SOFIA WASTE Phase II
MBT Option Analysis

First Interim Report



06 / 2011

egis International

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List of Acronyms

Acronym	Definition
ABPR	Animal By-product Regulation
6EAP	6^{th} Environmental Action Program of the EU
AD	Anaerobic Digestion
AF	Application form for the ERDF
Application Form (AF)	meaning the filled application form for the application of funds from the EUROPEAN REGIONAL DEVELOPMENT FUND / COHESION FUND
BGN	Bulgarian Lev
BMW	Biodegradable Municipal Waste
C & D waste	Construction and Demolition Waste
CAPEX	Capital Expenditure – includes capital (Depreciation) and costs of financing (interest, fees)
CBA	Cost-Benefit Analysis
CHP	Combined Heat and Power
CW	Commercial Waste, i.e. Municipal waste produced by commercial enterprises
DM	Dry Matter
DUC	Discounted Unit Costs
DWFD	Draft Waste Framework Directive
EC	European Commission
EIB	European Investment Bank
ERDF	European Regional Development Fund
EU	European Union
Feasibility Study (FS)	Meaning "Feasibility Study and Supporting Documents for Project: "Management of Household Waste of Sofia Municipality" for financing by the EU Funds" carried out for SM to prepare the application.
FEL	Front End Loader
FSF09	Feasibility Study 2009
GHG	Green House Gas
GW	Green Waste
HHW	Household Waste, i.e. Municipal waste produced by households
IPP	Integrated Producer Policy
IPPC	Integrated Pollution Prevention and Control
IPWM	Investment Plan for Waste Management
LCA	Life Cycle Assessment
LV	Low Voltage
MBT	Mechanical Biological Treatment, sometimes also called Bio-Mechanical Treatment (BMT)
MSW	Municipal Solid Waste
MW	Municipal Waste
MWM	Municipal Waste Management

MW-system	The is the Sofia MW system comprised of prevention, recycling, composting, treatment and disposal measures for MW generated in Sofia
NPV	Net Present Value
NWMP	National Waste Management Programme
OP Project	Meaning the investment project applied funder the operational program with the application form comprised of an MBT plant and landfill at Sadinata site and a green and a biowaste composting plant at Han Bogrov site.
OPEX	Operation Expenditure – expenditure for staff, consumables, maintenance and repair, including revenues for products, such as recycling materials, RDF and Electricity
PRO	Recovery Organizations, which implement the Producer Responsibility Principle. Organizations are established by the producers or importers of packaged product, WEEE, Vehicles, Oils and Batteries and Accumulators, in order to organize its collection and sorting, as well as achievement of recycling and recovery quotas and quotas for secondary use for some of the waste streams.
Project or "the Project"	This term is not used in our responses, as it may be used for different types of projects and thus it may become confusing.
RDF	Refuse Derived Fuel
RDF PP	Specialized Power Plant for the combustion of RDF
SM	Sofia Municipality
SRF	Solid Recovered Fuel
TOC	Total Organic Carbon
TOR	Terms of Reference for the Project
UK	United Kingdom
US or USA	United States of America
VS	Volatile Solids
WEEE	Waste Electrical and Electronic Equipment
WFD	Waste Framework Directive (Council Directive 75/442/EEC as codified in Directive 2006/12/EC)
WMA	Waste Management Act (Dated 18 September 2003, promulgated in State Gazette 86/2003, last amended SG 63/ 04.08.2006)

List of Reports

Referenced documents in this Document:

Task 3a Report	Market survey – annexed to the Application Form under "Section K: Supporting documentation; item 3".
	This report contains the technology analysis, option identification and option analysis for the complete Sofia MW management system and is part of the project: - "Feasibility Study and Supporting Documents for Project: "Management of Household Waste of Sofia Municipality" for financing by the EU Funds".
Task 7a Report (March 2009)	Final report on Feasibility Study – annexed to the Application Form under "supportir documentation section K item 3". This report summarizes the complete project: - "Fe Study and Supporting Documents for Project: "Management of Household Waste of Municipality" for financing by the EU Funds" -. Task 3a and Task 4 where part of the Study.
SOFIA application (29th April 2011)	Application from correction 29 APRIL 2011 Infrastructure investment Integrated System of Municipal waste Treatment Facilities for Sofia Municipality
COWI	COWI 12 July 2010 Quick appraisal of major project integrated system of municipal waste treatment facilities in Sofia municipality

1 Introduction

The project concerns the establishment of a modern, compliant and integrated municipal waste management system for the city of **Sofia** in Bulgaria. Sofia is the capital city of Bulgaria located in the western part of the country with population of 1.281 million people (source NSI). The current waste generation stands at 480 000 t/y for 2009, results in a unit generation rate of 374 kg/cap/a (equivalent to 1.02 kg/cap/day).

The project shall supplement the measures already implemented by the Sofia municipality, and complete the waste management system of the capital city. The project involves implementation of the following investment measures: construction of landfill for non-hazardous waste on which waste will be landfilled following treatment of the household waste stream in an MBT plant, construction of composting plant for separately collected green waste, as well as construction of treatment plant for separately collected bio-waste and construction of an MBT plant. The project consists of two phases, which are technically dependent; moreover the targets of the integrated system cannot be reached if one of the two phases is not realized.

The implementation of the project started in 2007. The main identified "no-regret" elements of the waste management system subject of realization in 2011 – 2013 (first phase), upon completion of the public procurement procedures are as follows:

- Design and build Contract (FIDIC Yellow Book) for Installations for treatment of green waste and bio-waste (“Han Bogrov”) site
- Construction (FIDIC Red Book) of the non-hazardous waste landfill (“Sadinata”) site.
- Technical supervision.

In addition, with respect to the changed circumstances related to the ownership of Toplofikatsia Sofia, a study will be carried out to assess the viability of using RDF produced in the MBT plant for energy recovery in Toplofikatsia Sofia.

This study will result in completion and submission of an application form for the second phase of the project.

The ToR for this additional study have been prepared by EIB and consulted with Sofia Municipality and the European Commission Services.

The expected results are:

A) Review, on the basis of best available data, the waste stream generated in the City of Sofia

B) Provide an in-depth study of two options that were not included in the original feasibility study, namely:

1) MBT without the production of RDF
2) MBT with the production of RDF to be combusted in the Sofia District Heating Plant.

These two analyses are treated in the 1st interim report, available at the beginning of June 2011.

The Consultant will carry out a comparison between the above MBT solutions. Both of the above options should be elaborated on the basis of the use of the landfill (Sadinata) that is included in the first phase of the project. Investments into combustion facilities in the Sofia District Heating Plant could be considered for co-financing in the framework of a complementary EU investment. These costs are not to be included in the framework of this feasibility study, but account should be taken of a parallel ongoing study of the enhancement of the energy efficiency of the Sofia District Heating Company that will include an option for RDF combustion.

C) Propose, on the basis of the above mentioned analysis, the most suitable option for waste treatment in Sofia.

D) Compare the design and treatment parameters of MBT plant that was included in the original application for funding with a view to determine, in how far this design is compatible with the chosen treatment option.

E) Determine, on the basis of the design and parameter review, in how far the tender of the original MBT plant (launched in 2010) is compatible with the configuration of the MBT in the chosen option. The Consultant shall make pertinent technical recommendations towards achieving better value for money;

These three items (C, D, and E) will be treated in the 2nd interim report, available at the beginning of July 2011

G) Preparation of Application form, CBA and all supporting documents for approval of second phase of the Project.

This item will be developed in the 3rd interim report, available by the end of July.

A completion report will be finalized by the consultant, mid-August, providing:

- A summary of the activities undertaken during the assignment
- A list of the points diverging with the initial objectives
- Potential risks, linked to these diverging points
- Steps recognized to remedy the situation
- Impact for the project (time, money).

2 Project summary- 1st interim report

An update of the waste production, waste composition and waste management by Sofia Municipality including the data regarding the forecast about population and growth rate was made at the beginning of this study. Since the feasibility study was made in 2007 and update in 2009, there was new information available.

For the population, a census was made beginning of 2011, given very new data regarding the population of SM and given new forecasts. The new population beginning of 2011 is 1,359,520 inhabitants, plus 25,000 workers.

The difference between forecast of the Feasibility Study for 2011 and data from 2011 national census amounts to **41,955 people.**

The forecast for 2020 is estimated 1 549 778 inhabitants. Compare to the FS, the difference is about 75,000 inhabitants.

For waste organization and waste production, compare to 2007, SM has implemented new waste organization like home composting, and developed source selective collection.

Based on this new and update information, the volume of 2010 were calculated and totally represents 505 000 t. This figure is closed to the initial forecast of the FS (515,000t), less than 2% difference.

Based on this new data, an update of the forecast has been made with the following assumption for 2021:

- Household waste : 526,000t
- Commercial waste : 122,000t
- Total waste production before recycling, composting and treatment : 648,000t

After assumption for home composting, recycling, and composting of green waste and biowaste, the remaining waste to be proceed in the MBT project are the following:

- Waste forecast in 2021 considered as the year of reference for the MBT project
  - Household waste in MBT plant : 350,000t
  - Commercial waste in MBT plant : 46,000t
- Waste composition: new assumptions were made for the waste composition at the entrance of the MBT project (see page 54). There are some differences with the FS, linked to the update information related to waste collection and recycling.

This new data will be the one used for the study on the MBT technical study.

The main results of this first interim report are as follow:

- The waste amount taken into account at the entrance of the MBT is closed to the FS. Waste composition change quite significantly. The new estimations shows more recyclables and less organics
- Mass Balance of the MBT with RDF production is compatible with the “minimal technical performance” for the MBT plant described in the tender documentation.
- For the option MBT without RDF, the outputs to the landfill increase in an important way, so that the life duration of the landfill is reduced in a significant way.

3 Waste stream generated in the city of Sofia

Two of the main socio-economic determinants of future waste quantity trends will be population and living standards. Regarding quality or composition, municipal waste is of course not homogeneous, but consists of different waste streams of different origin (e.g. households or commercial) or different types of material (e.g. biodegradable or non-biodegradable, packaging materials, etc.). In projecting waste volumes arising in the future, it is necessary to keep track of these different streams, because in the integrated system different waste streams are managed in different ways. Different waste streams may also evolve at different rates.

As mentioned earlier, the development of waste volumes will evolve in response to a number of factors, some acting in different directions. The demographic effect has been taken account of by working with per capita waste generation indices, which are then multiplied by the relevant population.

The income effect also may be taken on board in the projections but here it is required to consider the trend towards a weakening correlation (decoupling) between waste and GDP. Otherwise the approach is to split total waste arising in the base year down according to its constituent main categories - urban household waste (further sub-divided by various sub-components: various types of packaging, biodegradable matter, hazardous household waste, bulky waste, the residual household waste stream), the waste stream from industry, commerce and other institutions which is similar in composition to household waste, park and garden waste, market waste, street waste, etc.

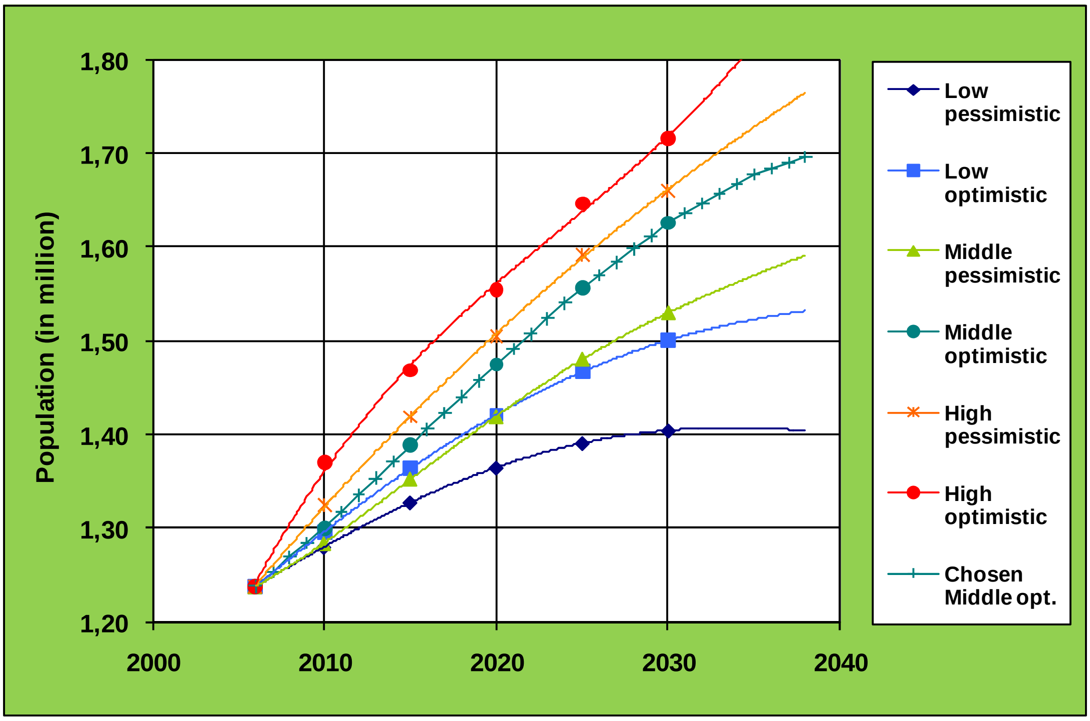
The projections have been established on a yearly basis during the planning period.

3.1 Population update and forecasts

3.1.1 Main data of the FS

For the Feasibility Study (2009) Sofia Municipality made available their population forecast which contained 6 Scenarios (see Figure 1). As reported in the FS a strong growth of population, mainly from movements from the country to Sofia has been observed. The middle optimistic scenario was considered the most likely to happen in the future and thus was chosen for the population development, which will be used in the MW quantity forecast.

Figure 1: Population forecast of Sofia Municipality



Source: Feasibility Study

3.1.2 Updated 2010 /2011 data – comparison with Feasibility Study

3.1.2.1 Data and sources

In February 2011 Bulgarian National Statistical Institute (NSI) carried out nation-wide census (as a part of EU-wide census). According to preliminary outcomes (made available in April 2011) number of permanent residents in Sofia amounts to **1,359,520**. Compared to previous census from 2001 the population has increased by 185,000 resulting in average growth rate of 1.39% per year. The last official statistical data publish on NSI web-page (data for 31.12.2010) is **1,259,446 inhabitants** (7.4% lower than census data).

The demographic data of the National Statistical Institute refers to '**permanent resident population'**. This category includes people, who live permanently (usually) in the country and have not left it officially as of 31.12 of the respective year for a period more than one year[1]. This data does not take into temporary residents in Sofia (seasonal migration).

As presented in the Feasibility Study the population of Sofia in 2006 amounted to **1,253,375**. The forecast within 20 years in the FS are the following:

Table 1: Population forecast of SM in FS

	2006	2011	2015	2020	2025	2030
Population number	1,253,375	1,317,565	1,388,519	1,474,832	1,556,197	1,625,617

Source: Feasibility Study (March 2009)

[1] www.nsi.bg

The difference between forecast of the Feasibility Study for 2011 and data from 2011 national census amounts to **41,955 people**. – **Namely 3% more**

3.1.2.2 Temporary population

The representatives of the municipality report that actual number of people residing in Sofia is higher as it includes migration of people to Sofia (temporary workers, seasonal migration, etc.). According to the study conducted in 2007 by Bulgarian Academy of Science number seasonal migrants in 2006 was 25,000 and daily migrants 45,000.

3.1.3 Forecast

Since the results of the national census are currently the most reliable source of information on Sofia population they serve as the basis for further population forecasts. The forecasts cover the years 2011 to 2035.

This report takes into consideration following information:

- Growth variants (scenarios) prepared by the National Statistical Institute (covering period up to 2060);
- Growth rates presented in the Feasibility Study;
- Number of non-temporary residents (seasonal migration) as estimated in 2007 study of Bulgarian Academy of Science.

The National Statistical Institute prepared three variants (scenarios) for population changes in Bulgaria:

- Variant I (target): The variant is defined as realistic and is prepared according to the EU regulations on the member states demographic and social-economic development.
- Variant II (relative acceleration): The variant suggests that the country demographic development will be accompanied by the favorable social-economic processes.
- Variant III (relative delay): The prognosis on population development is done under the hypothesis for unfavorable social-economic processes in the country[2].

The data available for each variant cover years 2015, 2020, 2025, and 2030, (up to 2060). Average annual growth rate between 2015 and 2025 as resulting from Variant I is app. **0.6%.** The annual growth rate for the same period, applied in the Feasibility Study is app. **1.2%**. For comparison the average annual growth rate between 2001 and 2011 (based on census data) is 1.4%. **The growth rates adopted in this report are the same as the rates adopted in the Feasibility Study.** These rates are close to the ones actually observed between 2001 and 2011 (i.e. continuation of the growth trend similar to the one from past decade is assumed).

The starting year for the forecast is 2011 (number of residents of **1,359,520**).

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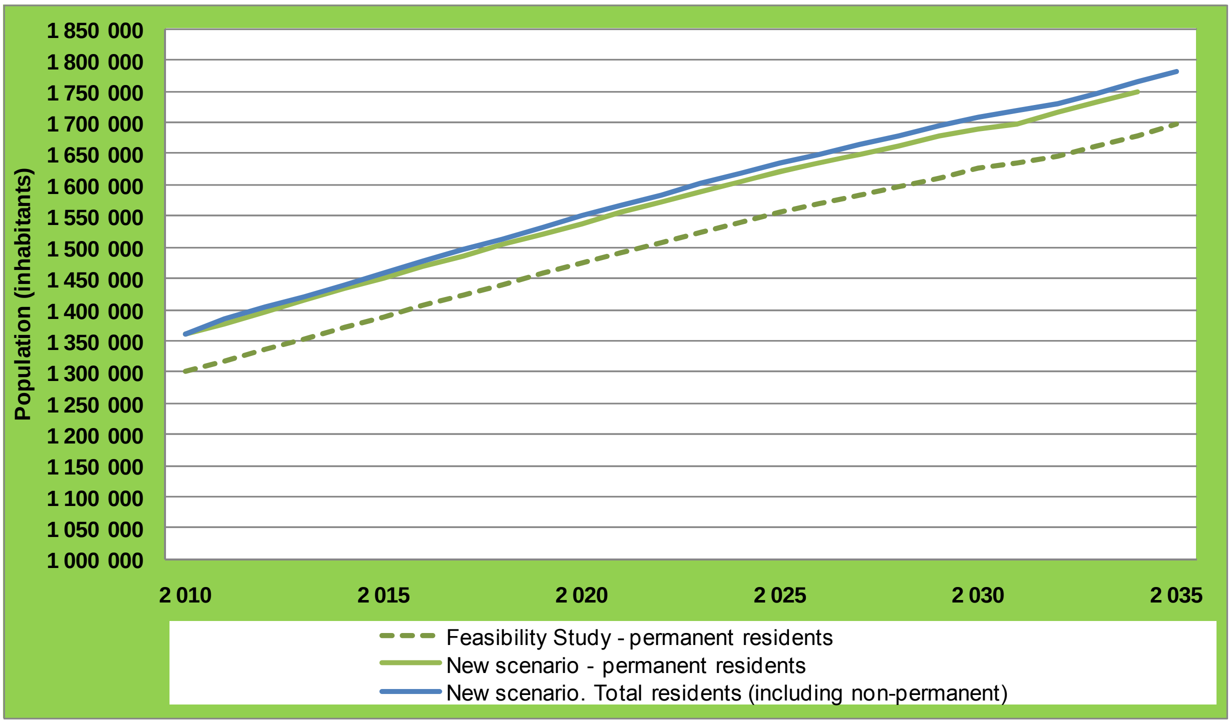
[2] www.nsi.bg

Table 2: New population forecast of SM

	2011	2015	2020	2025	2030	2035
Permanent residents	1 359 520	1 432 733	1 521 794	1 605 750	1 677 381	1 750 235
Non-permanent residents (seasonal migrants)	25 000	26 346	27 984	29 528	30 845	32 185
Total	1 384 520	1 459 079	1 549 778	1 635 278	1 708 226	1 782 419

The difference in population forecasts in the present study and Feasibility Study results from application of the updated information from 2011 census and taking into account temporary residents in Sofia.

Figure 2: Population growth scenarios



3.2 Waste tonnage and composition- update of existing situation

The aim of this chapter is to update the data on waste tonnage and composition produced on Sofia District. Within the FS made in 2008 and updated in 2009, there were a full description of the waste organization within Sofia Municipality and the different waste flows.

The updated information is the following:

3.2.1 Collection

3.2.1.1 Household waste

Current collection of Municipal Waste

Collection of commingled MSW is contracted by Sofia Municipality to private operators. Currently there are seven operators collecting MSW:

1. Consortium “Titan Sofia Centre”
2. Consortium “Titan Sofia Iztok”
3. “A. S. A. Bulgaria ”
4. Consortium “AES –X- BAT PEL”
5. Consortium “AEC –X- PTK”
6. “Strabag Wemvelt services”
7. “Zaubermaher Bulgaria” EAD

The duration of contracts is four years (all the contracts were signed in 2010). Typically in multi residential areas and city center collection is done using 1.1 cubic meter containers placed beside a street. The containers are commonly accessible and are not assigned to specific properties. The collection frequency depends on the location (e.g. daily collection in the city center).

Pilot project for home composting

A pilot project for home composting in 5 regions of Sofia Municipality was successfully completed in 2009. The project resulted in the purchase and delivery of 700 composters, and activators as well as the distribution of informational materials to five new regions of the Municipality. A continuation of the project in six new regions was successfully completed in 2010. It is foreseen a project continuation in 2011, as well.

Separate Collection of Packaging Waste

As a part of the implementation of the updated Waste Management Program of Sofia the project “Development of criteria and requirements (technical, organizational, informational, etc) to be considered in the Sofia Municipality contracts”, was launched with the purpose to establish a permanent dialog and regular meetings between the local authorities and PROs.

New requirements and technical specification for the bay-back centers are under preparation.

The quantity of generated packaging waste on the territory of Sofia Municipality was estimated to be 145,000 t in 2009 and therefore resource recovery is a major element in the solid waste management plan for SM. In accordance to the Packaging and Packaging Waste Directive, which has been reflected in the national legislation, the responsibility for recycling is on producers, implemented through Producer Responsibility Organizations (PROs).

For this purpose, Sofia Municipality has signed agreements with four PROs (Ecopack Bulgaria, Ecobulpack, Repack and Bulecopack) for the separate packaging waste collection and dedicated buy-back centers.

