municipal waste at the source provides for best results in recycling certain materials.

A change in waste collection has been proposed in order to move waste further up the waste hierarchy, through a two- bin collection system (recyclable waste bin and residual waste bin).

Furthermore, the proposed Material Recovery Facility (MRF), which sorts waste into different material streams which are then sent to reprocessors, will provide high quality recyclates, as the contens of the recyclable waste bin will be treated.

The windrow composting of green waste is a viable option, due to the significant share of the organics within municipal waste.

Finally, the Green points will receive separated waste streams, which are suitable for recycling or for further suitable management. Apart from recyclables, a range of waste can be delivered such as batteries, electrical goods, bulky waste, C&D waste. The following fractions will be collected: 100% of WEEE fraction, 100% of Hazardous material fraction, 30% of C&D material fraction and 3% of recyclable materials fraction.

3.11.3.5 Stage 4 – Other Recovery

Waste management options that fall under the category of „Other recovery”, as specified in the Waste Framework Directive, were not proposed.

3.11.3.6 Stage 5 – Disposal

Whilst landfill is the least preferred management option, the waste management technologies leave residual waste which needs to be landfilled.

This stage should be examined in combination with the next paragraph, which presents the measures for the diversion of biodegradable waste from landfill. Biostabilisation extents the life of the landfill. Also, the landfill taxes are key drivers to divert waste from landfill.

The overall landfill will be developed in 3 cells – phases, separated normally by embankments. The life-time of first cell will be 7 to 8 years, whereas the total lifetime of landfill is 20-30 years.

3.11.3.7 Measures for Diversion of Biodegradable Waste from Landfill

The promotion of home composting, the separate collection of green waste and the Mechanical Biological Stabilisation (MBS) of the residual waste bin are the proposed measures for diversion of biodegradable waste from landfills.

Home composting will be applied to 20% of rural population and that corresponds to 7% of green waste, biodegradable waste and wood.

Regarding separate collection of green waste, 40% of green waste fraction will be collected. Collected green waste will be directed to windrow composting.

3.11.3.8 Measures for Increase of Packaging Waste Collection and Treatment Rate

As mentioned in Stage 3 – Recycling, the increase of packaging waste collection rate will be achieved through a two- bin collection system (recyclable waste bin and residual waste bin).

Furthermore, the proposed Material Recovery Facilities (MRFs), which sort waste into different material streams which are then sent to reprocessors will provide high quality recyclates, as the contens of the recyclable waste bin will be treated.

3.11.3.9 Proposed Action Plan

Action plan for project implementation

Having set the regional targets and objectives as well as the measures via which these targets will be achieved in the previous paragraphs, an action plan for the proposed interventions is prepared. This plan focuses on the priority measures and the respective main infrastructure investments, but it also gives an indication of all future activities (reinvestment or other activities) that will need to be implemented.

The set of measures for implementation of the plan are:

1. Priority measures for a period of up to three years
2. Short-term measures for a period of up to five years
3. Medium-term measures for a period of six to ten years
4. Long-term measures for a period longer than ten years.

The content of short-term measures addresses the most pressing weaknesses in the existing waste management system, and the need to build a foundation for the future waste management system in the region.

The Action Plan includes sufficient data on whose grounds the level of required investment and reinvestment during different periods, together with estimates of the necessary operating costs can be determined.

The Action Plan may be divided into the following periods:

1. Priority measures for a period of up to three years (2015-2017)

- **1st period 2015 – 2016:** The maturation of the priority projects will take place and the raising of public awareness will commence.
- **2nd period 2017 – 2018:** Supply of the main collection equipment i.e. collection vehicles and bins. Initation of construction of priority infrastructures (landfill for residues-cell A, Material Recovery Facility, Green Points, Transfer station, MBS plant), continuation of raising of public awareness through campaigns.