At the current moment 22 out of 24 districts at its territory are covered. Two of all 24 districts (Ovcha Kupel and Kremikovci) are not included yet in the current PRO system. The duration of all four contracts is until 31.12.2011. The criteria used for selection of the organizations were:

- quantity targets;
- number of population covered;
- funds invested in information campaigns (recommended – 1 BGN for inhabitant annually).

Besides that, most of the PROs have invested in sorting plants for further sorting of the collected materials.

Table 3: Details of each PRO operation

Ecopack Bulgaria LC	Serviced Districts*: Krasno Selo; Triadica; Oborishte; Sredec.	Contract until 31/12/2011
Ecobulpack LC	Serviced Districts: Krasna poliana; Vitosha; Serdika Nadejda; Ilinden; Vazrajdane; Bankia; Izgrev; Slatina; Lozenec.	Contract until 31/12/2011 for districts: Serdika Nadejda; Vazrajdane; Izgrev; Slatina; Contract until 8/4/2013 for districts: Krasna poliana; Vitosha; Lozenec; Ilinden
Bulekopack LC	Serviced Districts: Mladost; Liulin; Iskar; Novi Iskar	Contract until 31/12/2011
Repack LC	Serviced Districts: Vrabnica; Studentski; Pancharevo; Poduene.	Contract until 31/12/2011 for districts: Studentski; Pancharevo; Contract until 8/4/2013 for districts: Poduene; Vrabnica.

Table 4: Key contract commitments of the PROs

Population Covered	1,200,921 citizens for 2010
Contract targets	14 kg/cap/yr
Commitments of the PROs	PROs have : ➢ to invest 1 leva/cap/yr in public awareness. ➢ to provide twice weekly transportation of containers for paper, plastic and metals. ➢ to provide twice monthly transportation of glass containers. ➢ to provide at least one separate collection point for each 350 residents. ➢ to keep containers and surrounding area clean. ➢ to provide plastic bags to trade markets free of charge. ➢ to provide separation of the collected wastes in sorting plants. ➢ to send monthly reports to the SM.
SM commitments	➢ to provide location for the separate collection bins. ➢ to provide an appropriate site for the disposal of residual waste. ➢ to create and apply a penalty mechanism to residents and economic units which do not use the separate collection system.

SM is in process of preparation of new contracts for the period 2012 and onwards with the PROs covering the whole territory of Sofia aiming at improving the system with commonly agreed measures.

3.2.1.2 Commercial waste

The Municipal waste management regulation was updated in 2009. Obligation for a separate waste collection is foreseen for the economic operators such as shops, restaurants and offices. As a proof a copy of the contract with PRO will be required.

3.2.1.3 Green waste and biowaste

Green wastes from different sources are already partly collected separately even if the composting plant doesn't exist yet (Han Bogrov project). It gives an overview of the potential of this fraction, and of the capacity of SM to reach the expected volume for Han Bogrov composting future plant. The volume collected in 2009 is 8,000 t and in 2010 is 12,000t.

For home composting, a pilot project started in 2009, and is in progress. It is still difficult to measure the impact on waste production as there is no way to quantify exactly all volumes.

3.2.1.4 Construction and demolition waste and bulky waste

For bulky and inert waste, SM has started a specific collection for these material sent to the facility of Vrajdevna. The volume collected in 2010 is 25,000 t.

3.2.2 Pretreatment/Sorting

3.2.2.1 Household waste and commercial waste

The table below provides information on the separation facilities which were constructed and are into operation on the territory of Sofia Municipality:

Table 5: List of separation facilities within SM (2010)

№	PRO	Facility Operator	Venue	Capacity			
				separated t/h	mixed t/h	t/d	t/yr
1	REPACK LC	Evroimpex Ltd.	Gara Iskar	5		40	10 000
2	ECOPACK LC	Unitrade BG Ltd	Bozhurishte	3,5		28	7 000
3		Evroimpex Ltd.	Gara Iskar	32		254	64 000
4		Unitrade BG Ltd (under construction)	Gara Iskar				64 000
5	ECOBULPACK LC	Ecobulsort JSC	Filipovtsi/ Philipovci	10	25	350	120 000
6		Ecobulsort JSC	Trebich	10	15	160	60 000
7	Municipaly owned	Chistota-ISKAR	Suhodol		25	330	80 000
TOTAL							405 000

The facilities constructed by the PRO's under positions 1 to 4 are only suitable for the waste collected separately.

In 2009, SM started to sort and process Household Waste and Commercial Waste with potential of recyclables and RDF. These materials are processed in plant 5, 6 and 7 both by PRO and by SM.

Table 6: List of private companies for HW sorting with the duration of the contract:

Companies with contracts for separation of mixed municipal waste	Chistota-Iskar	Capacity of sorting facility – 400 t/day	Duration of the contract: until 12/2011
	Ecobulsort LLC	Capacity of sorting facility – 450 t/day	Duration of the contract: until 12/2011

For the sorting plant, including the PRO, the total recyclables volumes for 2010 is 60,382t.

The residual fraction has been estimated to be 12,000 t sent back to SM from the PRO sorting plant. These residues were taken into account in the FS within the overall tonnage but not estimated specifically.

The volume processed for the 3 facilities (5,6 and7) in 2010 is 229,000 t, with on average about 8% recyclables sorted, 11% RDF and 10% fines fraction considered as “inert”. In fact it is mainly organic fraction, including some organic material.

3.2.2.2 Construction and demolition waste and bulky waste

For bulky and inert waste, SM has started a specific collection for these material sent to the facility of Vrajdevna.

SM invested in some equipment in order to process these material and has started to do some separation of inert and RDF fraction. For 2010, within the quantities processed of 25,000 t, 3,000 t of RDF were produced, the remaining being considered as “inert” and sent to local landfill on the same site. In order to have really inert fraction, additional processed will need to be added in order to clean the fines fraction and sort out light material.

On the figure next page, there is a summary of these 4 processing plants (5, 6 and 7 in the figure before + Vrajdevna facility):

Table 7: List of separation facilities for residual waste within SM (2010)

Sorting Plant	Trebich	Philipovci	Suhodol	Vrajdevna
Operator	Ecobulsort (Subsidiary of PRO Ecobulpack)		Chistota Iskar - Municipal company	Sofinvest – Municipal company
Owner	Site/building: SM Equipment: Ecobulpack (in renovation in 05/2011)	Ecobulpack	Sofia Municipality	Site: SM Facility: Sofinvest
Sorted material	Mixed residual waste	• Mixed residual waste • Additional line for glass sorting	Mixed residual waste	Non mineral construction waste and bulky waste
Capacity	160 t/d (60,000 t/a)	350 t/d (120,000 t/a)	330 t/d (80,000 t/a)	60 to 80 t/h
Technology (manual sorting)	Screen for fines fraction Long picking belt Baler for recyclables	Screen for fines (to be installed) Long picking belt Baler for recyclables	Shredder Trommel 2 picking belts Baler for recyclables	Shredder Trommel Short picking belt
Recyclable materials	Plastic and PET Glass Metals Paper/ Cardboard	Plastic and PET Glass Metals Paper/ Cardboard	Plastic and PET Glass Metals Paper/ Cardboard	Plastic Metals Paper/ Cardboard
Generation of RDF	Positive picking of dirty paper and plastic	Positive picking of dirty paper and plastic	Air separator > 80mm after manual picking	Air separator
Quantities generated				
Recycling Low quality RDF	12,000 t/a for 2010 RDF: 20,000 t/a for 2010		6,000 t for 2010 10,000 t/a for 2010	 3,000 t for 2010
Sorting efficiency RDF efficiency	8.7% 11.8%		7.6% 11.3%	 12%
Cost for sorting	37 €/t Revenues for recyclables remain with sorting company			

3.2.3 Final treatment

3.2.3.1 Green waste and biowaste

Green wastes from different sources are already partly collected separately even if the composting plant doesn't exist yet (Han Bogrov project). It gives an overview of the potential of this fraction, and of the capacity of SM to reach the expected volume for Han Bogrov composting future plant. The volume collected in 2009 is 8,000t and in 2010 is 12,000t.

For home composting, a pilot project started in 2009, and is in progress. It is still difficult to measure the impact on waste production as there is no way to quantify exactly all volumes. A estimation of 9,000 t was taken as assumption for 2010.

3.2.3.2 Residual Household and commercial waste

After collection and sorting of different king of material, the results for 2010 for final destination of the different outlets are:

- Recycling: a total tonnage of 60,382t has been sold to recyclers (included metal fraction from HW and CW) without sorting from residual waste. Taken also into account the 18,040 t from residual waste sorting, the overall tonnage is 78,422t for 2010

Table 8: Tonnage of recycled products per year (2007 to 2010)

Annual tonnage (in t)	2007	2008	2009	2010	2010 with residual waste
Paper*	17,000	18,500	22,000	18,000	22,500
Cardboard*	21,067	21,950	23,531	18,020	22,608
Plastics	2,505	4,252	15,065	12,768	18,003
Glass	680	1,170	2,579	3,049	5,984
Metal	10,010	10,049	10,021	8,545	9,327
TOTAL	51,262	55,921	73,196	60,382	78,422
FS FORECAST	51,400	52,750	63,090	76,723	76,723

* estimation between paper and cardboard, the only data available is total fraction

- Energetic valorisation: a total volume 29,154 t has been sent to two cement plants Holcim and Titan in Bulgaria
- Landfilling of inert in Vrajdevna : 25,000t.
- Landfill of "pretreated" and non pretreated waste: Operation of a sanitary landfill (Suhodol) receiving the remaining fraction.

About the Sanitary Landfill at Suhodol: SM operates a sanitary landfill in the district of Suhodol. This landfill was closed during 2006 and 2007 as a result of protests from local population, but is now back in operation as an interim solution until the project is implemented. The landfill had some remaining capacity at the time it was closed, and in October 2009 a new cell was opened on the Suhodol landfill with capacity of 650,000 tonnes. After this, no more cells can be developed on the landfill due to reaching the depth/capacity limits of Suhodol. At the current waste generation rate of Sofia, and measures for improvement of the separate collection and reducing of the volume for disposed waste, this would be sufficient until the middle of 2012.

SM has constructed one separation plant for manual sorting on Suhodol site, to reduce the MSW quantity going to the landfill. Another two private installations are also constructed on the territory of Sofia Municipality and are in operation. The sorting facility at Suhodol landfill will remain in operation after the completion of the current project and will be additionally upgraded and improved within the first phase of the project.

In addition the requirements for the separation services will be introduced – the Terms of Reference of the future contracts are under preparation and the tender will be launched till the end of January 2011. The new contracts are expected to be in force since June 2011. These additional measures together with all listed up to now will allow the Suhodol landfill to be used until the middle of 2012.

3.2.3.3 Global results for recycling

Through these and other measures Sofia Municipality is improving recycling/ recovery rate and increases the rate achieved in 2009 up to 23.6% of the total quantity which is 6.6% above the national targets (17%) for recycling/recovery for 2010 according to the National Waste Management Program (see the table below). For 2010, the rate is 23,1%, not taken into account the green waste separately collected but not yet composted, as Han Bogrov composting facility is not yet open.

Table 9: Comparative analysis between National targets 2010 and results achieved

	National targets for recycling/ recovery for 2010 according to the National Waste Management Program	Total quantity of waste (municipal, commercial) generated by SM	Total quantity of recycled waste (including home composting, packaging, etc.)	Achieved recycling/ recovery rate in SM	Exceeded rate
2009	17% min.	478 871 t	112 869 t	23.6 %	6.6 %
2010	17% min.	505 524 t	116 576 t	23.1 %	6.1 %

3.2.4 Update of waste production 2010 - comparison with FS

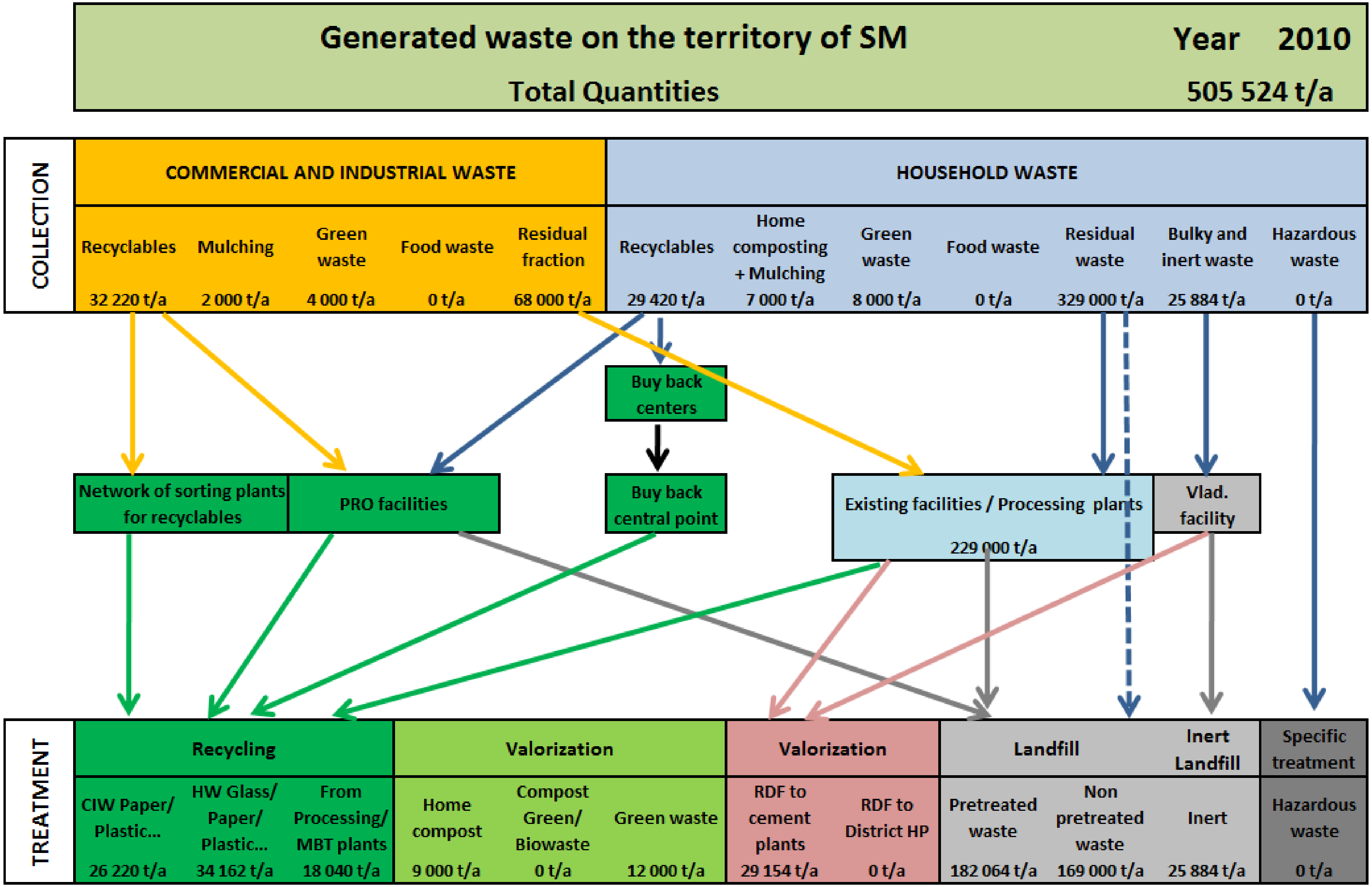
Based on the data given by SM, the tonnage of 2010 can be sum up in the following chart (see next page). **The overall volume of Municipal Solid Waste within Sofia Municipality for 2010 is estimated to be 505.000 t** including recycling, energy valorization and land filling.

In comparison with the FS, these figures are closed to the assumption. It was already the same for 2008 and 2009.

Table 10: Development of SM waste between 2007 and 2010

Tonnage (in t/a)	2007	2008	2009	2010
Home composting and mulching green waste (estimation)			6,000	9,000
Recycling	51,255	59,388	90,269	78,422
RDF	0	3,460	16,600	29,154
Green waste (not processed before having Han Bogrov composting facility)	10,000	14,000	8,000	12,000
MW and CW Baled	67,462			
MW and CW landfilled in Plovdiv and Karlovo	279,973			
Inert waste landfilled in Vrajdevna				25,884
MW and CW landfilled in Suhodol	25,454	392,438	364,002	351,064
Total generated	**434,144**	**469,286**	**478,871**	**505,524**
Forecast in Feasibility Study (including estimates of not collected green, garden wastes, which are burnt)		**489,000**	**503,000**	**515,000**

Figure 3: Waste production within Sofia Municipality (2010)



3.2.5 Waste composition

3.2.5.1 Analysed composition

In the period from September 2007 to May 2008, a MW composition analysis has been carried out by Sofia Municipality. The final report has been submitted to Sofia Municipality in May 2008 and the summary is within the FS. Since that, no update information is available on waste composition.

The next table shows the average composition with for both categories (MW and CW) analyzed as it was carried out during the analysis and the estimation of overall composition of the waste arriving in the landfill. It doesn't take into account the other material like e.g. recyclables. This calculation will be done in the following paragraphs.

Table 11: MW and CW analyzed composition of Sofia Municipality

Waste fractions	MW from households	Commercial waste	Overall
Proportion of waste	82%	18%	100%
Food waste	31,1%	21,1%	29,2%
Paper	9,5%	18,0%	11,1%
Cardboard	7,3%	15,7%	8,9%
Plastics	12,6%	19,2%	13,8%
Textile	3,5%	2,6%	3,3%
Rubber	0,6%	0,5%	0,6%
Leather	0,7%	0,6%	0,7%
Garden green waste	7,4%	0,8%	6,1%
Wood	1,4%	2,3%	1,6%
Glass	8,9%	8,2%	8,8%
Metals	1,6%	2,0%	1,7%
Inert	14,8%	8,4%	13,5%
Hazardous waste	0,6%	0,5%	0,6%

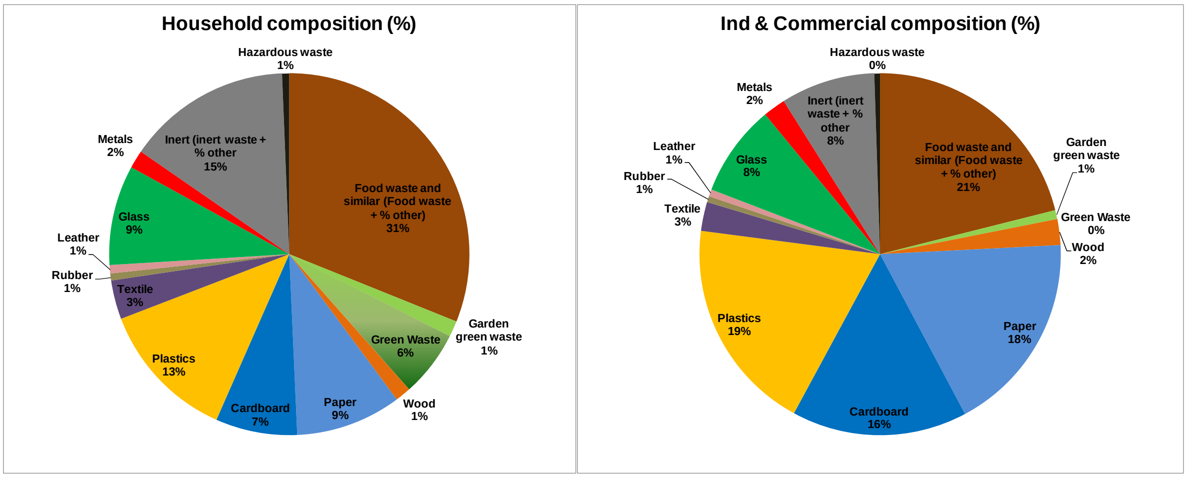
(Source FS different from annex 2 responses to comments of DGReg send by letter)

The figures hereunder shows the composition of both main flows (MW and CW) and the significant difference of composition between MW and CW, with mainly less organic fraction and more packaging within CW.

It is important to see and understand these differences, which have an impact on collection, sorting, processing and final treatment. This was not enough underlined in the FS, and the overall tonnage of household waste and commercial waste was taken into account for final treatment for the MBT plant.

The difference of composition as it is today, and as it will be after implementation of different source selective has an impact of the overall strategy of SM.

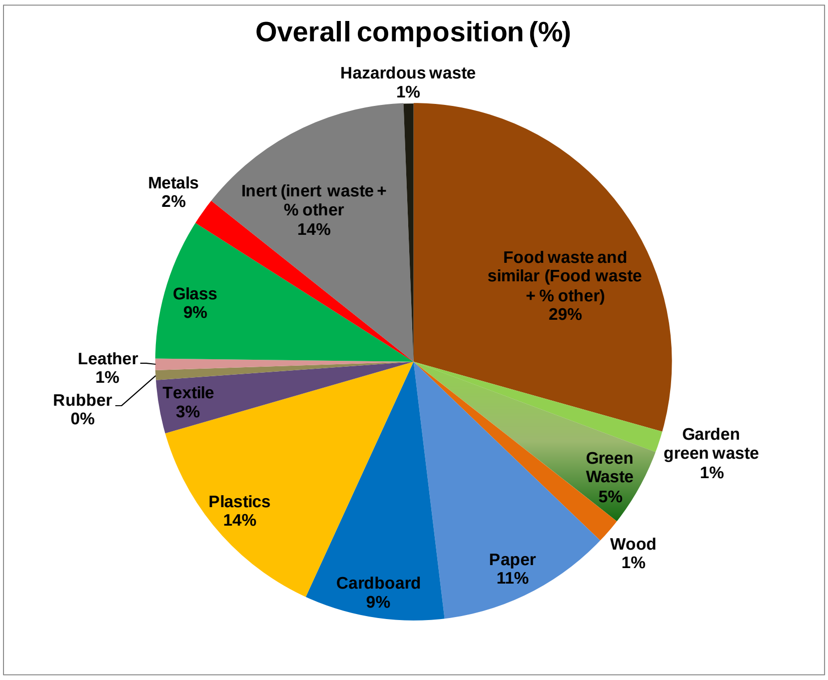
Figure 4: MW and CW analyzed composition of Sofia Municipality (source FS)



These figures show for HW the high percentage of biowaste (food waste and green waste) closed to 40%. For CW this is far lower, and should be underlined that this composition is an average of all CW including restaurant, and industrial parks, where there is a difference of composition (see later on).

Taken into account the tonnage of both flows (MW and CW), the overall composition of waste arriving in the landfill in 2009 are estimated to be:

Figure 5: Overall MW and CW composition landfilled of Sofia Municipality (source FS)



Regarding this overall composition, the percentage of inert material is high compare to usual composition in Western Europe. This point was underlined to SM, and should be taken into account in the overall strategy of collection and treatment.

3.2.5.2 Comment on inert fraction within HW and CW

For this inert fraction, first it should be clarified by SM, what is really the composition of this so called “inert fraction” within HW and CW. Then for the fraction which is really inert, an implementation of a source and separate collection of this material should be done.

It can be via:

- obligation of separate collection for the producers,
- limitation of collection with HW and CW,
- development of civic amenities in order to propose to citizens a way to bring this material when they do repairing at home (some of these civic amenities are scheduled to be closed to the buy-back centers).

This separation of inert fraction should be combined with the separate collection of bulky waste, which can be done within the same way of collection. This was not clearly taken into account in the FS. These bulky and inert wastes are not suitable for the MBT plant.

For inert waste, a separate collection of this material will have the following positive impact:

- Reducing treatment costs by avoiding to have this inert waste in the MBT future plant
- Improving the quality of the different output fraction. Inert should be reduced to the lower level as possible within RDF, compost material and in recyclables.
- Improving the maintenance of the MBT process by avoiding abrasive material which increase the costs of maintenance
- Improving the MBT process and working conditions
- Reducing volume in the MBT process and further in the final treatment

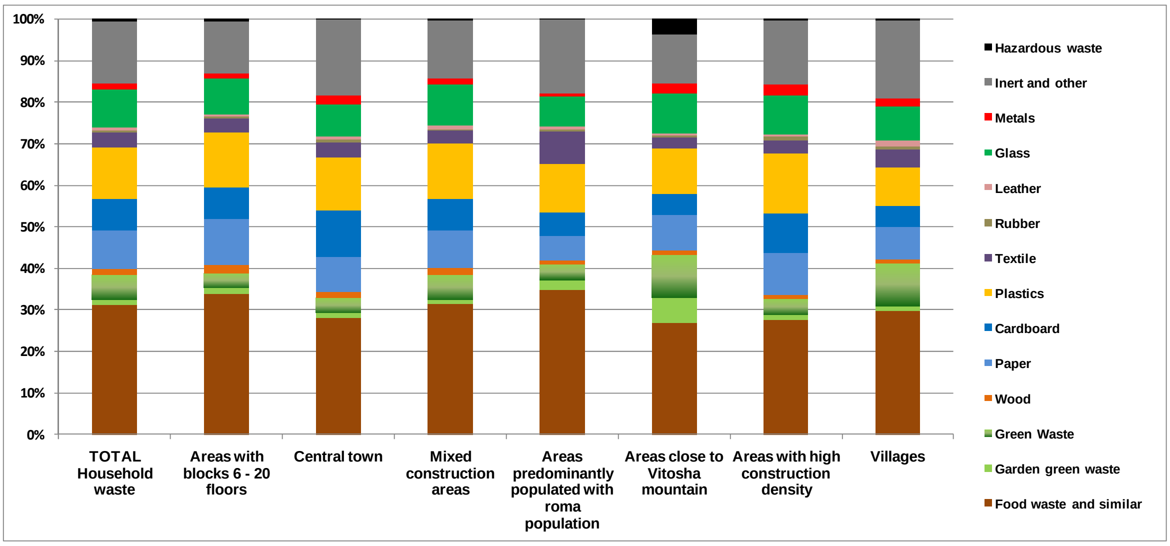
SM has already started to implement a separate collection and has opened a facility in Vrajdevna to receive and process these materials. This facility will be dedicated to bulky and inert waste.

3.2.5.3 Detailed composition by material and areas

Within the composition analysis, different samples of different areas in Sofia, reflecting different income levels, housing structures, hotels, markets, business parks etc. have been taken and analyzed separately. Again, only mixed HW and CW transported to landfill has been analyzed.

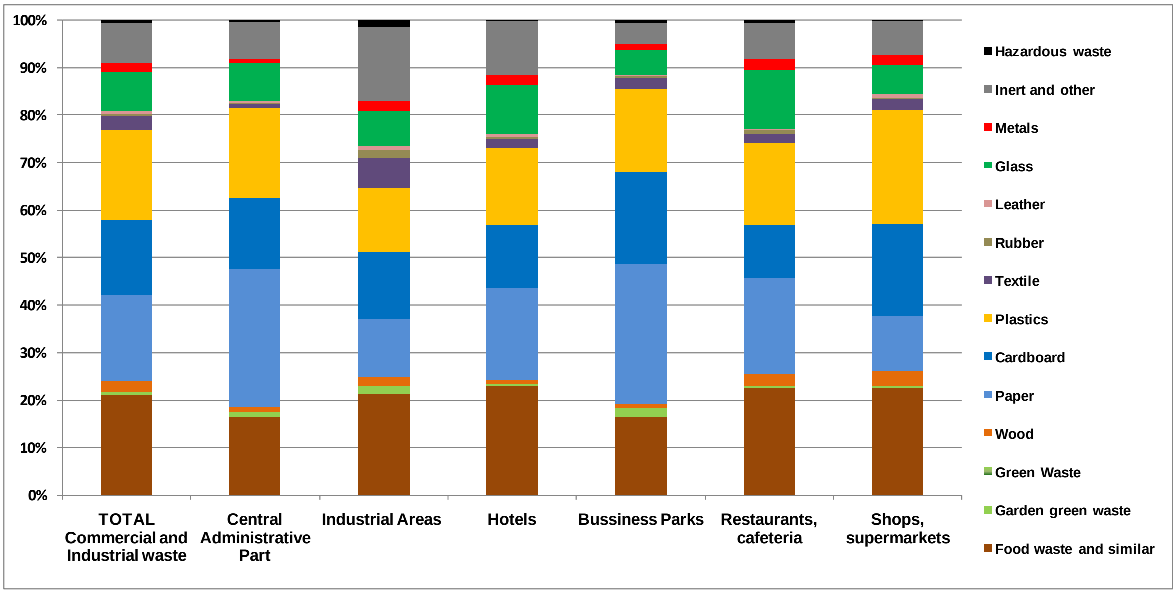
A deeper analysis can shows the composition within each area.

Figure 6: Detailed HW composition land filled of Sofia Municipality (source FS)



On this figure, there are some slight differences between areas with higher organic fraction for villages than for central town, and in opposite higher level of packaging (cardboard and plastic) in the central town than in villages. These data are helpful for strategy for waste management to focus on the main flows in order to improve the overall recycling level of SM.

Figure 7: Detailed CW composition land filled of Sofia Municipality (source FS)



In this figure for CW, the differences of composition depending of origins are higher than HW.

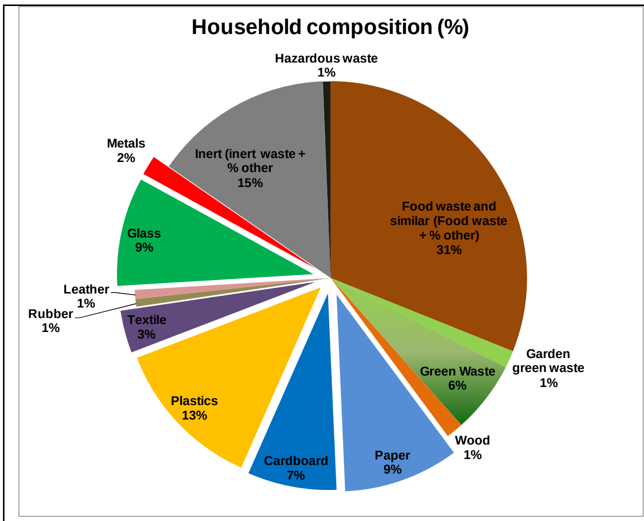
As already mentioned for organic waste, there is higher level of organic and glass with hotels, restaurants and cafeterias, showing that it should be a focus type of producers for source selective collection of these materials. Same comments can be done on paper, cardboard and plastic fraction within business parks and central administrative. These data should be used by SM to develop dedicated selective collection.

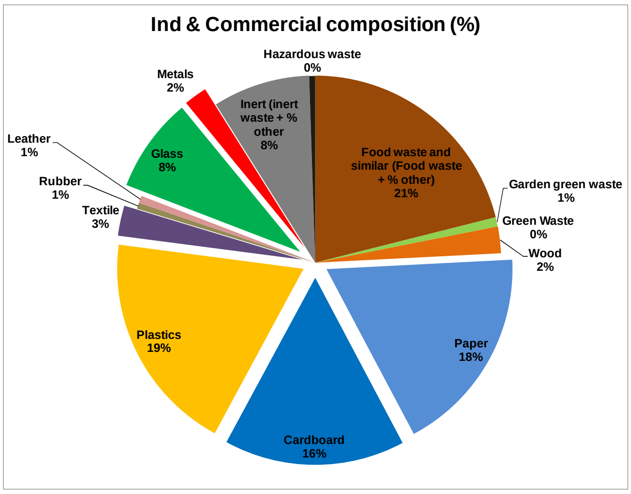
3.2.5.4 Analysis of the different fractions

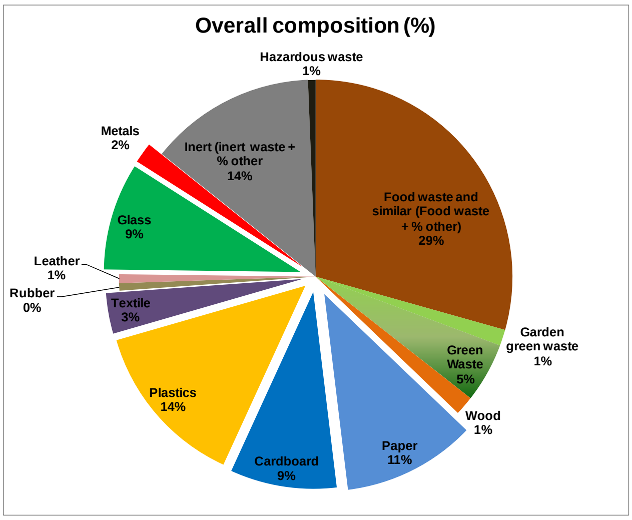
Within these compositions, an estimation of the potential of the 4 main fractions can be done for household and commercial waste:

- Recyclables fraction
- Organic fraction
- Combustible fraction
- Inert/others fraction

Figure 8: Estimation of recyclables fraction within waste land filled (source FS)





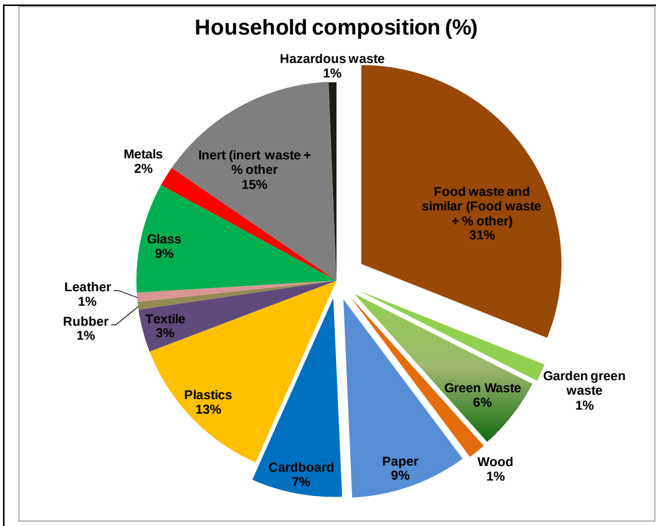


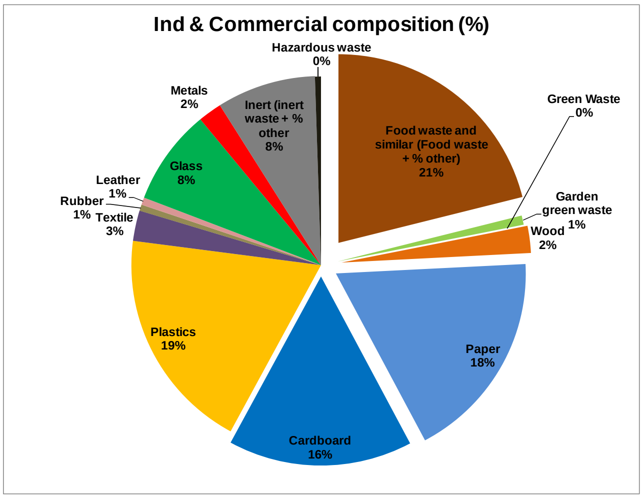
For recyclables, considering mostly packaging and paper, the potential within:

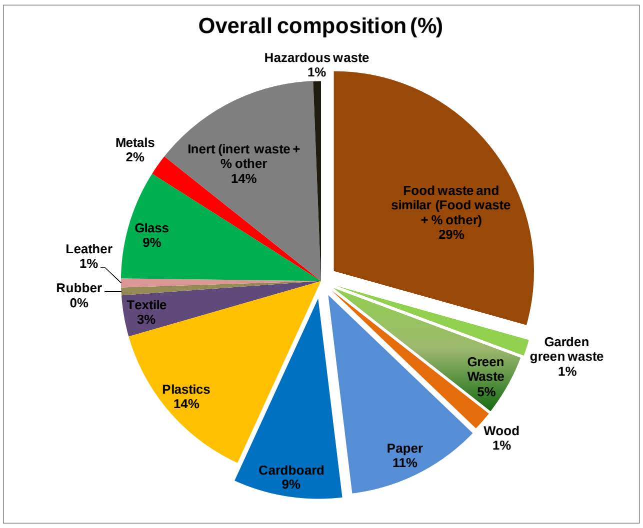
- **Household waste** is about 30% considering that for plastic and textile, about ¼ to 1/3 can be recyclable. Meaning that a potential of about 90 kg/inh/a of recyclables is still within household waste. For glass, based on the fact that the value of this material is low, there is low/no interest for household and scavengers to bring this material to the buy-back centers. For paper and cardboard and some plastic, there is a value for these materials. The development of source selective collection will decrease significantly the quantities of recyclables still in residual household waste.

- **Commercial waste** is about 50% considering that for plastic and textile, there are partly recyclable. There is clearly a higher potential within commercial waste and some improvement can be done by separating these valuable material. For glass, a source selective collection within restaurant and bars should separate easily this fraction.

Figure 9: Estimation of organic fraction within waste land filled (source FS)







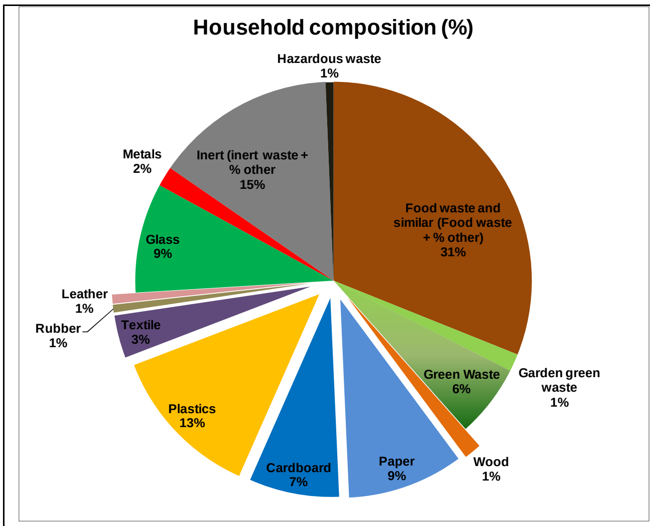
For organic fraction, considering mostly food waste, green waste, wood and paper/cardboard, the potential within:

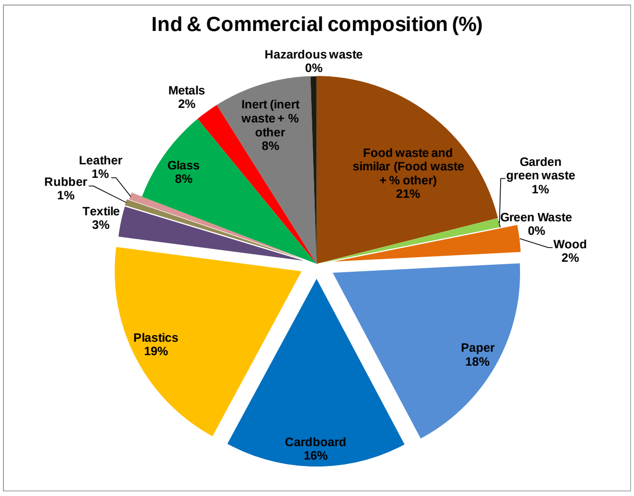
- **Household waste** is about 60%. It is the main fraction taken into account paper/cardboard fraction. Green waste is about 7% based on the available data, which should be partly collected separately in the future.

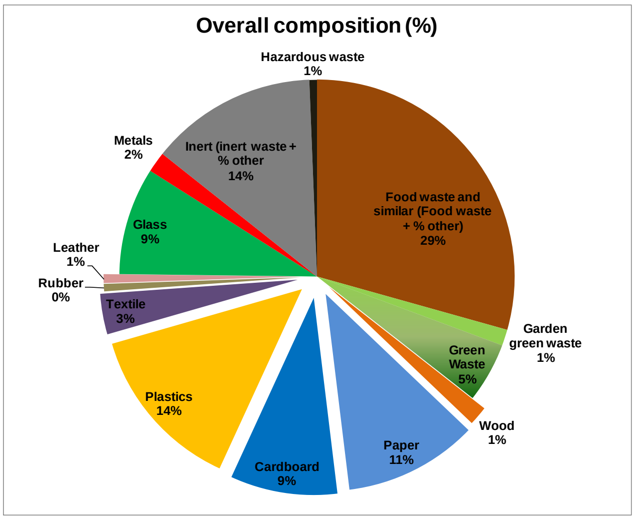
. For paper and cardboard, there is a value for these materials. The development of source selective collection will increase significantly the quantities of recyclables and consequently decrease the percentage within residual household waste. This will be taken into account within the MBT project.

- **Commercial waste** is about 60% also, with about 1/3 food waste, 1/3 paper and 1/3 cardboard. The scheduled development of source selective collection of green waste and biowaste in one side and recyclables (paper, cardboard) in other side will change within the next years these data.

Figure 10: Estimation of calorific fraction within waste land filled (source FS)







For calorific fraction, considering mostly wood, paper/cardboard, plastic and some textiles, the potential within:

- **Household waste** is about 30%. It is an important fraction taken into account paper/cardboard fraction. Plastic will remain the main flow, even after large development of source selective collection due to the fact that recyclables will be mostly for high valuable material (like plastic bottles) and most of plastic will stay within residual waste.

- **Commercial waste** is about 50% also, with about 1/3 paper, 1/3 cardboard and 1/3 plastic. The scheduled development of source selective collection of the recyclables fraction will decrease the volumes of these fractions.

3.2.5.5 Overall Municipal waste composition

The next table shows the average composition with for both categories (MW and CW) taken into account all waste (recycling, home composting…) managed by Sofia Municipality. This information is needed in order to make the forecasts of waste production and waste composition within the next years. The overall composition was also estimated to show the figures.

Table 12: Recalculated MW and CW composition of Sofia Municipality

WASTE FRACTIONS	MW FROM HOUSEHOLDS		COMMERCIAL WASTE		OVERALL	
	NEW DATA	FS	NEW DATA	FS	NEW DATA	FS
Proportion of waste	77,9%	77,8%	22,1%	22,2%	100%	100%
Food waste	28,0%	28.8%	12,9%	13.8%	24,4%	18.17%
Paper	11,5%	11.1%	19,8%	19.4%	14,5%	12.73%
Cardboard	9,4%	9.7%	20,5%	19.6%	13,7%	13.51%
Plastics	13,7%	12.0%	16,1%	13.4%	12,9%	11.99%
Textile	3,0%	3.2%	1,6%	1.7%	2,7%	4.81%
Rubber	0,6%	0.6%	0,3%	0.4%	0,5%	1.17%
Leather	0,7%	0.7%	0,4%	0.4%	0,7%	1.13%
Garden green waste	7,2%	6.8%	11,0%	12.7%	8,4%	10.79%
Wood	1,2%	1.3%	1,4%	1.5%	1,3%	3.97%
Glass	8,5%	9.9%	5,0%	10.0%	8,2%	8.56%
Metals	2,8%	1.7%	5,6%	1.3%	1,6%	2.31%
Inert	12,9%	13.6%	5,1%	5.5%	10,7%	10.50%
Hazardous waste	0,6%	0.6%	0,3%	0.3%	0,5%	0.34%

This data shows again the difference between the two flows and the importance for SM to manage as much as possible these two flows separately. Taken into account all waste generated by both household and commercial, the results show some difference with the FS.

The main reasons of these differences are:

- Glass source selective collection lower than estimation in 2007 (closed to 0 in fact). One of the mains reasons is that the value is very low, so even in buy back centers the quantities are very low. Furthermore within commercial waste, it has a higher impact for bars and restaurants.

- Plastic source selective collection higher than estimation in 2007. One of the mains reasons is that the value is very high, so in buy back centers the quantities are very high.
- On overall composition, some data are quite different like food waste which is really lower,

3.2.6 Waste tonnage and composition - forecasts

Three alternative MW quantity projection scenarios have been developed, taking into account the following parameters:

- Development of population; The demographic development is shown here above.
- Economic growth, reflected by the GDP: This parameter has particular influence on the commercial waste. Experience shows, that there is no direct linear relationship between the GDP growth (in real terms) and the quantity of waste, but a decoupling has been experienced, allowing the waste to grow more slowly than the GDP.
- Growth of UGR (Unit Generation Rate): Practice shows, that the growth of the UGR results from different growth of the different fractions. For example, in the past, the UGR of glass has been constant or even declined, while plastic and paper waste has increased. It was assumed, that Sofia UGR and MW composition will develop in the direction of typical waste compositions in Western Europe. In general, the following fractions were adjusted:
  - considerable increase of paper and cardboard waste generation;
  - slight increase of food, garden and plastic waste;
  - insignificant increase of UGR for glass;
  - the other fractions have been kept constant

3.2.7 Forecast for waste production and waste composition

Based on the last data and on the FS, it was assumed an adjustment of certain MW fractions towards Western European levels within the next 20 years, i.e. until 2027 and remain constant after that time. The increase will be logarithmic, first having a fast growth rate which then slows down until 2027.

- For household waste, it was assumed, that the generation per capita will increase by 50 kg/inb/a between 2010 and 2027
- For the commercial waste, it was assumed, that the generation per capita (around 78 kg/cap/a) will remain constant. This means that commercial waste will grow in line with population growth, in order to reflect the growing number of working population
- As assumed in the FS, three different scenarios were analysed

The following assumptions were taken:

Table 13: Assumptions taken for increase of UGR in Sofia

	2009 kg/cap/year	2020 kg/cap/year	2027 kg/cap/a
Food and garden waste	122	132	134
Paper/cardboard	94	118	124
Plastic	53	57	58
Others (glass, metal, mineral, textile, etc.)	104	105	106
Total	374	412	422

On average, 120 to 160 kg/cap/year of food and garden waste, as known from big cities in Western Europe, are usual. Sofia is at the lower end of this range and comparatively low in comparison with low and middle income countries. It is assumed that the food and garden waste will increase, given the fact that, with increasing income, more food will be consumed and wasted.