2. Short-term measures for a period of up to five years (-2019)

Completion of construction of priority infrastructures (landfill for residues-cell A, Material Recovery Facility, Green Points, Transfer station, MBS plant). Review of the Regional Waste Management Plan, implementation of any required additional investments, which may be pending or determined in the revised RWMP, closure and rehabilitation of the non conforming landfills and dumpsites. The remediation procedure will be applied according to the remediation plan, i.e. very high-risk landfills and dumpsites are first priority and the remediation of existing high-risk and medium risk landfills and illegal dumpsites will follow. Public awareness campaigns on waste management and waste prevention. Implementation of bundle of measures for waste prevention.

3. Medium-term measures for a period of six to ten years (2020-2024)

Review of the Regional Waste Management Plan. Constuction of second landfill cell for residues.

4. Long-term measures for a period longer than ten years (-2042).
Substitution of old waste collection, transportation and treatment equipment, review of RWMP, implementation of any required additional investments (according to revised RWMP). Construction of third landfill cell for residues.

The Action Plan clearly defines the actions, duration and responsibility for implementation, along with the costs of the measures to be implemented. It includes clear and measurable stages for each of task and measure set, presented in tabular form. The following table summarises the necessary actions, which should be taken.

Table 3-140: Action plan for the period 2015 – 2042 – East Region

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
1.	**Priority measures for a period of up to three years (2015-2017)**				
1.1	Maturation of the priority projects (Feasibility Studies, CBA, EIA, environmental permits, application for funding, approval, tendering and contracting)	2015 - 2016	MoEPP, Inter-municipal Board for Waste Management	1,300,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.2	Supply of collection equipment - recyclables, mixed waste, green waste, home composting	2016-2017	Inter-municipal Board for Waste Management	2,078,920	Cost will be reconsidered during the feasibility study and cost benefit analysis.
1.3	Technical assistance & supervision during implementation	2017-2018	Inter-municipal Board for Waste Management	1,500,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.4	Construction of integrated waste management infrastructure (Material Recycling Facility for recyclables, biostabilization plant for residuals, landfill cell A for residues, transfer station, green points)	2017-2018	Inter-municipal Board for Waste Management, with Municipalities	13,584,228 (Land acquisition – 425,204)	Cost will be reconsidered during the feasibility study and cost benefit analysis.
2.	**Short-term measures for a period of up to five years (-2019)**				
1.3	Technical assistance & supervision during implementation	2017-2018	Inter-municipal Board for Waste Management	1,500,000	Delays might occur during the approval phase. Duration depends on the tendering procedure, which may be delayed by objections, etc
1.4	Construction of integrated waste management infrastructure (Material Recycling Facility for recyclables, biostabilization plant for residuals, landfill cell A for residues, transfer station, green points)	2017-2018	Inter-municipal Board for Waste Management, with Municipalities	13,584,228 (Land acquisition – 425,204)	Cost will be reconsidered during the feasibility study and cost benefit analysis.
2.1	Raising of public awareness campaigns on waste management and common campaigns on waste prevention and waste management	2015-2019	MoEPP and Inter-municipal Board for Waste Management	170,000	Promoting an information, awareness-raising and motivation system for the public and all relevant stakeholders. The cost depends on the