A strong increase in paper cardboard is expected, given the consumption of more print-media with increasing wealth.

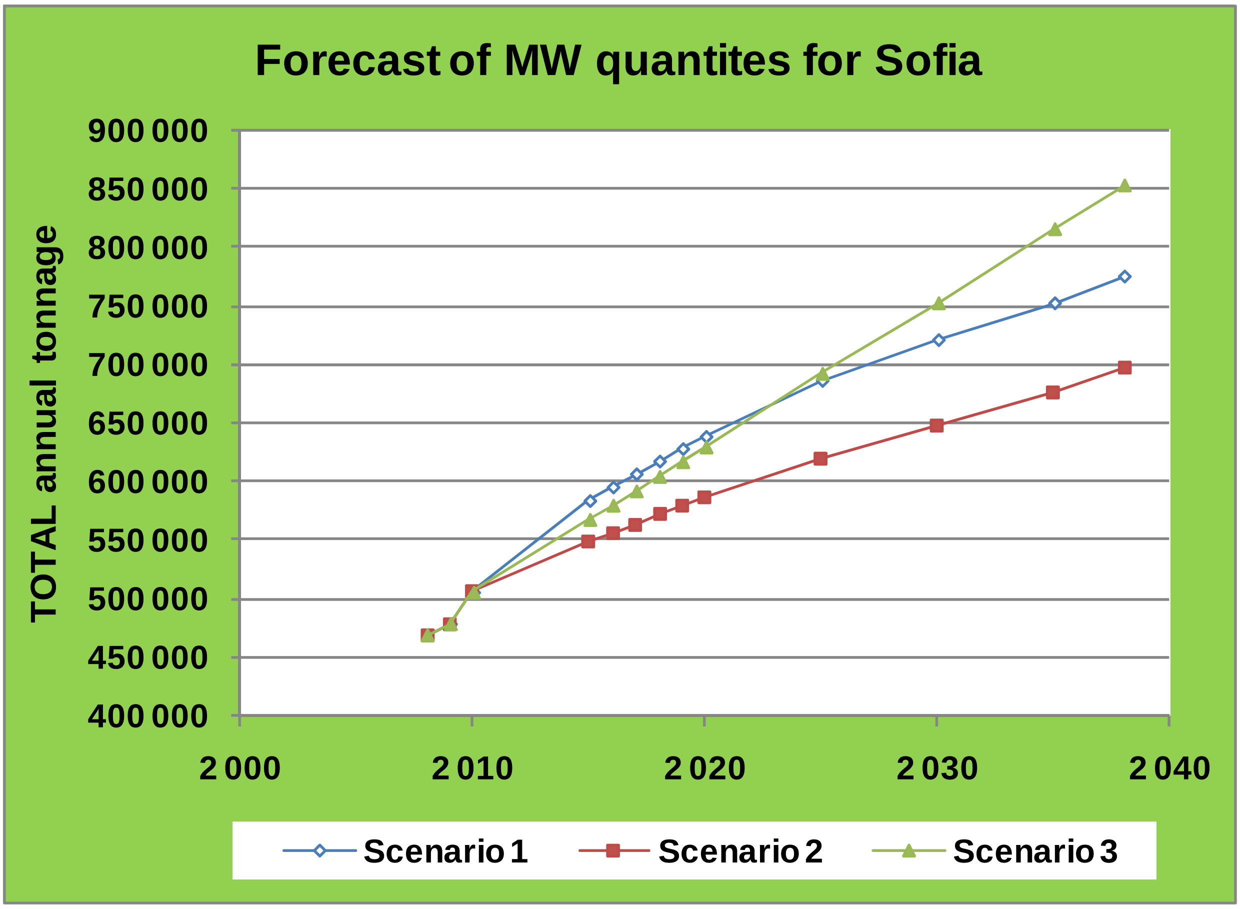
- Scenario 2: Low Scenario

This Scenario assumes that the overall UGR will remain constant, i.e. there will be no increase in waste quantity produced per inhabitant. In absolute terms, this means that the MW quantity will increase in line with the population growth. This implies that also commercial waste will grow in line with population growth.

- Scenario 3: High Scenario

Scenario 3 assumes a similar target UGR in 2027 as Scenario 1; however it will be achieved by a linear growth. It also is assumed that the UGR will continue growing after 2027.

Figure 11: Results of MW quantity projection for Sofia (before prevention and recycling)



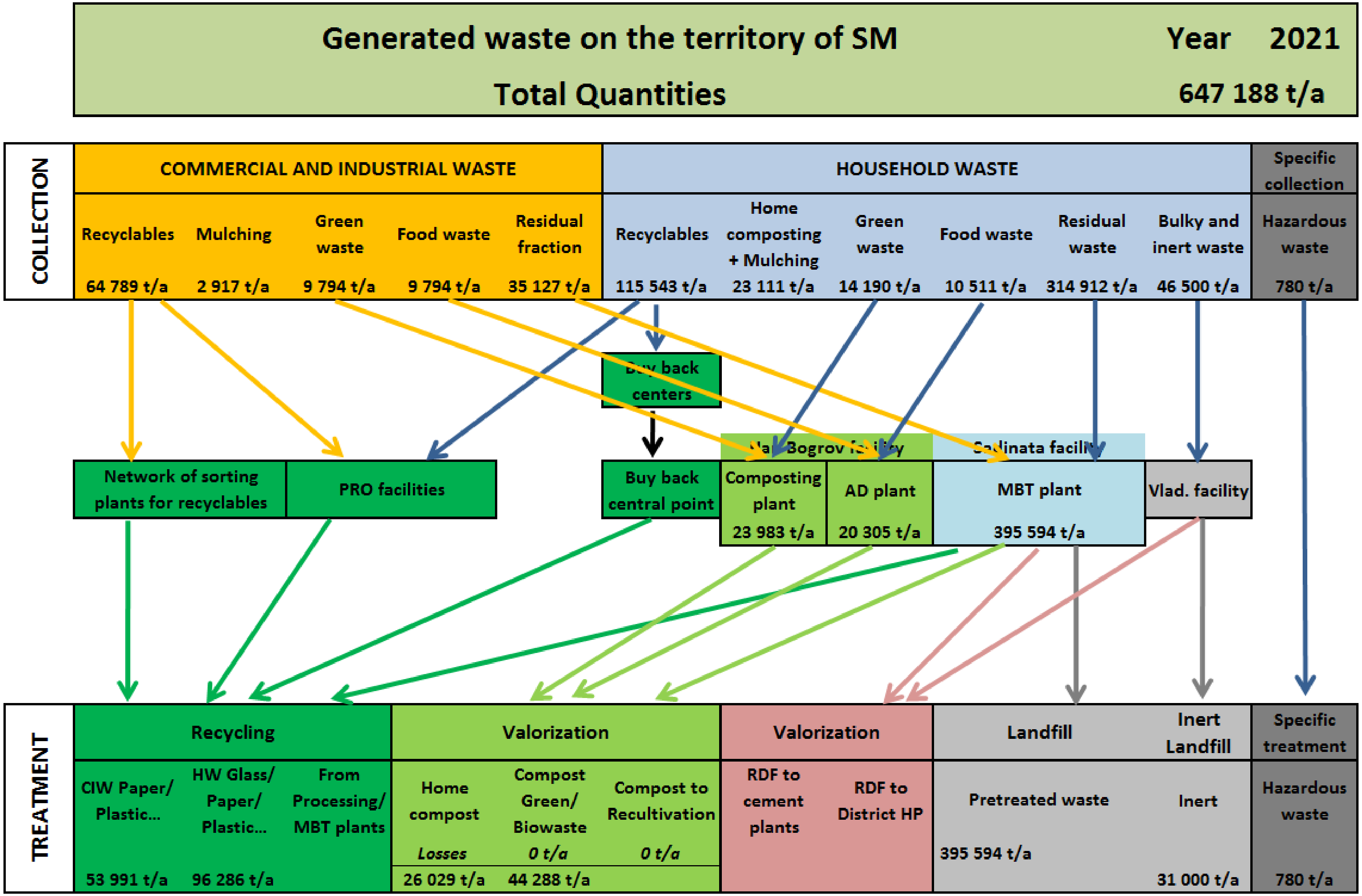
- Based on these 3 scenarios, the overall tonnage in 2027 can be estimated between 630,000t and 720,000 t/a.
- A comparison between the FS and the new forecast are shown in the table next page. It shows that due to population increase and waste production, the estimated quantity in 2020 will be about 7,000 t more than the FS.

Based on scenario 1, for 2021, the overall waste production is estimated to be about 650,000t. (see figure 12).

Table 14: Comparison of waste production between FS and new forecast

		2007	2008	2009	2010	2015	2020	2025	2030	2035	2038
Number of inhabitants	Feasibility Study/Master Plan forecast	1 252 403	1 266 914	1 281 426	1 299 827	1 388 519	1 474 832	1 556 197	1 625 617	1 696 223	1 747 620
	New forecast	1 252 403	1 266 914	1 281 426	1 359 520	1 459 079	1 549 778	1 635 278	1 708 226	1 782 419	1 836 429
	Difference - permanent inhabitants (with FS)				59 693	70 560	74 946	79 081	82 609	86 197	88 809
Waste production (FS forecast) in t/a	Household waste (HHW)	368 433	380 691	392 465	403 359	456 609	503 819	544 443	572 910	591 166	597 689
	Commercial waste (CW)	107 576	108 905	110 234	111 563	119 176	126 584	133 567	139 526	143 972	145 560
	TOTAL	476 009	489 596	502 699	514 923	575 785	630 403	678 010	712 436	735 137	743 249
Waste production (new forecast) in t//a	Household waste (HHW)			372 800	399 304	469 541	517 093	558 087	587 134	612 635	631 198
	Commercial waste (CW)			106 000	106 220	113 999	121 085	127 765	133 465	139 261	143 481
	Total MSW	434 100	469 300	478 800	505 524	583 540	638 178	685 852	720 598	751 896	774 679
	Difference waste production (with FS)	-41 909	-20 296	-23 899	-9 399	7 755	7 775	7 841	8 162	16 759	31 430

Figure 12: Waste production within Sofia Municipality (2021)



After updating the waste composition (see above in this report) and based on the forecast of UGR per inhabitant and increase of waste production, the new forecast can be the following:

Table 15: Forecast of Changes in total MW composition

Composition	2010	2015	2020	2025	2030	2035	2038
Food waste	24,7%	24,0%	23,8%	23,6%	23,6%	23,6%	23,6%
Paper	13,4%	14,5%	15,0%	15,3%	15,3%	15,3%	15,3%
Cardboard	11,9%	13,1%	13,6%	13,9%	14,0%	14,0%	14,0%
Plastics	14,2%	13,9%	13,8%	13,7%	13,7%	13,7%	13,7%
Textile	2,7%	2,6%	2,6%	2,5%	2,5%	2,5%	2,5%
Rubber	0,5%	0,5%	0,5%	0,4%	0,4%	0,4%	0,4%
Leather	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%
Garden green waste	8,0%	8,2%	8,2%	8,3%	8,3%	8,3%	8,3%
Wood	1,3%	1,2%	1,2%	1,2%	1,2%	1,2%	1,2%
Glass	7,7%	7,3%	7,1%	7,0%	6,9%	6,9%	6,9%
Metals	3,3%	3,2%	3,1%	3,1%	3,1%	3,1%	3,1%
Inert	11,2%	10,4%	10,1%	9,9%	9,9%	9,9%	9,9%
Hazardous waste	0,5%	0,5%	0,5%	0,4%	0,4%	0,4%	0,4%

If we compare the forecast of waste composition with the FS as shown in the table here under, there are quite difference for:

- Food waste with about 5% more
- Plastic with 2% more

Table 16: Comparison of waste composition between FS and new forecast

Composition	New forecast 2025	Forecast FS 2023
Food waste	23,6%	18.72%
Paper	15,3%	14.90%
Cardboard	13,9%	14.83%
Plastics	13,7%	11.61%
Textile	2,5%	4.21%
Rubber	0,4%	1.02%
Leather	0,6%	1.00%
Garden green waste	8,3%	11.04%
Wood	1,2%	3.46%
Glass	7,0%	7.59%
Metals	3,1%	2.04%
Inert	9,9%	9.27%
Hazardous waste	0,4%	0.30%

3.2.8 Overall recycling rate, compliance with the EU Waste FW directive.

The compliance with Article 11 of waste framework directive 2008/98/EC is necessary i.e.: by 2020, the preparing for re-use and the recycling of waste material such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50 % by weight.

The overall recycling rate based on the total waste production of each material is the following:

Table 17: Recycling rate estimation of overall material

	2010	2015	2020	2025	2030
Paper	26,6%	37,3%	48,8%	53,1%	56,0%
Cardboard	30,1%	39,3%	50,0%	54,0%	56,8%
Plastics	17,8%	20,7%	23,3%	23,3%	23,3%
Glass	7,8%	29,6%	52,0%	60,2%	65,0%
Metals	50,5%	54,0%	56,7%	60,8%	63,2%
Total	**23,7%**	**33,3%**	**43,3%**	**47,0%**	**49,4%**

This doesn't include the recyclables sorted out from the MBT facility.

Based on a estimation of 14,000 t of recyclables sorted out within the MBT plant, the recycling rate will reach 47% in 2020 and 50,9% in 2025.

The EU Waste Framework Directive (i.e. article 11) of the directive with regard to the Municipal waste gives recycling targets for year 2020. 50% of the potential tonnages of the 4 following flows have to be recycled:

- Glass
- Paper, cardboard
- Plastics
- Metals.

As shown in the table 17, the overall recycling rates taken as hypothesis in this study are in line with the recycling rates of the EU Waste Framework Directive, except for plastics.

3.2.9 Forecast for residual waste production and waste composition

The update of waste composition is necessary to estimate waste production in the next years. After deducting the objectives of SM for next years in term of recycling, composting of green waste and biowaste, an estimation of residual waste can be done.

Table 17: Forecast of residual waste production for HW and CW

		2010	2015	2020	2025	2030	2035	2038
Residual waste production (new forecast) in t/a	Household waste (HHW)	328 142	351 000	348 000	357 000	363 000	376 000	386 000
	Commercial waste (CW)	74 000	61 000	47 000	48 000	50 000	52 000	54 000
	Total MSW	402 142	412 000	395 000	405 000	413 000	428 000	440 000

Based on these new forecasts, **the estimated volume of residual waste to be treated within the MBT plant is 396,000 t for 2021.**

This volume included the tonnage of waste coming from direct collection of residual waste but also all residues coming from other facilities (sorting plants from PRO, packaging, commercial waste, bulky waste …).

The waste composition of these two fractions HW and CW is expected to be the following in 2021:

Table 18: Forecast of composition of residual waste production for HW and CW in 2021

Composition	MW from Households	Commercial waste	Overall	Waste input for MBT project (as in the tender documents)
Food waste	32,27%	12,9%	30,0%	**34.5%**
Paper	12,33%	13,2%	12,4%	**9.6%**
Cardboard	10,69%	13,7%	11,0%	**8.2%**
Plastics	15,87%	27,8%	17,3%	**14.3%**
Textile	4,17%	4,2%	4,2%	**4.0%**
Rubber	0,72%	0,9%	0,7%	**0.7%**
Leather	1,05%	1,0%	1,0%	**0.9%**
Garden green waste	4,97%	1,7%	4,6%	**2.5%**
Wood	1,80%	3,8%	2,0%	**1.9%**
Glass	5,44%	4,7%	5,3%	**5.2%**
Metals	2,23%	1,6%	2,2%	**1.2%**
Inert	7,96%	13,7%	8,6%	**16.5%**
Hazardous waste	0,51%	0,8%	0,5%	**0.5%**

3.2.10 Comments about the transfer station

It should anyway be reconsidered the need of a transfer station for the following reasons:

- Costs estimation was made on the basis of full trucks, which is not the case for all rounds of collection. On the second round, for household waste, when the area of collection is finished, the truck is going to empty his load, and it is not possible to have full trucks. Commercial waste has also a lower density.
- Furthermore, assumptions of transport was only considered the distance, which is the case in rural areas, but not sufficient in urban areas. Time of transport should be considered taken into account traffic, time when the trucks have to empty their loads. This can change quite consequently the time of transport (increasing in fact), and so given quickly more justification for the transfer station.

- The uses of truck with walking floor allow transporting until 24t per truck compare to a maximum of 10t when collection trucks are full.
- The used for example of Suhodol site, which will stay open when Sadinata site will open, benefit already of all infrastructures (access road, permit, weighbridge and administrative people, loaders …). So consequently, for Suhodol the cost for a transfer station is lower than to build a new one, and can give better value for money than using collection truck to go to Sadinata.
- Furthermore, Sadinata site will receive all trucks at about the same time and mostly in the morning. A transfer station in Suhodol for example, will allow capacity storage in a second site and will reduce the traffic in the MBT plant, and will allow some deliveries in the afternoon allowing more regular reception during the day.

4 In deep technical study of two options for the MBT

Considering the opinion of the experts involved in the FS and the strong preference of Sofia Municipality for a technical solution based on Mechanical-Biological Treatment (MBT), the objectives of this assignment are to carry out the financial and economic analysis of the following two options:

- - OPTION 1: MBT without Refuse Derived Fuel (RDF) production but with a degree of bio-waste stabilisation and low levels of gas and leachate generation at the landfill that is in compliance with the EU relevant Directives (Waste Framework Directives, Landfill Directives, etc.) and in line with the Hierarchy principle;
- - OPTION 2: MBT plant with RDF production in combination with the establishment of an RDF cogeneration facility connected to the Sofia Heating Plant. Nevertheless, the combustion of the RDF in cement factories could be studied as a provisional solution under this second option to be operational for a limited period of time until the cogeneration facility is in place. This option will also be assessed with respect to the same above-mentioned Directives.

4.1 General data for the two options

The waste to be treated in the MBT Plant is delivered by the common municipal waste collection system in Sofia.

The waste collection occurs 7 days per week, 365 day per year. On Sundays, the collection amount will be less than on other days.

It is foreseen that bio-waste and green waste will be collected separately and treated in a dedicated plant at Han Bogrov site. The household waste will contain a lot of biowaste which should be separated for treatment in Han Bogrov by correct source separation. Therefore this waste was considered in the design.

The annual waste amount and the composition have been analysed and a prognosis has been made about the development of these values. It was agreed to take the value from the year 2021 (10 years after the plant started operation) as the basis for the necessary capacity of the treatment plant. The amount and the composition will be shown in hereunder.

The composition of the waste was determined via sorting of the collected waste.

4.1.1 Inputs characteristics

Quantities and composition of waste input,

- Based on the forecast, the waste quantities for 2021 will be :
  - Household waste : 349,669 t

- Commercial waste : 45,925 t
- TOTAL : 395,594 t

The following table show the detailed assumed amount and composition of residual waste in 2021.

Table 18: Assumption of waste amount of residual waste in 2021

Material	Household residual waste	Commercial residual waste	Total in t/a
Food waste	112 831	5 938	118 769
Paper	43 106	6 047	49 153
Cardboard	37 370	6 288	43 658
Plastics	55 489	12 779	68 269
Textile	14 570	1 944	16 514
Rubber	2 515	399	2 915
Leather	3 674	468	4 142
Garden green waste	17 364	764	18 128
Wood	6 311	1 730	8 041
Glass	19 009	2 145	21 154
Metals	7 810	750	8 560
Inert	27 843	6 289	34 132
Hazardous waste	1 776	384	2 161
Total	349 669	45 925	395 594

Based on the update of the FS, the composition in % is the following:

Table 19: Assumption of waste amount of residual waste in 2021

Material	Household residual waste	Commercial residual waste	Overall
Breakdown	88,4%	15,6%	100%
Food waste	32,3%	12,9%	30,0%
Paper	12,3%	13,2%	12,4%
Cardboard	10,7%	13,7%	11,0%
Plastics	15,9%	27,8%	17,3%
Textile	4,2%	4,2%	4,2%
Rubber	0,7%	0,9%	0,7%
Leather	1,1%	1,0%	1,0%
Garden green waste	5,0%	1,7%	4,6%
Wood	1,8%	3,8%	2,0%
Glass	5,4%	4,7%	5,3%
Metals	2,2%	1,6%	2,2%
Inert	8,0%	13,7%	8,6%
Hazardous waste	0,5%	0,8%	0,5%

It is important to know the composition within the main flows in order to have the possibility to process these flows separately to optimize the results.

Projection of variations in quantity and quality

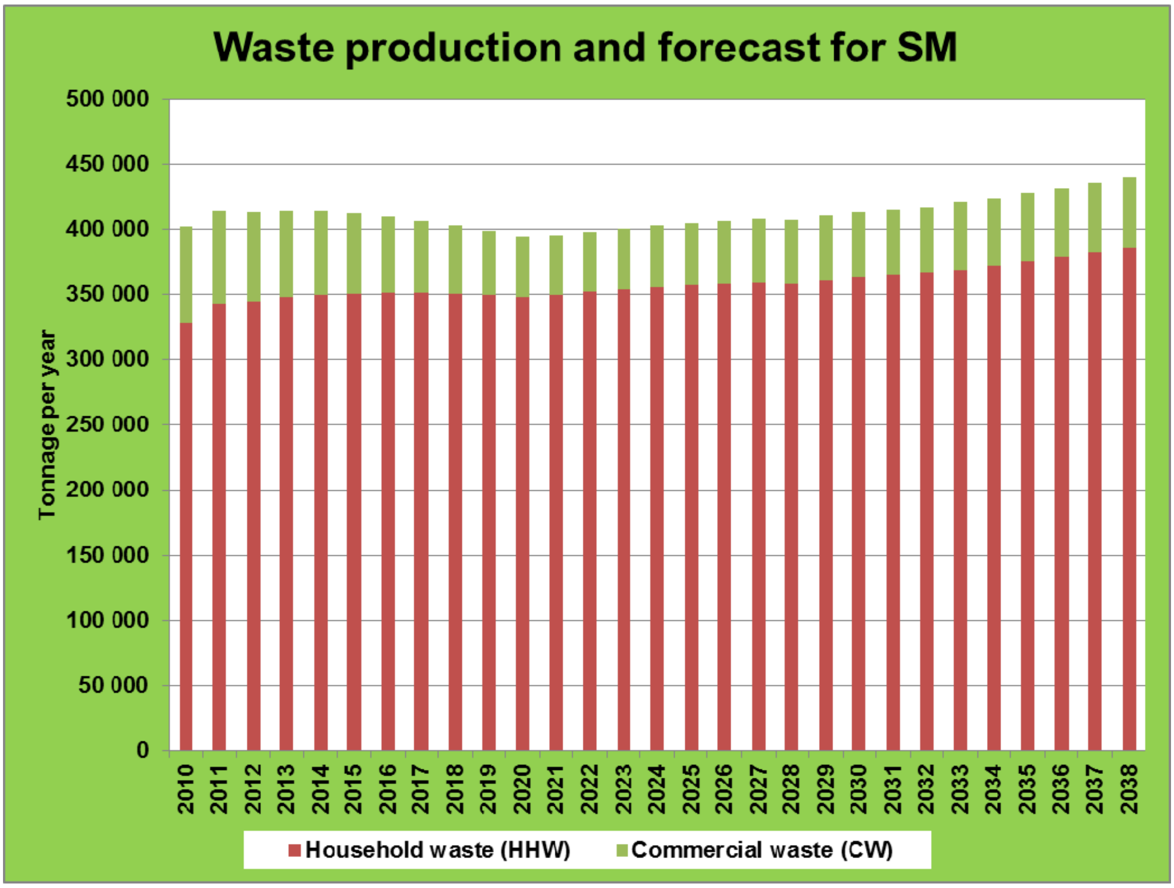
Based on the forecast of the FS and updated data, the variation in quantity between 2014 and 2038 for residual waste is estimated to be:

Table 20: Quantity of residual waste between 2013 and 2038

	2013	2014	2015	2016	2017	2018	2019	2020
Household waste (HHW)	347 647	349 715	350 889	351 246	351 045	350 372	349 289	347 840
Commercial waste (CW)	66 667	64 107	61 458	58 701	55 857	52 927	49 910	46 807
TOTAL	**414 314**	**413 823**	**412 347**	**409 948**	**406 903**	**403 299**	**399 200**	**394 648**

	2021	2022	2023	2024	2025	2030	2035	2038
Household waste (HHW)	349 669	351 833	353 820	355 645	357 321	363 268	376 023	386 287
Commercial waste (CW)	45 925	46 427	46 928	47 429	47 930	50 068	52 280	53 927
TOTAL	**395 594**	**398 259**	**400 748**	**403 074**	**405 252**	**413 336**	**428 303**	**440 214**

Figure 12: Quantity of residual waste between 2013 and 2038



Within these forecasts, it shows that a capacity of 410,000t as assumed in the FS is sufficient to cover 20 years of operation of the MBT.

Based on the forecast of the FS and updated data, the variation in quality between 2014 and 2038 for residual waste will be:

Table 21: Variation of composition for HW waste between 2010 and 2038

Household waste	2010	2015	2020	2025	2030	2035	2038
Food waste	32,1%	30,6%	32,0%	33,3%	34,4%	34,7%	34,9%
Paper	11,2%	12,4%	12,4%	12,0%	11,6%	11,7%	11,7%
Cardboard	9,2%	10,6%	10,7%	10,4%	10,1%	10,2%	10,2%
Plastics	13,9%	14,6%	15,7%	16,4%	17,0%	17,1%	17,2%
Textile	3,7%	3,8%	4,1%	4,3%	4,4%	4,4%	4,5%
Rubber	0,7%	0,7%	0,7%	0,7%	0,8%	0,8%	0,8%
Leather	0,8%	0,9%	1,0%	1,1%	1,1%	1,2%	1,2%
Garden green waste	6,1%	4,9%	5,1%	5,2%	5,3%	5,4%	5,4%
Wood	1,5%	1,6%	1,8%	1,9%	1,9%	1,9%	2,0%
Glass	9,3%	7,4%	5,6%	4,7%	4,2%	4,2%	4,2%
Metals	2,0%	2,1%	2,3%	2,1%	2,0%	2,0%	2,0%
Inert	8,9%	9,9%	8,1%	7,4%	6,6%	5,8%	5,4%
Hazardous waste	0,7%	0,5%	0,5%	0,5%	0,5%	0,5%	0,5%

Table 22: Variation of composition for CW waste between 2010 and 2038

Commercial waste	2010	2015	2020	2025	2030	2035	2038
Food waste	18,4%	16,8%	13,7%	12,9%	12,9%	12,9%	12,9%
Paper	17,6%	15,9%	12,8%	13,2%	13,2%	13,2%	13,1%
Cardboard	16,0%	15,1%	13,3%	13,7%	13,7%	13,7%	13,7%
Plastics	17,6%	21,1%	27,0%	27,8%	27,8%	27,8%	27,8%
Textile	2,3%	2,9%	4,1%	4,2%	4,2%	4,2%	4,2%
Rubber	0,5%	0,6%	0,8%	0,9%	0,9%	0,9%	0,9%
Leather	0,5%	0,7%	1,0%	1,0%	1,0%	1,0%	1,0%
Garden green waste	7,7%	5,7%	3,4%	1,7%	1,7%	1,7%	1,8%
Wood	2,0%	2,6%	3,7%	3,8%	3,8%	3,8%	3,8%
Glass	7,2%	6,3%	4,5%	4,7%	4,7%	4,7%	4,7%
Metals	2,4%	2,1%	1,6%	1,6%	1,6%	1,6%	1,6%
Inert	7,4%	9,5%	13,3%	13,7%	13,7%	13,7%	13,7%
Hazardous waste	0,5%	0,6%	0,8%	0,8%	0,8%	0,8%	0,8%

Table 23: Variation of composition for overall waste between 2010 and 2038

Overall composition	2010	2015	2020	2025	2030	2035	2038
Food waste	29,6%	28,6%	29,8%	30,9%	31,8%	32,1%	32,2%
Paper	12,3%	12,9%	12,4%	12,1%	11,8%	11,9%	11,9%
Cardboard	10,4%	11,3%	11,0%	10,8%	10,6%	10,6%	10,7%
Plastics	14,6%	15,6%	17,1%	17,8%	18,3%	18,4%	18,5%
Textile	3,4%	3,7%	4,1%	4,3%	4,4%	4,4%	4,4%
Rubber	0,6%	0,7%	0,7%	0,8%	0,8%	0,8%	0,8%
Leather	0,8%	0,9%	1,0%	1,1%	1,1%	1,1%	1,1%
Garden green waste	6,4%	5,1%	4,9%	4,8%	4,9%	4,9%	5,0%
Wood	1,6%	1,8%	2,0%	2,1%	2,2%	2,2%	2,2%
Glass	9,0%	7,2%	5,5%	4,7%	4,2%	4,3%	4,3%
Metals	2,1%	2,1%	2,2%	2,0%	2,0%	2,0%	2,0%
Inert	8,6%	9,9%	8,7%	8,1%	7,5%	6,8%	6,4%
Hazardous waste	0,6%	0,5%	0,5%	0,6%	0,6%	0,6%	0,6%

Within these figures, the composition of household waste and commercial waste change a bit during the period, mainly due to:

- Development of source selective for packaging and paper
- Increase of consumption within household waste for packaging and paper

However considering the period after starting the MBT plant (beginning of 2014 on the soonest), the impact is lower as SM will have develop more source selective collection than 2011.

Moisture content

Within the waste characterization made in 2007-2008 no data are available regarding the moisture content of the waste. Consequently the following assumption will be taken based on experience:

- Household residual waste : 35 - 40%
- Commercial residual waste : 20 - 25%

Calorific value of each fraction

Based on data available on the market, the following data will be taken for the calorific value:

Table 24: Assumption of calorific value for each category

Category	Net Calorific Value (in MJ/kg)
Food waste	4.2
Paper	17-18
Cardboard	16
Plastic	38-42
Textiles	16 (lower for sanitary textiles (4)
Rubber	25
Leather	26
Green waste	4-18
Wood	17-19
Glass	0
Metal	0
Inert	0

It is assumed that these calorific values are available for dry material. The usual content of moisture for this material is usually between 10 and 20% (except for food waste, green waste, fine fraction).

Physical/chemical parameters

One of the key parameters to design a process (MBT, Sorting …) is the size of the incoming material and the breakdown depending of the size. The only data available within SM is the characterization made in 2007-2008.

The data are the following:

Table 25: Analysis of HW and CW per size

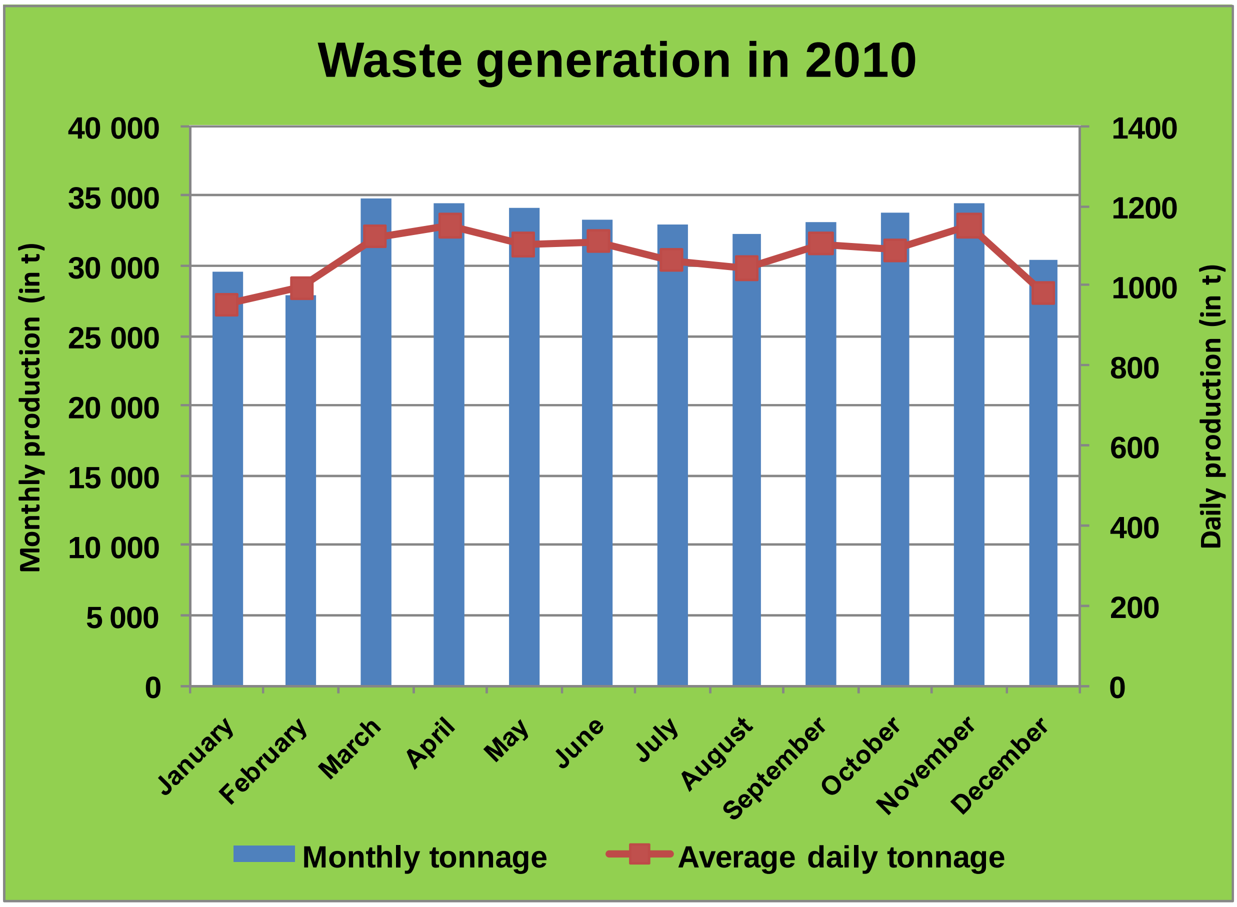
Fraction analysis	Household residual waste	Commercial residual waste
0 - 10 mm	7,12%	6,16%
10 - 40 mm	18,30%	11,36%
40 - 120 mm	28,47%	26,59%
>120 mm	46,10%	55,88%
Total	100,0%	100,0%

4.1.2 Input delivery organization and characteristics:

Peaks and variations during the year

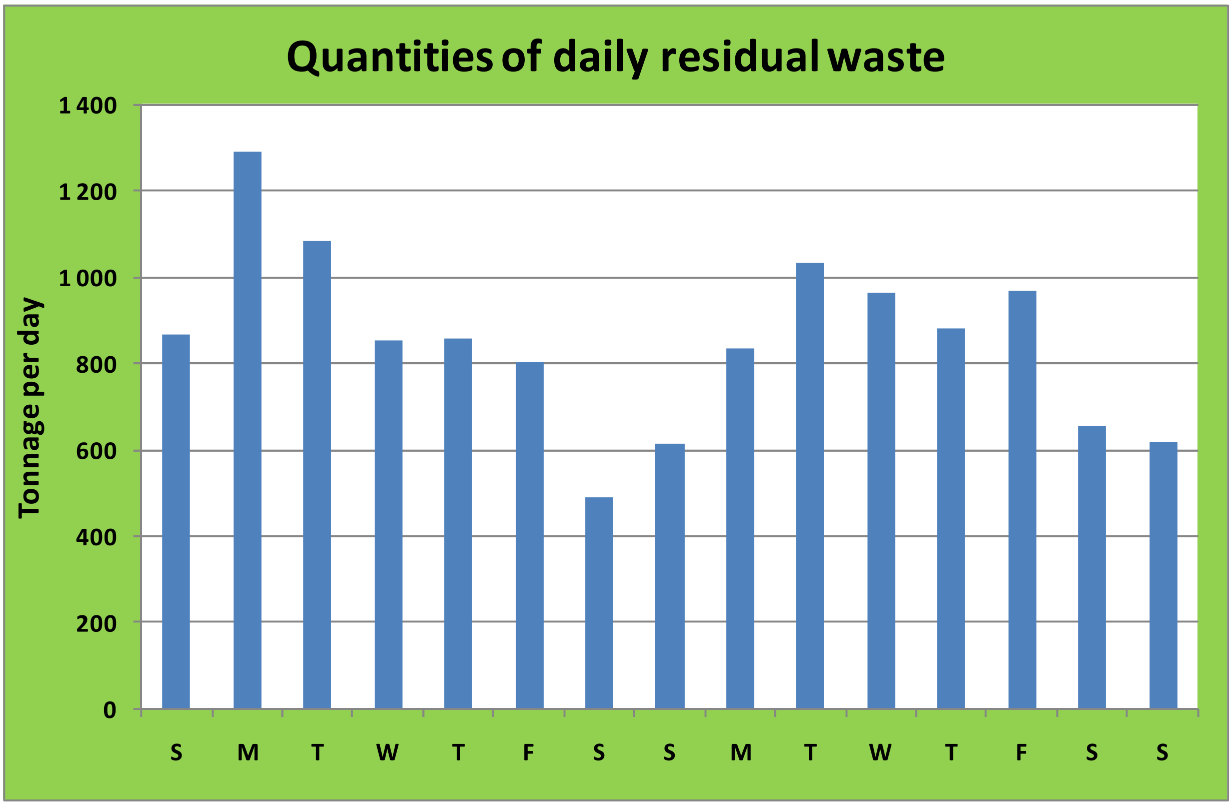
The following figures give the variation of residual waste collection during the months of 2010.

Figure 13: Monthly variation of residual waste production during year 2010



This shows that average daily tonnage can go from 953 t to 1151 t per day (based on 7 days a week).January is the lowest month and April the highest one. It means that variation of +/-10% should be considered on average monthly basis.

Figure 14: Daily variation of residual waste production during two weeks (example)



This figure shows that variations on the daily basis are quite high, going from 500 t to 1300 t per day. This should be carefully considered within the design and storage capacity for the MBT plant.

Projection of changes

Based on the forecast, the annual volumes of residual waste will stay about the same within the period. The variation during the year will change slightly due to selective collection. In particular, selective collection of green waste has an impact, because of highest production of this kind of waste in spring and fall, compare to winter time. Consequently, it will have a positive impact on the monthly production, and even more and on the weekly production, by reducing the changes.

This will stabilised more the waste production compare to the existing one, based on the development of these collections within SM.

For the other changes, the development of selective collection and recycling will not change the daily production. One of the possible change can be a change within collection, with less collection on Sunday, increase the volume collected during the week day. Anyway as it is scheduled for the MBT plant to work on 6 days per week, it is already taken into account.

4.1.3 Treatment capacity

Based on the data here above, a treatment capacity of 410,000 t per year is the basis of design of the plant.

With a delivery on 360 days, an average delivery amount from 1,140 tonnes per day arises. With the inclusion of monthly variations, an average day amount from 1,250 tonnes of delivered waste is considered for the highest month. This doesn't take into account everyday variation, and it is based on 7 days collection, which is not the case for all areas of SM.

As shown here above for the variations during the week, the assumption for the daily tonnage should be considered to go up to 1400 t per day.

The treatment of the waste will happen 310 days a year. That means that the average daily treatment capacity must be 1,320 t per day. Based on the highest month and daily variation, **this capacity must be 1,500 t per day in order to be able to manage peaks and with reserves for availability and safety factor**.

The average bulk density of the loose material is assumed to be 0.25 t/m^3.

The task of the treatment should be:

- to maximise the amount of recycling of the separated materials
- to process organic fraction by an aerobic process in order to obtain a Compost Like Output (CLO) or stabilized compost, which can be at minimum applied for land remediation or soil improver, if this type of compost is accepted in future regulation by the Chamber of Mining
- only for OPTION 2, to produce a RDF fraction which can be used as alternative fuels in a cogeneration facility or/and in cement factories in Bulgaria.
- to segregate and minimise the amount of the waste anticipated to be deposited in the landfill and to reduce the potential emissions within the landfill.

The treatment process is divided into several steps:

- Entrance area
- Reception and storage
- Pre-sorting
- Sorting
- Processing and separation in different flows
- Biological treatment (aerobic process)
- Separation post biological treatment
- Biological post treatment (Maturation)
- Refinement (separation and cleaning) of MBT compost
- Processing of RDF fraction (for OPTION 2)

4.1.4 Performance requirements:

For both options, MBT without and with RDF, the waste treatment facility to be constructed and delivered should guarantee the treatment of municipal waste into preferably marketable fractions. The residual amount of waste directed to landfill must be as low as possible.

4.1.4.1 Quality of outputs

Recyclables

It is required that separating the materials into the following fractions should be possible:

Within the sorting line in the sorting area:

- **paper and cardboard (in commercial waste):**
  - carton and cardboard
  - newspapers and magazines

  These materials are sorted from clean residual waste only and if the organic content is very low (commercial waste).
- **metal**
  - ferrous metals
  - non- ferrous metals
- **plastics:**
  - foils
  - bottles (PET, HDPE, PP,…)

Within the other parts of the plant, the following main fractions shall be produced:

- problematic waste (presorted out in the reception area)
- ferrous metals and non-ferrous metals
- other recyclables
- waste compost
- calorific fraction (for OPTION 2)
- residual waste for disposal

For recyclables, the quality must fulfil the European quality standard. These qualities are known within SM and their subcontractors for the different materials already recycled. The material from the MBT sorting step will be similar:

- paper and cardboard
- plastic
- glass

- metal

Compost

For waste compost quality, European and Bulgarian regulation are not yet fully implemented. Anyway most of the criteria are known, but some limits are still in discussion. Consequently, the process should be able to reach at minimum a sufficient quality for land remediation or landscaping. It should be able to evolve in the future to fulfil upcoming regulation.

The letter of the President of Bulgarian Chamber of Mining and Geology, expresses interest to utilized compost from SM, sets a number of conditions that need to be met.

- **Condition 1**: Existence of a functioning, by the moment of offering, normative setting allowing for the utilization of compost for re-cultivation – currently, such does not exist.
- **Condition 2**: Availability of a certificate certifying the quality of the compost.
- **Condition 3:** The prices of the offered compost to be competitive with regard to the delivery of earth masses for the construction of the upper re-cultivating layer. The preliminary evaluation indicates that the price of compost delivery to the re-cultivation site should not exceed BGN 10-16 per m^3. Each individual case should be negotiated with the utilities, which will carry out the re-cultivation.].

At the present time, there is no assurance that these conditions are satisfied.

Within the different criteria for used of compost, they can be listed in different categories depending on the way to improve the quality:

Table 26: Overview of main criteria for compost and way to improve the quality

Criteria	Objectives	Improvement by the upstream process	Improvement within the process
Size	Having compost <20mm and <10mm depending on applications	-	Screening with adapted size
Plastic contamination	To reduce as much as possible (<0,25%) visible contamination	Removal of plastic by source selective collection	Light / Heavy separation to remove this product
Glass contamination	To reduce as much as possible (<0,25%) visible contamination	Removal of glass by source selective collection	Avoiding to break the glass to limit contamination Extract some glass in the light heavy separators
Inert contamination		Removal of inert by source selective collection	Extract some inert in the light heavy separators
Heavy metal contamination	Respect the regulation for contamination	The removal of heavy metal containing waste fractions must be achieved by the upstream process (collection of hazardous waste)	Extract remaining metal but low impact on heavy metal contamination

RDF

For RDF specification, it is still not yet fully finalized for the District Heating plant. An update during the second report will be made.

Table 27: Overview of main criteria for RDF and way to improve the quality

Criteria	Objectives	Improvement by the upstream process	Improvement within the process
Size	To be accepted by end users	-	Shredding and Screening with adapted size
Glass contamination	To reduce as much as possible (<0,25%) visible contamination	Removal of glass by source selective collection	Extract most of the glass in the light / heavy separators
Inert contamination		Removal of inert by source selective collection	Extract most of inert in the light / heavy separators
PVC contamination	To reduce as much as possible (<0,5%) contamination		Using specific technology to remove this product
Aluminium contamination	To reduce as much as possible contamination		Using specific technology to remove this product
Heavy metal contamination	Respect the regulation for contamination	The removal of heavy metal containing waste fractions must be achieved by the upstream process (collection of hazardous waste)	Extract remaining metal but low impact on heavy metal contamination

4.1.4.2 Other performance

Other treatment performance

It is required that the plant be constructed and delivered to allow the implementation of the above objectives while respecting the following principles:

- The installation should be characterised by low energy-consumption.
- The operation costs must be as low as possible
- The installation should meet the requirements of reduction of emissions and the conditions of the Environmental Protection Law

- The environmental impact of the plant operation may not exceed the levels set as acceptable by regulations applicable in Bulgaria and within the European Union.

- The installation should ensure maximum efficiency.