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
					strategy and means of the public awareness campaign.
2.2	Implementation of bundle of waste prevention measures, including sector specific awareness campaigns that are not included in 2.1	2015 - 2019	MoEPP and Inter-municipal Board for Waste Management		The cost depends on the strategy applied at municipal or regional level and the means of the awareness campaign
2.3	Promotion of establishment of repair / reuse centres and public awareness activities to promote repair/remanufacture	2018-2019	MoEPP and Inter-municipal Board for Waste Management		The cost depends on various elements, i.e. the ownership of the repair/reuse centers (public/private) or the strategy applied at municipal or regional level and the means of the awareness campaign
2.4	Review of the Regional Waste Management Plan	Every two years	MoEPP and Inter-municipal Board for Waste Management	N/A	
2.5	Remediation of existing very high-risk landfills and dumpsites	2017-2018	MoEPPInter-municipal Board for Waste Management	2,810,560	Depends on approval of application or funding. The closure of the landfill is closely connected to the starting of operation of the transfer station and central landfill. Cost will be reconsidered during the feasibility study and cost benefit analysis.
2.6	Remediation of existing high-risk landfills and dumpsites	2018-2019	MoEPP and Inter-municipal Board for Waste Management	270,760	Cost will be reconsidered during the detailed design study.
2.7	Remediation of existing medium-risk landfills and dumpsites	2018-2019	MoEPP and Inter-municipal Board for Waste Management	162,240	Cost will be reconsidered during the detailed design study.
3.	**Medium-term measures for a period of six to ten years (2020-2024)**				
3.1	Review of the Regional Waste Management Plan	Every two years	MoEPP and Inter-municipal Board for Waste Management	N/A	Implementation of any add\itionally required measures according to the review of the RWMP
3.2	Construction of landfill cell B in for residues	2024	MoEPP and Inter-municipal Board for Waste Management	TBA	Cost will be reconsidered during the feasibility study and cost benefit analysis.
4.	**Long-term measures for a period longer than ten years (-2042)**				
4.1	Reinvestment - substitution of collection equipment and transfer station	2027	Inter-municipal Board for Waste Management	2,126,352 (collection equipment), 400,000 (transfer station)	Cost will be reconsidered during the detailed design study.
4.2	Reinvestment - substitution of treatment equipment (plant and machinery)	2031	Inter-municipal Board for Waste Management	4,143,828	Cost will be reconsidered during the detailed design study.

A/A	Action	Timescale	Organization responsible	Relevant indicative cost (Euro)	Possible obstacles/Comments
4.3	Reinvestment - substitution of collection equipment and transfer station	2036	Inter-municipal Board for Waste Management	2,126,352 (collection equipment), 400,000 (transfer station)	Cost will be reconsidered during the detailed design study.
4.4	Construction of landfill cell C for residues	2032	MoEPP and Inter-municipal Board for Waste Management	TBA	Cost will be reconsidered during the feasibility study and cost benefit analysis.

3.11.4 Project implementation plan

3.11.4.1 Principal procurement options and procedures

The various procurement procedures, allowing for a different degree of competition as showing below:

a. **Open public tender** - takes place in a single stage and any interested party may submit a bid;

b. **Restricted public tender** - consists of two stages, and only the bidders selected by the contracting authority at the first stage will be invited to submit bids at the second stage;