Environmental performance: emissions to air, emission to water, noise

The potential environmental impacts form MBT processes for both options are:

- Emissions to air :
  - Dust:
  - Bio-aerosols:
  - Odours:
  - Ammonia (NH3):
  - Methane (CH4):
  - VOC's:
- Emissions to water:
  - water in contact with waste
  - water coming from the biological process (evaporation) containing organic matter
  - water from road

Working hours

The working hours will be from Monday to Saturday and from 6.00 to 22.00 each day. The working days together are approximately 310 days a year. Normally there are two shifts a day which is operating the plant; 8 hours per shift, 16 hours per day and an efficiency of 90%; which correspond to an average of about 14.5 hours of process operation per day. Out of working hours, maintenance will be done.

As described before, the delivery will happen every day. It was assumed that on Sundays, the amount of delivered waste will be less than on the other days. On Sundays, the incoming waste will be stored inside the reception hall.

Diversion of organic fraction direct input in landfill

From 2013 onwards a BMW target of 50% reduction, to a proportion of 152 kg/cap/a is required, as stipulated in the landfill directive transposed in Bulgaria.

4.2 General features of the MBT plant

In every case, the design and the plant should be able to ensure an effective treatment if the waste changes in composition. That means that the plant should be flexible to fulfil present and also for future changes in waste composition.

For the treatment, reserves will be considered to cover times of outage, for maintenance, changes in the daily amount of delivered waste, etc..

The task of the treatment should be:

- to maximise the amount of recycling of the separated materials
- to process organic fraction by an aerobic process in order to obtain a Compost Like Output (CLO) or stabilized compost, which can be at minimum applied for land remediation or soil improver, if this type of compost is accepted in future regulation by the Chamber of Mining.
- only for OPTION 2, to produce a RDF fraction which can be used as alternative fuels in a cogeneration facility or/and in cement factories in Bulgaria.
- to segregate and minimise the amount of the waste anticipated to be deposited in the landfill and to reduce the emissions potential within the landfill.

Buildings

The MBT-Plant shall consist of the following buildings following the different steps of the process:

- Weighbridge, administrative and social building
- Reception building
- Mechanical Treatment (pre-sorting and processing)
- Sorting
- Intense Composting (Biological treatment)
- Separation post biological treatment
- Biological post treatment (Maturation)
- Refinement of MBT compost
- RDF Production
- Storage of end products

All buildings especially the Reception and the composting halls together with the composting units must have water-tight concrete slabs to avoid any pollution of the underlying soil.

The size of the building must be so designed that there is a corridor of minimum 1 m from machinery to the walls of the buildings for better accessibility.

Weighbridge

A weighbridge is located at the entrance of the Sadinata site for all trucks arriving in the facility. It was decided to implement a weighbridge which will be located between MBT plant and the road to landfill cells. The purpose of this weighbridge is to determine the weight of material directed from MBT-treatment plant to the landfill.

The weighbridge is similar to the weighbridges in the entrance area. The dimensions of the weighbridge should be at minimum 18 m long and 3 m width. The maximum capacity should be 60 tons.

The weighbridge should be equipped with a speaker and a camera system for appropriate operation. The data collected from this weighbridge should be transferred to the administration building via bus system or comparable safe system.

Roads and Spaces

Roads are necessary to connect the parts of the plant which each other and the entrance area.

Spaces are necessary as driving areas in front of buildings and for storage demand.

These places are made of asphalt on a frost proofed layer with a sufficient load-carrying capability. On parts of these places where containers are moved, it is better to use concrete as cover layer.

All roads and spaces have a slight slope towards pits for water drainage purposes.

Regulation No. 7, issued on the basis of the Waste Management Act, dated 24.08.2004 in Annex No 1, from Article 1 to Article 12, some coefficients for utilisation must be fulfilled:

- Composting: 0.75
- Recycling: 0.85

Due to these coefficients, an assignment of all areas of the MBT Plant inside the green boundary has to be made.

General description of MBT

In the following description of both OPTIONS MBT with RDF and MBT without RDF, some of the steps are identical in option with and without RDF production: reception hall, sorting. The chapters are identical in both options.

Some steps are different or completely new in the option MBT with RDF production: biological treatment and RDF preparation.

For the other steps the difference are small. But the flow and mass balance are changing: pretreatment step, maturation step, refining process.

4.3 Description of MBT without RDF

For OPTION 1, MBT without RDF, the main objectives of the process are:

- to maximise the amount of recycling of the separated materials
- to process organic fraction by an aerobic process in order to obtain a Compost Like Output (CLO) or stabilized compost, which can be at minimum applied for land remediation or soil improver, if this type of compost is accepted in future regulation by the Chamber of Mining
- to segregate and minimise the amount of the waste anticipated to be deposited in the landfill and to reduce the emissions potential within the landfill.

Hereunder there is a description for each step of the process with:

- The technical specifications
- The process description
- The flow sheet diagram
- The mass balance assumptions
- The building description

Technical specification

The main data and assumptions used for conceptual design of MBT without RDF are listed below:

Table 28: Technical specification for design of MBT without RDF

Criteria	Figures
Input capacity ➢ Household waste ➢ Commercial waste	410,000 t/a 360,000 t/a 50,000 t/a
Delivery (days/week)	7
Average input capacity ➢ Household waste ➢ Commercial waste	1,140 t/day 1,000 t/day 140 t/day
Number of shifts	2 shifts
Working hours/shift	8 h
Operating time (hours/shift)	7,5 h

Regarding the process, the following assumptions have been taken:

Table 29: Technical specification for material of MBT without RDF

Criteria	Figures
Density of input material (assumption)	0.25 t/m³
Water content of waste (assumption)	35 to 40%
Waste analysis (assumption): ➢ Fraction < 80 mm ➢ Fraction > 80 mm	 55-60% 40-45%
Water content (assumption): ➢ Fraction < 80 mm ➢ Fraction > 80 mm	 40 to 45% 25 to 30%
Duration of treatment ➢ Intense composting (tube) ➢ Post composting - Maturation step	 4 days 10 weeks
Compost maximum grain size	20 mm

Process Overview

The preferred chosen technologies, based on latest European experience and feedback are the following:

- For pretreatment, using mechanical separation with a combination of different equipment in order to optimize :
  - The separation of recyclables (metal, plastic using optical separators)
  - The separation of organic and fines, (including some paper to reduce volume to landfill) in order to reach a good quality.
- For biological treatment:

The composting methods currently in use in Europe can be divided into two different systems according to the aeration and turning technology used the duration of intensive digestion and the particular digestion system.

Closed static systems:

- Box composting without turning
- Container/module composting
- Tower composting

Closed dynamic systems:

- Box or Windrow composting with turning
- Row/tunnel composting

- Drum composting

The intense composting step should be undertaken in a closed area with a minimized air volume to reduce harmful air emissions.

Based on experience and combining with the fact that compost should reach a good quality to fulfill at minimum land remediation requirement, the chosen system should be with forced air to control degradation of organic matter and turning to accelerate the degradation of organic matter. The degradation of paper should also be taken into account, in order to reduce the volume in landfill.

As a result, rotating drum will be recommended with:

- Forced air
- Humidity control and if necessary water will be added
- Excess wastewater must be drained and collected outside the composting unit and directed to the wastewater treatment plant.
- Polluted air must be controlled and cleaned before discharging outside of the facility

This chosen system used in European Western and Southern countries, gives a technical and economical solution more adapted to SM.

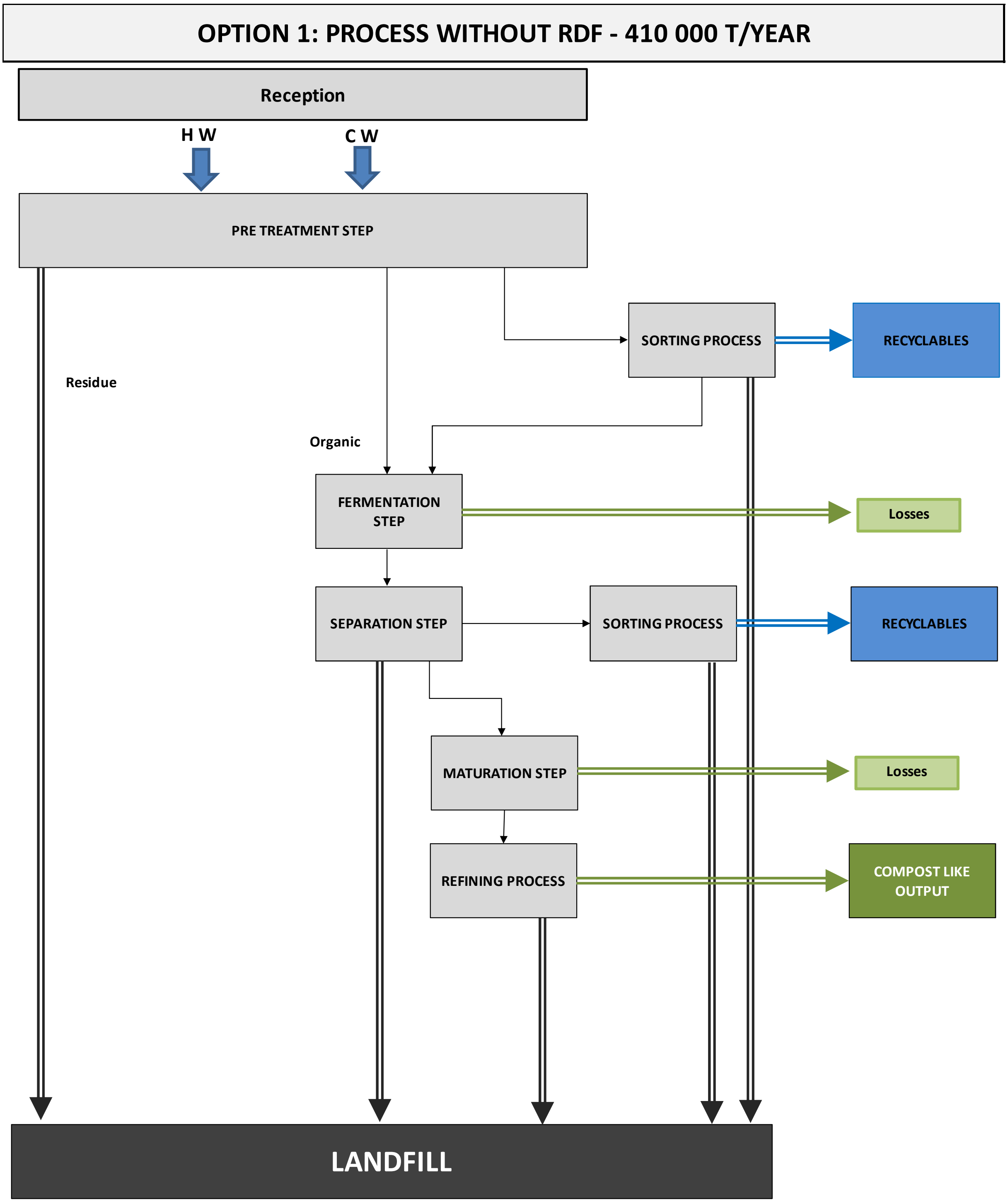
The process is divided into several steps:

- Reception area: incoming flow and presorting
- Pretreatment: separation of the main fraction (recyclables, organic, residue)
- Sorting of recyclables
- Biological treatment
- Separation step
- Biological treatment (maturation)
- Refinement of compost
- Storage of end products

Process flow sheet

Hereunder, there is general flow sheet diagram of the MBT process without RDF.

Figure 15: General flow sheet diagram of MBT process without RDF



4.3.1 Reception Hall

Technical specification

There will be a delivery of a total of 410,000 t of waste (household and commercial waste) per year.

In the MBT plant, two kinds of waste will be treated:

- Household Waste
- Commercial Waste similar to household waste

Mostly, inert and bulky waste will be delivered in the other facility of Vrajdevna. The residual fraction of Vrajdevna will be delivered in MBT plant.

Only household waste and similar waste shall be delivered to the MBT plant.

Table 30: Technical specification for reception hall

Criteria	Figures
Input delivery	1,200 – 1,300 t/d with a max of 1500 t/day
Delivery (days/week)	7
Storage necessary	2 days
Storage height	averagely 5 m
Density of waste	0.25 t/m³
Max volume of storage	12,000 m³
Area necessary for storage	2,400 m²

Process description - Delivery

The waste will be delivered by collection trucks or transfer trucks and weighed at the entrance of the site. Weighing will be carried out for the incoming and outgoing trucks. In case of no transfer station, the number of trucks per day is assumed to be 100 to 200, with an average capacity of 5 to 10 t.

Delivery peaks are to be expected after collection breaks. Assuming that most of the quantity will be delivered during these peaks, they should be a sufficient unloading space to limit waiting time and traffic for the incoming trucks.

Regarding the daily delivery and traffic estimation, it is recommended to have an outside manoeuvring zone before unloading, and for the unloading zone to have a quay which will improve safety by avoiding:

- to manoeuvre inside the building with loaders, cranes, and consequently avoid accidents

- to have drivers walking on the reception area when opening/closing the doors of containers or cleaning their trucks
- to optimise the space for the building by avoiding to have building space only for trucks manoeuvring

The most appropriate structure for reception area is a quay with a height of a minimum 2.5 meters using the slope of the land is possible (without heavy work for construction).

Furthermore, automatic doors on these quays will be opened only when trucks empty, limiting odours and dust outside of the building.

The waste will be dumped in the reception building and transported from there to the storage area or treatment line with a wheel loader. A crane can separate the problematic waste out of the incoming waste and deposit it into a container or a specific area.

Presorting will be carried out using cranes. For safety reasons, manual sorting will be forbidden in this reception hall. After presorting, the crane deposits the waste into the bunker hopper.

Waste which is designated for later sorting is stored in a separate area within the reception hall. It is proposed to separate the building in two halls, then in the first hall, only typical household waste should be delivered and in the second hall, commercial and source selected waste for sorting should be delivered in.

Mass balance

From this presorting step, it can be estimated that about 1% of input waste can be sorted out as unwanted waste and will go to specific treatment (e.g. hazardous waste) or to recycling (e.g. big metal pieces) or to landfill.

The residual fraction will go to the pretreatment process (see 4.3.2.)

Reception building

The reception area is divided into two parts. This is recommended to reduce the fire risks. It is also possible to separate the kind of waste. So in the first area the typical household waste will be delivered and treated and in the other area commercial waste and more valuable household waste will be delivered and presorted before treatment.

The estimated dimensions of the building are 4,000 m². The height should be about 14m for crane utilization.

The structure of the building is made of reinforced concrete because of the fire load of the temporary stored waste. Also the complete floor is made of concrete. The separation wall between the two buildings is also made of concrete to avoid fire transportation from one building to the other one.

The buildings is equipped with at a minimum 8 gates with dimensions of minimum 4 m (width) x 6 m (height) and sufficient number of emergency exits.

4.3.2 Pretreatment step

Technical specification

The following data of treatment capacity have been taken:

Table 31: Technical specification for pretreatment process

Criteria	Household waste	Commercial waste
Throughput Capacity of waste	360,000 t/a	50,000 t/a
Number of shifts	2 shifts	2 shifts
Working days a week	6 days	6 days
Working days a year	310 days	310 days
Hours per shift	8 h	8 h
Working hours per shift	7.5 h	7.5 h
Capacity per day	1,160 t/d	161 t/d
Capacity per hour	77 t/h	11 t/h
Capacity per hour with availability and safety factor	90 t/h	15 t/h
Number of treatment line	3 lines	1 line
Throughput per line (t/h)	30 t/h	20 t/h

The presorted quantities (estimated 1%) have been considered as negligible in the design specification.

Process description

The different steps of the pretreatment process are:

1. A mechanical separation of waste upper than 200mm in order to sort out the big fractions with potentially recyclables. The lower fraction will go to the sieve.
2. For waste upper than 200mm, there are two possibilities:
    a. For good quality with potential of recyclables, these wastes will be sent to the sorting area (see 4.3.3.)
    b. For low quality with mixed residual waste, these waste will be sent to the shredder
3. For the residue of sorting and for low quality upper size, a shredder will reduce the grain size below 200mm and break up compounds.

4. For the below 200mm fraction (see 1) and the after shredding fraction (see 3), the material will be sieved within a trommel. The sieving gives two fractions below and above 90 mm. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and future changes in waste composition.

5. The fraction below 90mm will pass through:

    a. an overband to get out ferrous metal conveyed to a storage area

    b. a non-ferrous separator to get out non-ferrous metal conveyed to a storage area

    c. The remaining fraction, mostly organic fraction, will be transported to the biological treatment rotating drum.

6. The fraction above 90 mm will be treated with so called ballistic separators. With this treatment, it is possible to separate the waste fraction into three fractions:

    a. a light, flat fraction: the light fraction coming out of the ballistic separation system will be conveyed to the optical sorting to recover fibre fraction. This fibre fraction will be transported to the biological treatment rotating drum. The remaining fraction will be sent to a storage area or a container to be sent to landfill.

    b. a heavy spherical fraction (hard fraction) : this hard fraction will be treated with:

        i. an over-belt magnet to separate ferrous metals transported to a storage area

        ii. a non-ferrous separator to sort out non-ferrous metals transported to a storage area.

        iii. an optical sorter to blow some recyclables like PET, HDPE, PP transported to the sorting area

        iv. an optical sorter to blow residual fibre fraction like paper, cardboard, other fibrous material (wood, textiles, …) which will be conveyed to the rotating drum.

        v. the residual fraction will be transported to a storage area or a container to be sent to landfill

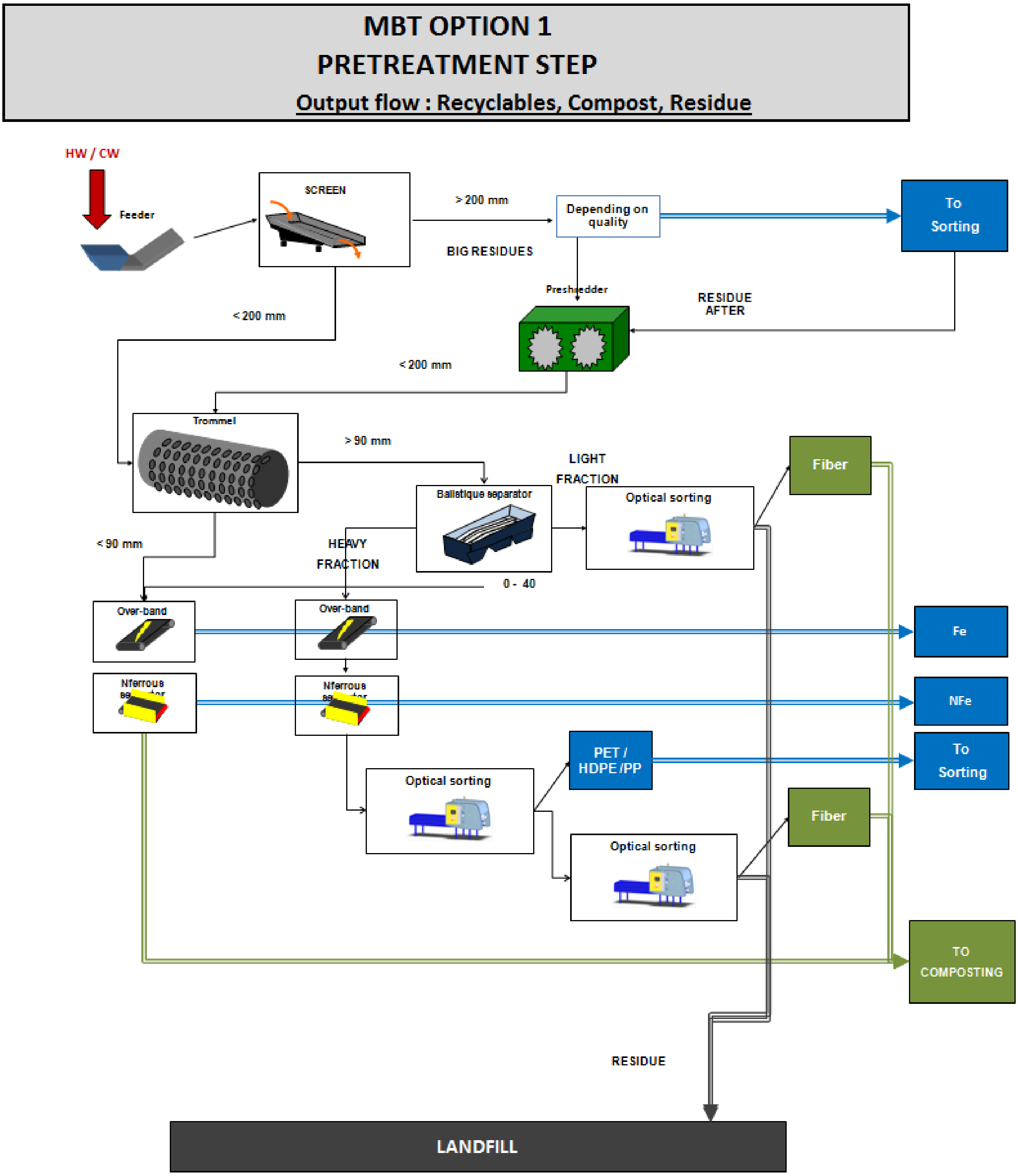
    c. a fine fraction: the fine fraction < 40 mm will be added to the fraction below 90 mm directed to the rotating drum.

Process flow sheet

Here under there is a flow sheet diagram of the pre-treatment process for MBT without RDF.

The process will be similar for the 3 lines for Household waste and for the line for commercial waste. For the shredder(s) receiving about 20 to 25% of the input flows, 2 shredders for the 4 lines are enough, meaning one shredder for 2 lines with a bypass to distribute the flow after shredding on both lines.

Figure 16: Flow sheet diagram of pretreatment process without RDF



Mass balance

From this pretreatment step, it can be estimated the following outputs:

Table 32: Mass balance for pre-treatment process

Destination	Household waste	Commercial waste
Sorting (from presorting) After sorting, the residue will be transported back to the pretreatment process	≈ 10%	≈ 30%

Destination after presorting	Household waste		Commercial waste		Total (in t/a)
Recycling (Fe and NFe)	≈ 1%	2,000 t/a	≈ 2%	1,000 t/a	3,000
Sorting (from optical sorters)	≈ 1%	3,000 t/a	≈ 1-2%	1,000 t/a	4,000
Other recyclables from sorting (see 4.3.3.)	≈ 0.3%	1,000 t/a	≈ 10%	5,000 t/a	6,000
Biological treatment rotating tube (inc. residue from sorting step (see 4.3.3)	≈ 60-65%	234,000 t/a	≈ 50%	25,000 t/a	259,000
Landfill (inc. residue from sorting step (see 4.3.3)	≈ 30-35%	120,000 t/a	≈ 35-40%	18,000 t/a	138,000

Pre treatment Building

The mechanical treatment building is located between the reception building and the intense composting.

The estimated dimensions of the building are 4,000m²

4.3.3 Sorting step

Technical specification

The following data of treatment capacity for the sorting step have been taken:

Table 33: Technical specification for sorting process

Criteria	Valuable material from Household waste	Valuable material from Commercial waste	Sorted material from optical sorting form pretreatment process
Throughput Capacity of waste	36,000 t/y	15,000 t/y	4 to 8,000 t/y
Number of shifts	2 shifts	2 shifts	2 shifts
Working days a week	6 days	6 days	6 days
Working days a year	310 days	310 days	310 days
Hours per shift	8 h	8 h	8 h
Working hours per shift	7.5 h	7.5 h	7.5 h
Capacity per day	116 t/d	50 t/d	25 t/d
Throughput per line (t/h)	8 t/h	3,5 t/h	1,5 t/h
Capacity per hour	10 t/h	5 t/h	3 t/h
Number of sorting line	1 line	1 line	1 line

Process description

The process will be the following:

- Valuable household Waste: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting paper, cardboard, plastic and metal fraction.
- Valuable commercial Waste: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting paper, cardboard, plastic and metal fraction.
- Recyclables from balistique: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting PET, HDPE, PP, and others recyclables.
- After sorting the residual fraction will go back directly to the reception hall and to the shredder.

The recyclables will be stored in box (some equipped with walking floor) and alternatively emptying on a conveyor to be baled (except for specific material like metal or glass).

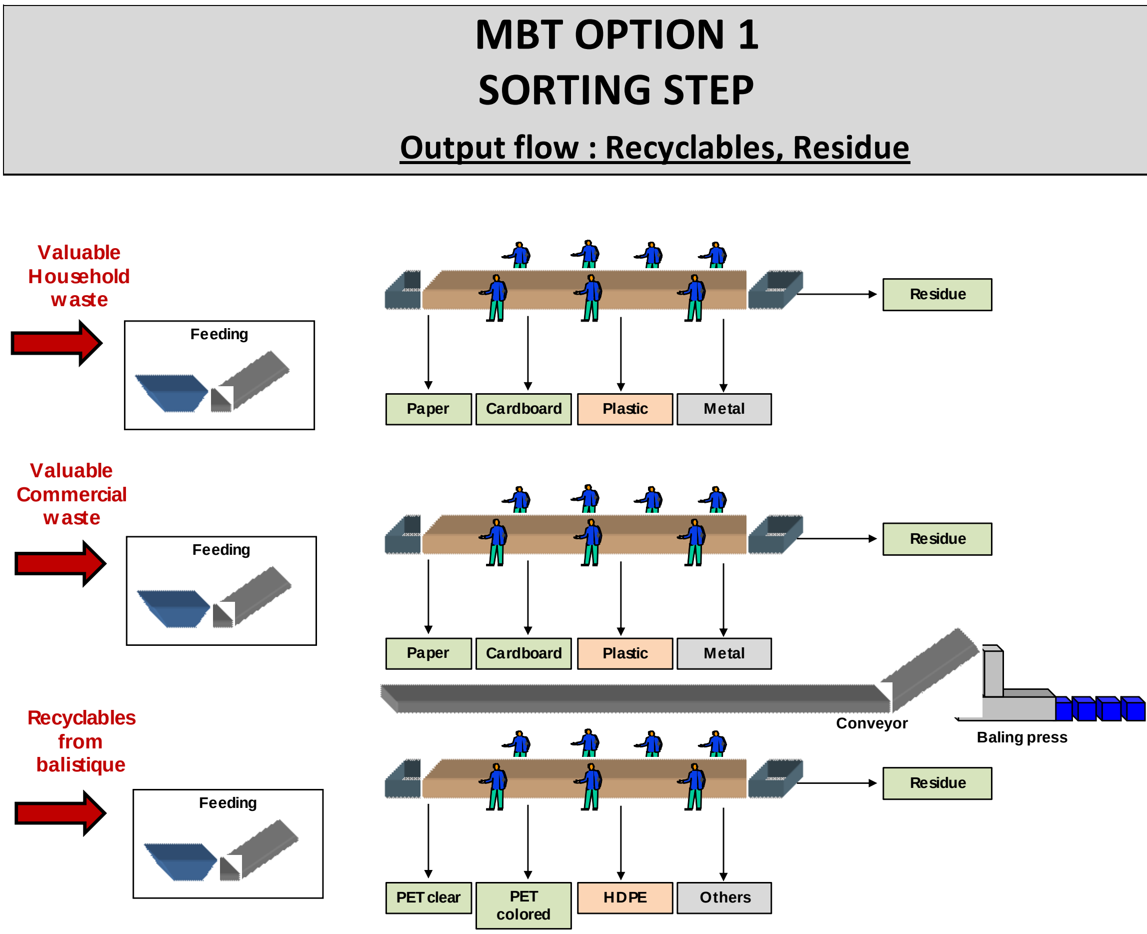
The bales and other recyclables will then be stored before being sent to recyclers.

Process flow sheet

Here under there is a flow sheet diagram of the sorting process for MBT without RDF.

The process will be similar for the 3 lines for Household waste, for commercial waste and for recyclables coming from balistique.

Figure 17: Flow sheet diagram of sorting process



Mass balance

From this sorting step, it can be estimated that from input of the sorting line:

Table 34: Estimated mass balance from the sorting step

Destination	Valuable material from Household waste	Valuable material from Commercial waste	Sorted material from optical sorting form pretreatment process
Recycling (Fe and NFe)	≈ 1%	≈ 2%	≈ 0%
Recycling (Paper and cardboard)	≈ 1%	≈ 20%	≈ 0%
Recycling (Plastic and others)	≈ 3%	≈ 3%	≈ 80%
Residue to be sent back to pretreatment process	≈ 95%	≈ 75%	≈ 20%

Destination after sorting	Household waste		Commercial waste		Total (in t/a)
Recycling (Fe and NFe)	≈ 1%	400 t/a	≈ 2%	300 t/a	700
Recycling (Paper and cardboard)	≈ 1%	300 t/a	≈ 20%	3,000 t/a	3,300
Recycling (Plastic and others)	≈ 3%	1,000 t/a	≈ 3%	1,000 t/a	2,000
Total (of overall household and commercial waste)	≈ 0.3%	1,000 t/a	≈ 10%	5,000 t/a	6,000

Sorting Building

The sorting step is located after the pretreatment step.

The estimated dimensions of the building are 2,000m².

4.3.4 Biological treatment step

Technical specification

According to the assumed mass balance after pre-treatment the input to the biological treatment step is about 260.000t/a.

The design specifications are the following:

Table 35: Technical specification for composting step process

Criteria	Fines fraction <90mm
Throughput Capacity of waste	260,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	840 t/d
Capacity per hour (t/h)	56 t/h
Capacity per hour with availability and safety factor	65 t/h
Density of waste	0,4 t/m³
Number of lines/tubes	6 lines

Volume of Composting Units

The treatment within the biological treatment tube will occur over a period of about 4 days.

The biological treatment tube will be installed outside of the building, the only part connected to the building are the feeding and discharge part.

Each rotating tube will have a diameter of about 4,5m and a length of about 45m.

Process description

The fraction below 90 mm after sieving (see 4.3.2) will be conveyed to the rotating tube and feed with a specific system in each tube. The treatment duration will be 4 days.

The rotating tubes will turn slowly then mix all waste and degrade organic fraction, including paper and cardboard.

After the biological treatment process, the material will be discharged and dropped to the separation step.

Mass balance

During the biological treatment step, biodegradation will occur. Consequently, some water will be evaporated from the waste flow and biodegradation will transform organic matter in CO_2 going to air.

After about 4 days, the following assumptions can be taken:

- Input material: ≈ 260,000 t
- Output material: ≈ 230,000 to 245,000 t
- Losses (water and CO2): ≈ 15,000 to 30,000 t

Building

There is no need of building for this biological treatment step.

4.3.5 Post biological treatment separation step

Technical specification

According to the assumed mass balance after biological treatment is about 233,000 t/a.

The design specifications are the following:

Table 36: Technical specification for composting step process

Criteria	Organic fraction
Throughput Capacity of waste	240,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	780 t/d
Capacity per hour (t/h)	52 t/h
Capacity per hour with availability and safety factor	60 t/h
Density of waste	0,4 t/m³
Number of lines	2 lines

Process description

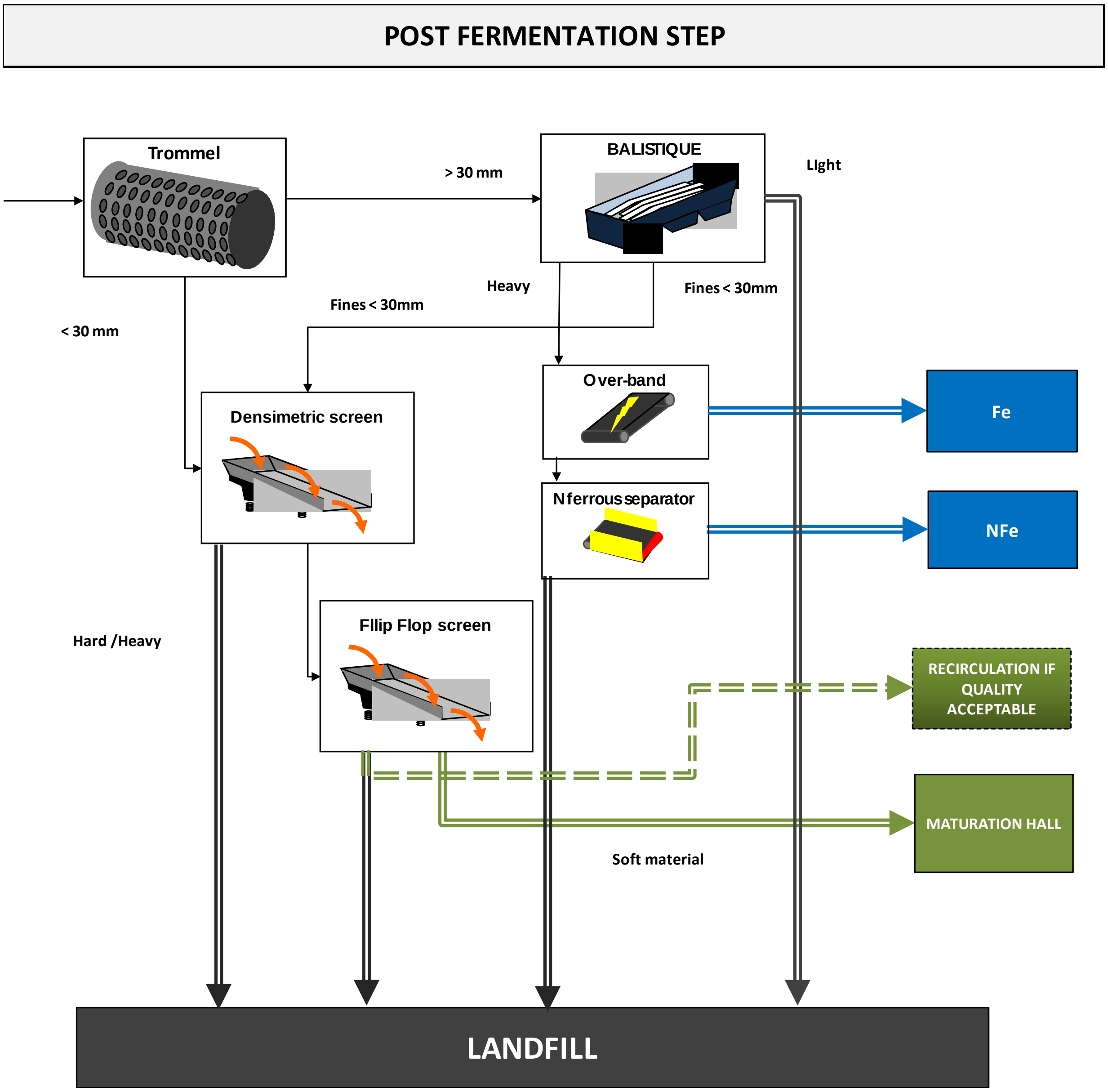
The different steps of the post biological treatment step process are:

1. The material will be sieved within a trommel. The sieving gives two fractions below and above 30 mm. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and quality of end products.
2. The fraction above 30 mm will be treated with so called ballistic separators. With this treatment, it is possible to separate the waste fraction into three fractions:
    a. a light, flat fraction: the light fraction coming out of air or ballistic separation system will be conveyed to a storage area or a container to be sent to landfill
    b. a heavy spherical fraction (hard fraction) : this hard fraction will be treated with:
        i. an over-belt magnet to separate ferrous metals transported to a storage area
        ii. a non-ferrous separator to sort out non-ferrous metals transported to a storage area.
        iii. the residual fraction will be transported to a storage area or a container to be sent to landfill
    c. a fine fraction: the fine fraction < 30 mm will be added to the fraction below 30 mm.
3. The fraction below 30mm will pass through:
    a. A first densimetric table/screen in order to eliminate inert and heavy fraction like glass
    b. A so called “flip flop” separator, to screen the fines fraction (<10 to 15mm) and separate residual fraction
    c. If necessary a second densimetric table/screen in order to eliminate inert and heavy fraction like glass
    d. The remaining fraction, mostly organic fraction, will be transported to the maturation hall.

Process flow sheet

Here under there is a flow sheet diagram of the post biological treatment process for MBT without RDF.

Figure 18: Flow sheet diagram of post biological treatment process



Mass balance

From this post biological treatment step, it can be estimated that:

Table 37: Output from the post biological treatment step

Destination	Organic fraction	Total in t/a
Recycling (Fe and NFe)	≈ 0,4%	1,000
Maturation hall (fine fraction)	≈ 60 - 65%	153,000
Landfill	≈ 35 - 40%	79,000

Post biological treatment Building

The post biological treatment treatment building is located between the rotating tube and the maturation. It can be combined with the pretreatment building.

The estimated dimensions of the building are between 2,500 to 3,000m² depending on the suppliers.

4.3.6 Biological treatment step - Maturation

Technical specification

According to the assumed mass balance after post separation the input to the biological treatment is about 153 000 t/a.

The design specifications are the following:

Table 38: Technical specification for composting step process

Criteria	Fines fraction
Throughput Capacity of waste	153,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	500 t/d
Capacity per hour (t/h)	33 t/h
Capacity per hour with availability and safety factor	36 t/h
Density of waste	0,45 t/m³
Capacity per hour (m³/h)	80 m³/h

The process should be able to receive some additional fraction like fiber residue if needed (in case of lack of structuring material). This fraction may come from the refining process or residue from the Green waste and Biowaste composting plant, this residue coming on Sadinata after refining compost. The used safety factors are necessary to cover changes in the waste amount and in the waste composition.

Dimension of Composting Units - maturation step

The treatment within the post composting-maturation step will occur over a period of 10 weeks.

As assumption, a unit has the following height: 2,5 to 2,7m for the feeding of organic matter.

Based on 10 weeks capacity and with the safety factor, it means a capacity of 67,000 m³. It means a necessary surface of box of about 22,000 to 27,000m² whatever the size of supplier of technology.

For calculation of space demand, there are additional areas for take-over of the material. An additional 1,000 m² for the input material and 1,000 m² for takeover are taken into account.

Process description

The fine fraction will be transported via conveying belt to the post composting section. As described in the intense composting, the material will be rewetted if necessary and mixed again to ensure enough biological activity for decomposition of organic matter.

The waste will be transported with a wheel loader into the composting units. The wheel loader will fill up the units with an average material height of 2.5 to 2,7m.

An automatic or semi-automatic system will be used on each unit in order to turn regularly each box, especially in the first stage of degradation (about 6 weeks).

After biological treatment (10 weeks), the material will be transported via conveyor to the refinement building.

Mass balance

During the maturation step, biodegradation will occur. Consequently, some water will be evaporated from the waste flow and biodegradation will transform organic matter in CO_2 going to air.

After 10 weeks, the following assumptions can be taken:

- Input material: 153,000 t
- Output material: 105,000 to 110,000 t
- Losses (water and CO_2): 40,000 to 45,000 t

Composting Building – maturation step

The building mainly consists of the composting units and the roof for enclosure. The assumed dimensions of the building are for the compost units 24,000 m² to 29,000m².

Each compost building may consist of 2 rows of units. Between the units is the driving area for the wheel and loaders. This area will be roofed.

For the treatment of waste, the individual size of each unit is dependent on the later chosen technology of the contractor. Additionally, space for material handling is necessary estimated around 25% of the composting units. So the overall dimensions of the compost building(s) are estimated to be 30,000 to 36,000m². If necessary, this can be split in 2 buildings depending on the sizing on the facility.

These units are mainly made of concrete. In the floor of every unit, aeration and drain systems will be integrated. Between the units, an underground tunnel is arranged. Within this tunnel, there is the collection system for all the leachate and condensate water and the pipeline for the aerations system.

4.3.7 Refining step

Technical specification

According to the assumed mass balance after post separation the input to the biological treatment is about 110,000 t/a.

Table 39: Technical specification for refining process

Criteria	Organic fraction
Throughput Capacity of waste	110,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	360 t/d
Capacity per hour	24 t/h
Capacity per hour with availability and safety factor	30 t/h
Number of treatment line	1 line

Process description

The different steps of the maturation step process are:

1. The material will be sieved within a trommel. The sieving gives two fractions below and above 20 mm or 10mm depending on local market and quality requirement. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and quality of end products.

2. The fraction above 10-20 mm will be treated with so called air or ballistic separators. With this treatment, it is possible to separate the waste fraction into two to three fractions:

    a. a light, flat fraction: the light fraction coming out of the air or ballistic separation system will be conveyed to storage area or a container to be sent to landfill

    b. a heavy spherical fraction (hard fraction) : this hard fraction will be transported to a storage area or a container to be sent to landfill

    c. in case of ballistic a fine fraction: the fine fraction < 10-20 mm will be added to the fraction below 10-20 mm.

3. The fraction below 10-20mm will pass through:

    a. A first densimetric table/screen in order to eliminate inert and heavy fraction like glass

    b. A so called “flip flop” separator, to screen the fines fraction (<10 mm) and separate residual fraction

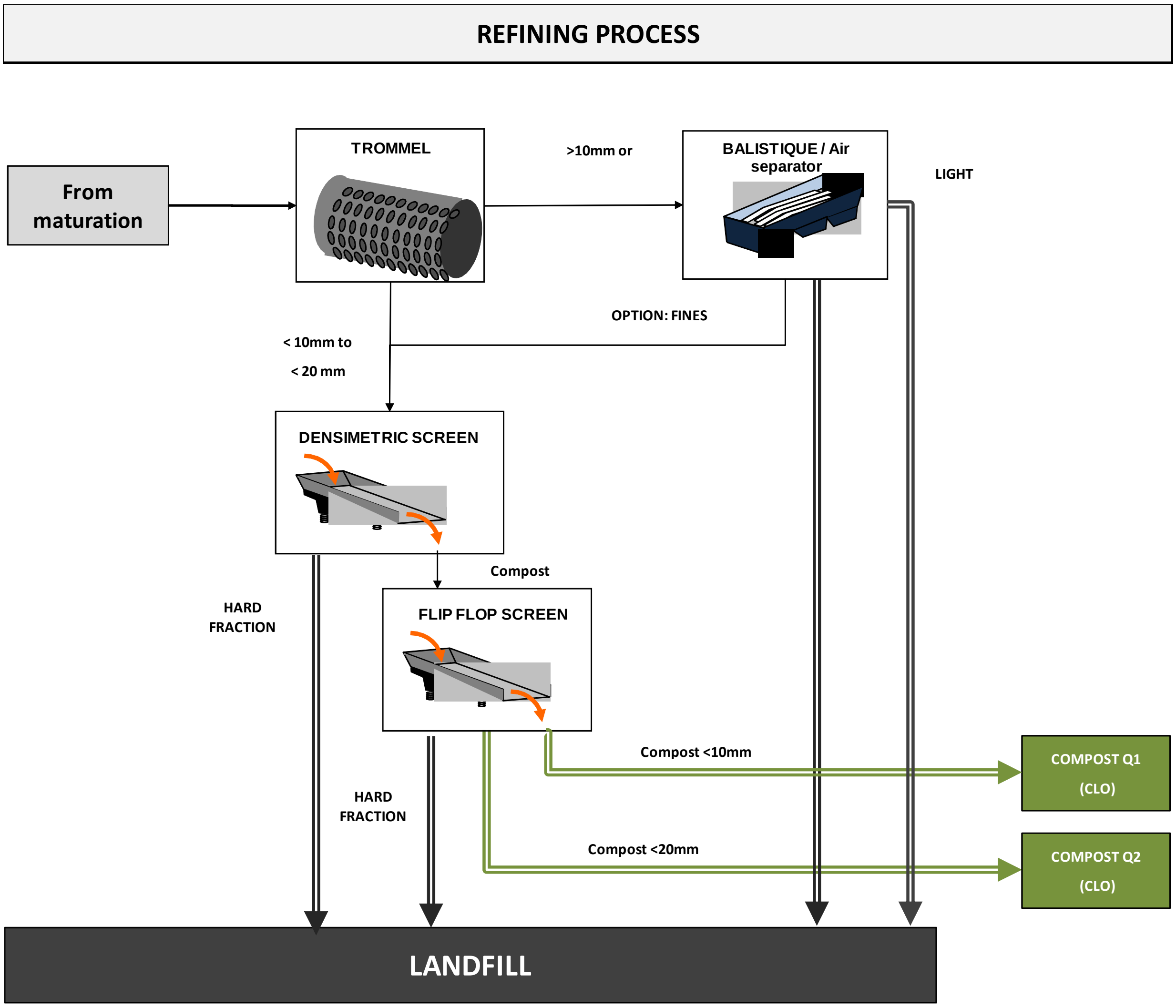
    c. If necessary a second densimetric table/screen in order to eliminate inert and heavy fraction like glass

    d. The remaining fraction, mostly organic fraction, will be transported to the storage hall.

Process flow sheet

Here under there is a flow sheet diagram of the refining process for MBT without RDF.