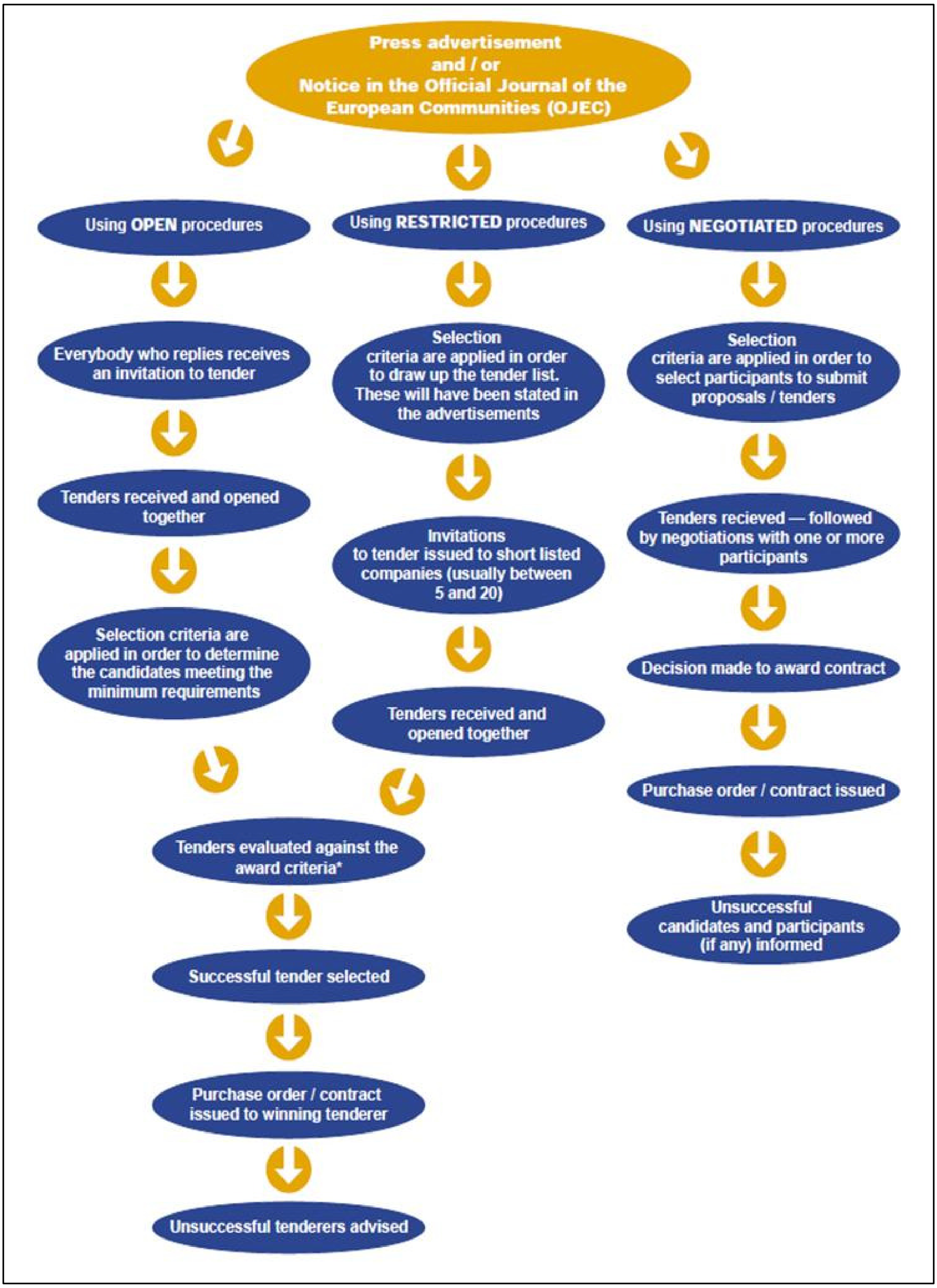
c. **Competitive dialogue** - any interested party may submit a bid. The contracting authority may have a competitive dialogue only with the accepted candidates. Only the candidates selected by the contracting authority are invited to submit a final offer;

d. **Negotiation** – the contracting authority discusses and negotiates the contractual clauses, including the price, with the selected candidates from amongst suppliers, contractors and providers. The contracting authority may, or may not publish a notice for invitation to negotiations;

e. **Offer request** – a simplified procedure according to which the contracting authority requests offers from several suppliers, contractors, and providers, and;

f. **Competition for the award of a project** – it allows the contracting authority to retain a project that was selected by a jury on a competitive basis, especially in the territorial planning, urban and zoning areas.

Figure 3-112: The Guide to tendering



3.11.4.2 Procurement steps

The appropriate set of steps in indicative procurement sequence for a waste management scheme, which sets out the milestones within the procurement process, is presented below:

⇨ **SPECIFICATIONS**

Requirements must be specified, avoiding brand names and other references, which would have the effect of favouring or eliminating particular providers, products or services. The Regulations now make it clear that authorities may use performance specifications rather than technical specifications. They also provide clarification on the scope to reflect environmental issues in specifications.

⇨ **SELECTION**

Rejection or selection of candidates based on:

- Evidence that they are not unsuitable on certain grounds, e.g. of bankruptcy, criminal conviction or failure to pay taxes. Certain offences now require, in normal circumstances, a mandatory exclusion;
- Economic and financial standing e.g. that they are judged to be financially sound on the basis of their annual accounts;
- Technical capacity, e.g. that they will be adequately equipped to do the job and that their track record is satisfactory.

⇨ **AWARD**

The award of contracts is either on the basis of 'lowest price' or various criteria for determining which offer is 'the most economically advantageous' to the purchaser. This is in keeping with the Government's Procurement Policy that all public procurement must be based on Value for Money (defined as the optimum combination of whole-life cost and quality to meet the user's requirement).

3.11.4.3 Selection of procurement procedure

The rules for applying the standard EU procurement procedures are summarised in the table below. They are divided between those for services (i.e. technical assistance, studies, provision of know-how and training), supplies (i.e., equipment and materials) and works (i.e. infrastructure and other engineering works). For the contracts that will be finaced by national or local funds, national procurement rules will be applied.

The thresholds given in the table are based on the maximum budget for the contract in question (including any co-financing). Where contracts are subdivided in lots, the value of each lot shall be taken into account when calculating the overall threshold.

Regardless of the procedure used, the Contracting Authority must ensure that all the basic principles are respected (including eligibility, exclusion and selection criteria). Note that projects must not be split artificially to circumvent the procurement thresholds. Other procedures can be applied regardless the thresholds, for instance, negotiated procedures as long as the relevant conditions are met.

Table 3-141: EU Procurement thresholds

<table>
<tr><td>SERVICE CONTRACTS</td><td>≥ € 300 000
International restricted tender procedure</td><td colspan="2">< € 300 000 but > € 20 000
- Framework contracts
or
- Competitive negotiated procedure</td><td rowspan="3">≤ € 20 000
Single tender

For service and supply contracts, a payment may be made against invoice without prior acceptance of a tender if the expenditure is ≤ EUR 2 500</td></tr>
<tr><td>SUPPLY CONTRACTS</td><td>≥ € 300 000
International open tender procedure</td><td>< € 300 000 but ≥ € 100 000
- Local open tender procedure
or
- Frame work contract</td><td><€ 100 000 but > € 20 000
- Competitive negotiated procedure
or
- Frame work contract</td></tr>
<tr><td>WORKS CONTRACTS</td><td>≥ € 5 000 000
- International open tender procedure
or
- International restricted tender procedure</td><td>< € 5 000 000 but ≥ € 300 000
Local open tender procedure</td><td>< € 300 000 but> € 20 000
Competitive negotiated procedure</td></tr>
</table>

3.11.4.4 Tender dossier (TORs and technical specifications)

The purpose of Terms of Reference (for service contracts) and Technical Specifications (for supply and works contracts) is to give instructions and guidance to contractors at the tendering stage about the nature of the project they will need to submit and offer for, and to serve as the contractor's mandate during project implementation. The Terms of Reference or Technical Specifications will be included in the Tender Dossier and will become an annex of the eventual contract awarded as a result of the tender.

The thorough preparation of the Terms of Reference or Technical Specifications is extremely important for the ultimate success of the project. It is important to ensure that the project has been properly conceived, that the work is carried out on schedule and that resources will not be wasted. Therefore greater effort during project preparation will save time and money in the later stages of the project cycle.

In particular, the budget for the standard service contract incorporates a fixed provision for incidental expenditure (for all, actual expenses not related to fees) as well as a provision for expenditure verification to be both determined in the tender dossier. Those provisions must correspond to the requirements of the Terms of Reference and must be carefully estimated. The Terms of Reference, Technical specifications and budget must afford equal access for candidates and tenderers and not have the effect of creating unjustified obstacles to competitive tendering.

Once the Tender Dossiers have been finalised the tender procedure should be launched. The Terms of Reference or Technical Specifications contained in a tender dossier – the basis for the

project work-plan - must reflect the situation at the time of project start-up so as to avoid considerable effort having to be spent re-designing the project during the inception period.
The contracting authority shall be under the obligation to send the intent notice for publication as soon as possible after the beginning date of the budget year; or a contracting authority shall be under the obligation to send an intent notice for publication as soon as possible after the approval of the program in which the works contract or framework agreement is being stipulated.
An intent notice shall be published:

- in the Official Journal of the European Union, in the ESPP (Electronic System for Public Procurement) and in the Official Gazette of Serbia, or;
- in the ESPP only, provided a simplified notice of prior information has been sent to the European Commission before its publication.

The publication of an intent notice shall not result in an obligation to make such public procurement.
The exact procurement plan and the relative timeplan for its implementation has to be identified in more detail, during Feasibility study stage and application for co-financing.

3.12 LIST OF INDICATORS

3.12.1Performance indicators

Waste management encompasses many issues that must be taken into account towards the establishment of a sustainable society. Performance indicators are the heart of a performance monitoring system, because they define the data to be collected to measure progress and enable actual results achieved over time to be compared with planned results. Thus, they are an indispensable management tool for making performance-based decisions about programmes strategies and activities. The main goal of the performance indicators is to measure the performance of the regional integrated solid waste system and help define and evaluate how successful the action plan is, in terms of making progress towards its long-term goals, covering all aspects of solid waste management, such as compliance with EU legislation, waste generation, recycling infrastructure, efficiency in relation to landfill targets, energy recovery and environmental awareness[68].

Waste generation and prevention

The amount of waste produced per unit of GDP/ GVA (kg/ €)

The correlation of waste generation and its relation to Gross Domestic Product (GDP) is one of the major issues concerning the waste management sector. In a general way, per capita waste generation is strongly correlated with income and social development but also affected by waste awareness and education; thus areas which concentrate more wealth tend to generate more waste per person. This indicator shows the quantity of waste per unit of income (€), and on a second basis, whether there has been any decoupling of waste generation from economic growth. GPD is usually expressed at market prices.

Number of environmental awareness raising events and percentage of population reached - surveys on knowledge about different aspects of waste and waste prevention

The number of the environmental awareness raising events is useful information, but it should be combined with population data in order to form an effective indicator. The percentage of the population targeted with the campaigns launched provides an insight on the campaign scale, but not on its intensity.

For Re-use: number and turnover of reuse organisations, number of sold second hand products

[68] BALKWASTE (2010). Action 7: *Study Regarding the Development of Indicators. Waste Network for sustainable solid waste management planning and promotion of integrated decision tools in the Balkan Region. LIFE07 ENV/RO/000686* [pdf]. Retrieved from http://www.balkwaste.eu/?page_id=90

Collection and transport

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste collection system).

Table 3-142: Performance indicators for collection and transport

	Indicator	Unit
1.	Percent of population connected to collection services in total and in urban, rural areas	%
2.	Percent of population connected to separate collection services (green waste, recyclables, WEEE, organic, etc.) in total and in urban, rural areas	%
3.	Total collected municipal waste	T / year
4.	Separately collected green waste	T / year
5.	Separately collected commercial waste	T / year
6.	Separately collected recyclable waste	T / year
7.	Provided container volume for waste collection	m^3 / inh x year
8.	No and volume of containers for mixed waste collection	m^3
9.	No of and volume of containers for separate waste collection	m^3
10.	No and capacity of collection vehicles	No and m^3
11.	No and capacity of press containers	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Recycling/recovery

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system and particularly the waste recycling/recovery of packaging waste. The recycling rate is the percentage of recyclables that are collected and recycled divided by the total amount of recyclables that are generated. This is an indicator that can be used at regional and national level. The target for the recycling/recovery of packaging waste is a national target, which is apportioned to the Region.

Table 3-143: Performance indicators for waste recycling/recovery

	Indicator	Unit
1.	Total population in human settlements concerned	capita*1000
2.	Recycling rate for paper	% and t/ year
3.	Recycling rate for plastic	% and t/ year
4.	Recycling rate for glass	% and t/ year
5.	Recycling rate for metal	% and t/ year
6.	Recycling rate for wood	% and t/ year
7.	No and capacity of sorting plants	No and capacity
8.	Total recycling	% and t/ year
9.	Total recovery	% and t/ year

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Biodegradable fraction

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the treatment of the biodegradable fraction of the waste).

Table 3-144: Performance Indicators for biodegradable waste treatment

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2	Total diversion rate for biodegradable waste not disposed of in landfills	% and t / year
3	Amount of biodegradable waste diverted through home-composting	% and t / year

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Waste disposal - landfill

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste landfilling).

Table 3-145: Performance Indicators for waste landfill

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2	Amount of waste disposed of in compliant landfills	t/year
3	No and capacity of landfills compliant with EU standards	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

The operation of the new regional landfill will facilitate the closing and environmental clearance of the existing non-compliant landfills.

Closing dumpsites

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste landfilling).

Table 3-146: Performance Indicators for closing and remediation of landfills

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2.1	No and volume of remediated urban landfills	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Special waste streams

The proposed indicators for this category are:

- Overall amount of WEEE collected per capita [tn/cap]*
- Amount of WEEE prep. for reuse/recycled [%]*

- Overall amount of construction and demolition waste collected per capita [tn/cap]
- Amount of construction and demolition waste prep. for reuse/recycled [%]
- Overall amount of waste oils collected per capita [tn/cap]*
- Amount of waste oils prepared for reuse/recycled [%]*
- Overall amount of waste batteries collected per capita [tn/cap]*
- Amount of waste batteries prepared for reuse/recycled [%]*
- Overall amount of end of life vehicles collected per capita [tn/cap]*
- Amount of end of life vehicles prepared for reuse/recycled [%]

Cost indicators

The proposed indicators for this category are:

Average cost per MSW collected (€/tn)

This indicator is one of the main indicators used by local authorities in order to monitor their collection costs. Its use for comparing different countries is not accurate since those costs depend mainly on the personnel expenses which significantly vary from country to country.

Average cost per MSW treated (€/tn)

Accordingly to the previous indicator this one is of added value when used within a certain region. When it comes to transnational comparison the different personnel expenses which account to around 50% of the operating costs hinder the effective comparison assessment.

Income spent on waste management per capita (€/cap)

Indeed, the important consideration is the impact the total costs have on waste management tariffs and tariff evolution on citizens. This is especially important because the issue of affordability and willingness to pay is an area that needs to be evaluated carefully to ensure that the main beneficiaries of the solid waste services (private households, businesses, public institutions, etc.) will accept the waste management scheme in place.

Public awareness

The proposed indicators for this category are:

Number of environmental awareness raising events and percentage of population reached

The number of the environmental awareness raising events is useful information, but it should be combined with population data in order to form an effective indicator. The percentage of the population targeted with the campaigns launched provides an insight on the campaign scale, but not on its intensity.

Coverage of the environmental campaigns launched

This indicator provides the average population coverage of the environmental campaigns launched, and can be measured as follows:

$$\text{Population Coverage} = \frac{\sum \text{Number of Campaings}_{1-k} \times \text{Population Coverage}_{1-k}}{\text{Total Number of Campaingns}} \%$$

3.12.2 Sustainability indicators

The sustainability objectives and indicators are shown below.

Objectives of the RWMP	Sustainability indicator
Environmental and Health Objectives (Aim A)	
Sustainable use of land and other resources	Depletion of resources (wood, etc.) Land take
Minimization of greenhouse gas emissions	Emission of greenhouse gas
Minimization of negative impacts on air quality and public health	Dioxin emissions Emissions dangerous for public health Extent of odour problem Extent of dust problem Emissions injurious to public health
Minimization of negative impacts on water quality and water resources	Water pollution (concentrations of various substances) Quantitative and qualitative status of groundwater Eutrophication
Land and cultural heritage conservation	Visual impacts
Socio-Economic Objectives (Aim B)	
Provision of public awareness campaigns, enhancement of public involvement	No of public awareness campaigns and training activities which educate and involve the public
Optimization of waste collection system and minimization of local transport impacts	Ratio between kilometers run and the amount of waste collected
Employment opportunities	Number of job likely to be created

CONTRACTING AUTHORITY

MINISTRY OF FINANCE
CENTRAL FINANCING & CONTRACTING DEPARTMENT

Address: Dame Gruev No.14, 1000 Skopje
website: http://cfcd.finance.gov.mk

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