Figure 19: Flow sheet diagram of refining process



Mass balance

From this maturation step, with an input of 110, 000 t/y, the outputs are:

Table 40: Output from refining process

Destination	Organic fraction	Total in t/a
Storage hall (fine fraction)	≈ 75 - 80%	85,000
Landfill	≈ 20 - 25%	25,000

Refining Building

The refining building is located after the maturation building.
The estimated dimensions of the building are 1,000m²

4.3.8 Storage step

Technical specification

According to the assumed mass balance after the different separation, the volume of material to be stored is:

Table 41: Technical specification for storage step

Criteria	Recyclables	Compost	Residue
Throughput Capacity of waste	Ferrous : 5,000 t/a Plastic : 6,000 t/a Paper : 3,000 t/a	85,000 t/a	242,000 t/a
Number of days of storage	–	1 month minimum	Delivered to landfill
Minimum quantities of storage	For baling, 40 t per quality For loose, 100m3		
Capacity of storage (t)	300 t	7,000 t	
Capacity of storage (m3)	600 m3	14,000 m3	
Quantity (m3/m²) inc. safety factor	2 m3/m²	4 m3/m²	
Necessary surface	500 m²	3,500 m²	

Process description

Recyclables will be stored by category (ferrous, non-ferrous, plastic (PET per color, HDPE, ..), paper, cardboard…). For each category, it will be necessary to have at minimum one truck (24t) in stock. With the safety factor, the capacity is estimated to be 300t.

Compost should be stored and cannot be sent everyday (even for land remediation, weather conditions is a constraints which should be taken into account). A minimum capacity of 1 month has been taken as assumption, meaning 7,000t to be stored.

Building

The storage building is located between the post composting building and the sorting building. The estimated dimensions of the building are 4,000 m².

4.3.9 MBT without RDF main data

4.3.9.1 Global mass balance

Table 42: Global mass balance option MBT without RDF production

Input	
Household Waste	360 000 t/y
Commercial Waste	50 000 t/y
TOTAL	410 000 t/y

Output			
Recycling	Metals	5,000 t/a	1,2%
	Plastics	6,000 t/a	1,5%
	Paper	3,000 t/a	0,7%
Compost Like Output (CLO)		85,000 t/a	20,7%
Losses		69,000 t/a	16,8%
Residue		242,000 t/a	59%
TOTAL		410,000 t/a	100%

4.3.9.2 Surface of the buildings

Table 43: Summary surface of building option MBT without RDF production

Building	Maximum surface
Reception Hall	4,000 m²
Pretreatment building	4,000 m²
Sorting building	2,000 m²
Separation post biological treatment	2,500 m² - 3,000 m²
Maturation building	30,000 m²- 36,000 m²
Refining building	1,000 m²
Storage building	4,000 m²
Total	**47,500 m²- 54,000 m²**

4.4 Description of MBT with RDF

For OPTION 2, MBT with RDF, the main objectives of the process are:

- to maximise the amount of recycling of the separated materials
- to process organic fraction by an aerobic process in order to obtain a Compost Like Output (CLO) or stabilized compost, which can be at minimum applied for land remediation or soil improver, if this type of compost is accepted in future regulation by the Chamber of Mining
- to produce RDF fractions which can be used as alternative fuels in a cogeneration facility or/and in cement factories in Bulgaria.
- to segregate and minimise the amount of the waste anticipated to be deposited in the landfill and to reduce the emissions potential within the landfill.

Hereunder there is a description for each step of the process with:

- The technical specifications
- The process description
- The flow sheet diagram
- The mass balance assumptions
- The building description

Technical specification

The main data and assumptions used for conceptual design of MBT with RDF are listed below:

Table 44: Technical specification for design of MBT with RDF

Criteria	Figures
Input capacity ➢ Household waste ➢ Commercial waste	410,000 t/a 360,000 t/a 50,000 t/a
Delivery (days/week)	7 days/week
Average input capacity ➢ Household waste ➢ Commercial waste	1,140 t/day 1,000 t/day 140 t/day
Number of shifts	2 shifts
Working hours/shift	8 h
Operating time (hours/shift)	7,5 h

Regarding the process, the following assumptions have been taken:

Table 45: Technical specification for material of MBT with RDF

Criteria	Figures
Density of input material (assumption)	0.25 t/m³
Water content of waste (assumption)	35 to 40%
Waste analysis (assumption): ➢ Fraction < 80 mm ➢ Fraction > 80 mm	 55 - 60% 40 - 45%
Water content (assumption): ➢ Fraction < 80 mm ➢ Fraction > 80 mm	 40 to 45% 25 to 30%
Duration of treatment ➢ Intense composting ➢ Post composting	 4 weeks 8 weeks
RDF maximum grain size	200 mm
Compost maximum grain size	20 mm

Process Overview

The preferred chosen technologies, based on latest European experience and feedback are the following:

- For pretreatment, using mechanical separation with a combination of different equipmens in order to optimize :
  - The separation of recyclables (metal, plastic using optical separators)
  - The separation of organic and fines in order to reach a good quality
  - The separation of RDF in different fractions
- For biological treatment, especially biological treatment:

The composting methods currently in use in Europe can be divided into two different systems according to the aeration and turning technology used, the duration of intensive digestion and the particular digestion system.

Closed static systems:

- Box composting without turning
- Container/module composting
- Tower composting

Closed dynamic systems:

- Box or Windrow composting with turning
- Row/tunnel composting
- Drum composting

The intense composting step should be undertaken in a building with a minimized air volume to reduce harmful air emissions.

Based on experience and combining with the fact that compost should reach a good quality to fulfill at minimum land remediation requirement, the chosen system should be with forced air to control degradation and turning to accelerate the degradation of organic matter.

As a result, modular composting in boxes made of concrete will be recommended including a turning system with:

- Forced air through the boxes
- Humidity control and if necessary water will be added
- Excess wastewater must be drained and collected outside the composting unit and directed to the wastewater treatment plant.
- Polluted air must be controlled and cleaned before discharging outside of the facility

This chosen system used in European Western and Southern countries, give a technical and economical solution more adapted to SM.

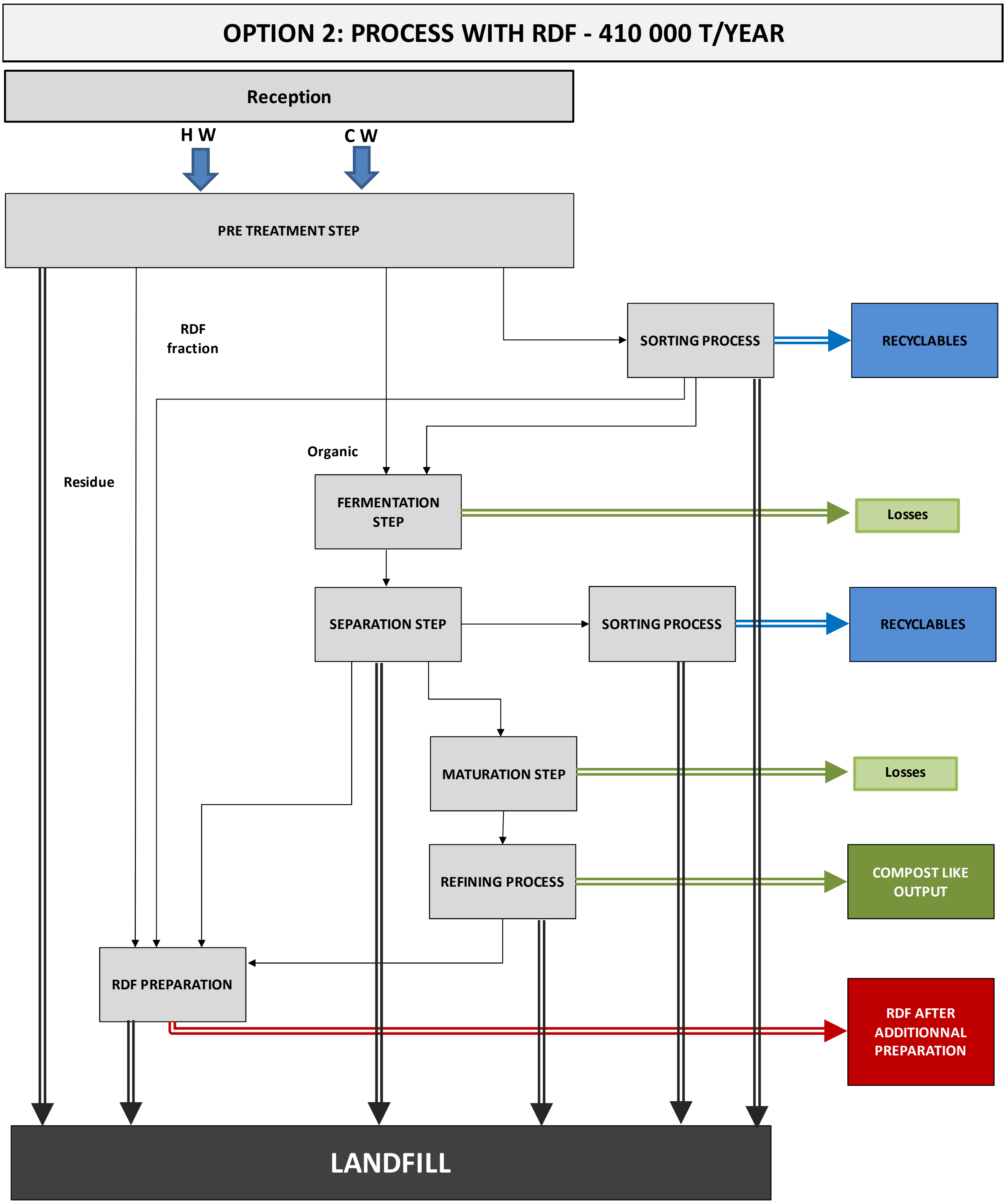
The treatment process is divided into several steps:

- Reception area: incoming flow and presorting
- Pretreatment: separation of the main fraction (recyclables, organic, RDF, residue)
- Sorting of recyclables
- Biological treatment
- Separation step
- Biological treatment (maturation)
- Refinement of compost
- RDF preparation
- Storage of end products

Process flow sheet

Hereunder, there is general flow sheet diagram of the MBT process with RDF.

Figure 20: General flow sheet diagram of MBT process with RDF



4.4.1 Reception Hall

Technical specification

There will be a delivery of a total of 410,000 t of waste (household and commercial waste) per year.

In the MBT plant, two kinds of waste will be treated:

- Household Waste
- Commercial Waste similar to household waste

Mostly, bulky waste will be delivered in the other facility of Vrajdevna. The residual fraction of Vrajdevna will be delivered in MBT plant.

Only household waste and similar waste shall be delivered to the MBT plant.

Table 46: Technical specification for reception hall

Criteria	Figures
Input delivery	1,200 – 1,300 t/d with a max of 1500 t/day
Delivery (days/week)	7
Storage necessary	2 days
Storage height	averagely 5 m
Density of waste	0.25 t/m³
Max volume of storage	12,000 m³
Area necessary for storage	2,400 m²

Process description - Delivery

The waste will be delivered by collection trucks or transfer trucks and weighed at the entrance of the site. Weighing will be carried out for the incoming and outgoing trucks. In case of no transfer station, the number of trucks per day is assumed to be 100 to 200, with an average capacity of 5 to 10 t.

Delivery peaks are to be expected after collection breaks. Assuming that most of the quantity will be delivered during these peaks, they should be a sufficient unloading space to limit waiting time and traffic for the incoming trucks.

Regarding the daily delivery and traffic estimation, it is recommended to have an outside manoeuvring zone before unloading, and for the unloading zone to have a quay which will improve safety by avoiding

- to manoeuvre inside the building with loaders, cranes, and consequently avoid accidents

- Have drivers walking on the reception area when opening/closing the doors of containers or cleaning their trucks
- Optimise the space for the building by avoiding to have building space only for trucks manoeuvring

The most appropriate structure for reception area is a quay with a height of a minimum 2.5 meters using the slope of the land is possible (without heavy work for construction).

Furthermore, automatic doors on these quays will be opened only when trucks empty, limiting odours and dust outside of the building.

The waste will be dumped in the reception building and transported from there to the storage area or treatment line with a wheel loader. A crane can separate the problematic waste out of the incoming waste and deposit it into a container or a specific area.

Presorting will be carried out using cranes. For safety reasons, manual sorting will be forbidden in this reception hall. After presorting, the crane deposits the waste into the bunker hopper.

Waste which is designated for later sorting is stored in a separate area within the reception hall. It is proposed to separate the building in two halls, then in the first hall, only typical household waste should be delivered and in the second hall, commercial and source selected waste for sorting should be delivered in.

Mass balance

From this presorting step, it can be estimated that about 1% of input waste can be sorted out as unwanted waste and will go to specific treatment (e.g. hazardous waste) or to recycling (e.g. big metal pieces) or to landfill.

The residual fraction will go to the pretreatment process (see 4.4.2.)

Reception building

The reception area is divided into two parts. This is recommended to reduce the fire risks. It is also possible to separate the kind of waste. So in the first area the typical household waste will be delivered and treated and in the other area commercial waste and more valuable household waste will be delivered and presorted before treatment.

The estimated dimensions of the building are 4,000 m². The height should be about 14m for crane utilization.

The structure of the building is made of reinforced concrete because of the fire load of the temporary stored waste. Also the complete floor is made of concrete. The separation wall between the two buildings is also made of concrete to avoid fire transportation from one building to the other one.

The buildings is equipped with at a minimum 8 gates with dimensions of minimum 4 m (width) x 6 m (height) and sufficient number of emergency exits.

4.4.2 Pretreatment step

Technical specification

The following data of treatment capacity have been taken:

Table 47: Technical specification for pretreatment process

Criteria	Household waste	Commercial waste
Throughput Capacity of waste	360,000 t/a	50,000 t/a
Number of shifts	2 shifts	2 shifts
Working days a week	6 days/week	6 days/week
Working days a year	310 days	310 days
Hours per shift	8 h	8 h
Working hours per shift	7.5 h	7.5 h
Capacity per day	1,160 t/d	161 t/d
Capacity per hour	77 t/h	11 t/h
Capacity per hour with availability and safety factor	90 t/h	15 t/h
Number of treatment line	3 lines	1 line
Throughput per line (t/h)	30 t/h	20 t/h

The presorted quantities (estimated 1%) have been considered as negligible in the design specification.

Process description

The different steps of the pretreatment process are:

1. A mechanical separation of waste upper than 200mm in order to sort out the big fractions with potentially recyclables. The lower fraction will go to the sieve.
2. For waste upper than 200mm, there are two possibilities:
    a. For good quality with potential of recyclables, these wastes will be sent to the sorting area (see 4.4.3.)
    b. For low quality with mixed residual waste, these waste will be sent to the shredder
3. For the residue of sorting and for low quality upper size, a shredder will reduce the grain size below 200mm and break up compounds.

4. For the below 200mm fraction (see 1) and the after shredding fraction (see 3), the material will be sieved within a trommel. The sieving gives two fractions below and above 80 mm. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and future changes in waste composition.

5. The fraction below 80mm will pass through:

   a. an overband to get out ferrous metal conveyed to a storage area

   b. a non-ferrous separator to get out non-ferrous metal conveyed to a storage area

   c. The remaining fraction, mostly organic fraction, will be transported to the composting hall.

6. The fraction above 80 mm will be treated with so called ballistic separators. With this treatment, it is possible to separate the waste fraction into three fractions:

   a. a light, flat fraction: the light fraction coming out of the ballistic separation system will be conveyed to the RDF-processing building. The description of RDF-production will follow after the description of the composting process (see 4.4.8)

   b. a heavy spherical fraction (hard fraction) : this hard fraction will be treated with:

      i. an over-belt magnet to separate ferrous metals transported to a storage area

      ii. a non-ferrous separator to sort out non-ferrous metals transported to a storage area.

      iii. an optical sorter to blow some recyclables like PET, HDPE, PP transported to the sorting area

      iv. an optical sorter to blow residual RDF fraction like paper, cardboard, other plastic, synthetic textiles, …which will be conveyed to the RDF processing building.

      v. the residual fraction will be transported to a storage area or a container to be sent to landfill

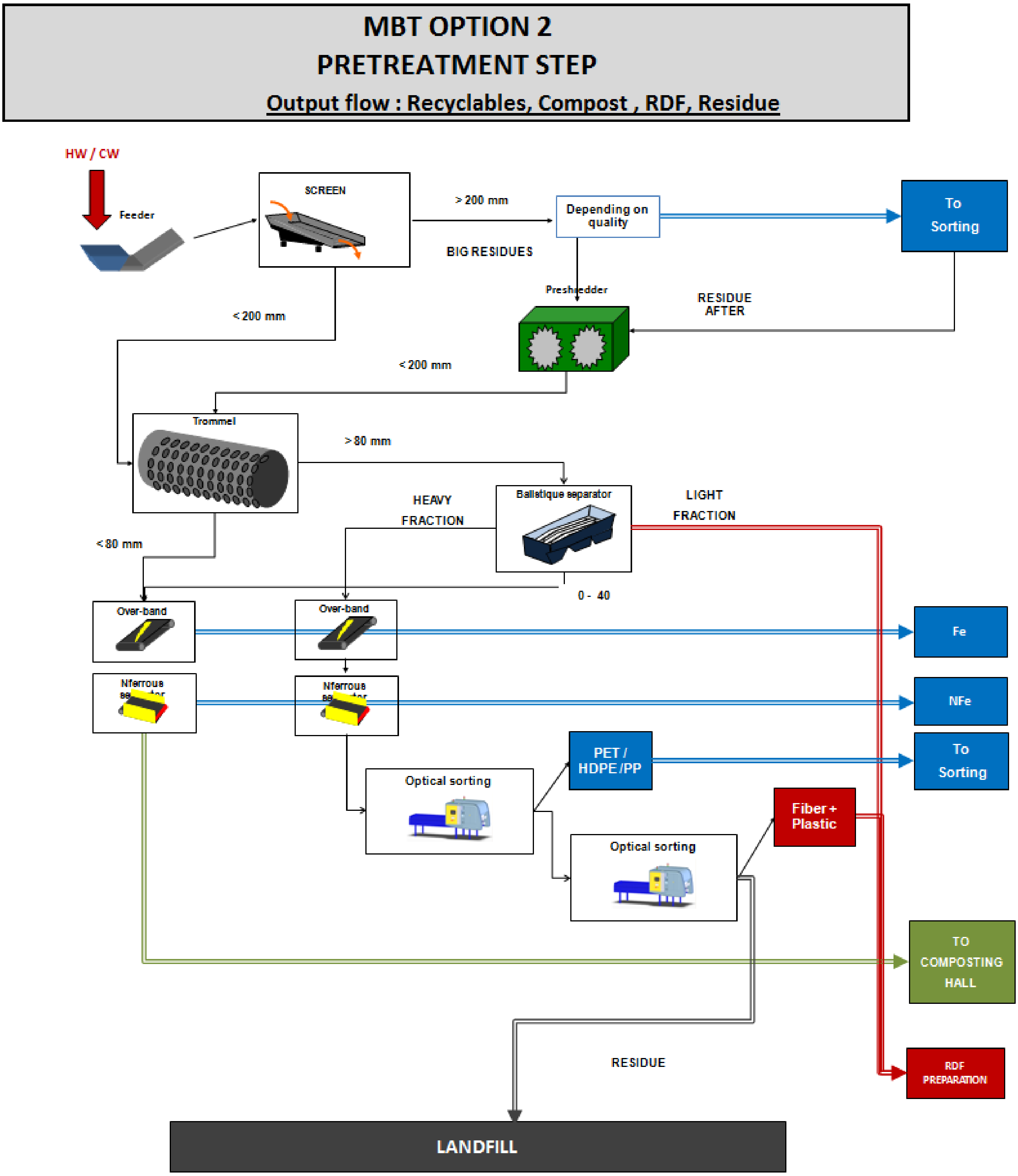
   c. a fine fraction: the fine fraction < 40 mm will be added to the fraction below 80 mm directed to the composting process.

Process flow sheet

Here under there is a flow sheet diagram of the pretreatment process for MBT with RDF.

The process will be similar for the 3 lines for Household waste and for the line for commercial waste. For the shredder(s) receiving about 20 to 25% of the input flows, 2 shredders for the 4 lines are enough, meaning one shredder for 2 lines with a bypass to distribute the flow after shredding on both lines.

Figure 21: Flow sheet diagram of pretreatment process with RDF



Mass balance

From this pre-treatment step, it can be estimated the following data:

Table 48: Mass balance for pre-treatment process MBT with RDF production

Destination	Household waste	Commercial waste
Sorting (from presorting) After sorting, the residue will be transported back to the pretreatment process	≈ 10%	≈ 30%

Destination after presorting	Household waste		Commercial waste		Total (in t/a)
Recycling (Fe and NFe)	≈ 1%	2,000 t/a	≈ 2%	1,000 t/a	3,000
Sorting (from optical sorters)	≈ 1%	3,000 t/a	≈ 1-2%	1,000 t/a	4,000
Other recyclables from sorting (see 4.4.3.)	≈ 0.3%	1,000 t/a	≈ 10%	5,000 t/a	6,000
Biological treatment (inc. residue from sorting step (see 4.4.3)	≈ 50-55%	198,000 t/a	≈ 20-30%	15,000 t/a	213,000
RDF (inc. residue from sorting step (see 4.4.3)	≈ 20-25%	88,000 t/a	≈ 40-45%	23,000 t/a	111,000
Landfill (inc. residue from sorting step (see 4.4.3)	≈ 20-25%	67,000 t/a	≈ 10-15%	5,000 t/a	72,000

Mechanical Treatment Building

The mechanical treatment building is located between the reception building, the intense composting and the RDF preparation.

The estimated dimensions of the building are 4,000m².

4.4.3 Sorting step

Technical specification

The following data of treatment capacity for the sorting step have been taken:

Table 49: Technical specification for sorting process

Criteria	Valuable material from Household waste	Valuable material from Commercial waste	Sorted material from optical sorting form pretreatment process
Throughput Capacity of waste	36,000 t/year	15,000 t/year	4 to 8,000 t/year
Number of shifts	2 shifts	2 shifts	2 shifts
Working days a week	6 days	6 days	6 days
Working days a year	310 days	310 days	310 days
Hours per shift	8 h	8 h	8 h
Working hours per shift	7.5 h	7.5 h	7.5 h
Capacity per day	116 t/d	50 t/d	25 t/d
Throughput per line (t/h)	8 t/h	3,5 t/h	1,5 t/h
Capacity per hour	10 t/h	5 t/h	3 t/h
Number of sorting line	1 line	1 line	1 line

Process description

The process will be the following:

- Valuable household Waste: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting paper, cardboard, plastic and metal fraction.
- Valuable commercial Waste: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting paper, cardboard, plastic and metal fraction.
- Recyclables from optical sorters: a feeding conveyor following by a sorting line with a width of 1200mm with sorters in both sides sorting PET, HDPE, PP, and others recyclables.
- After sorting the residual fraction will go back directly to the reception hall and to the shredder.

The recyclables will be stored in box (some equipped with walking floor) and alternatively emptying on a conveyor to be baled (except for specific material like metal or glass).

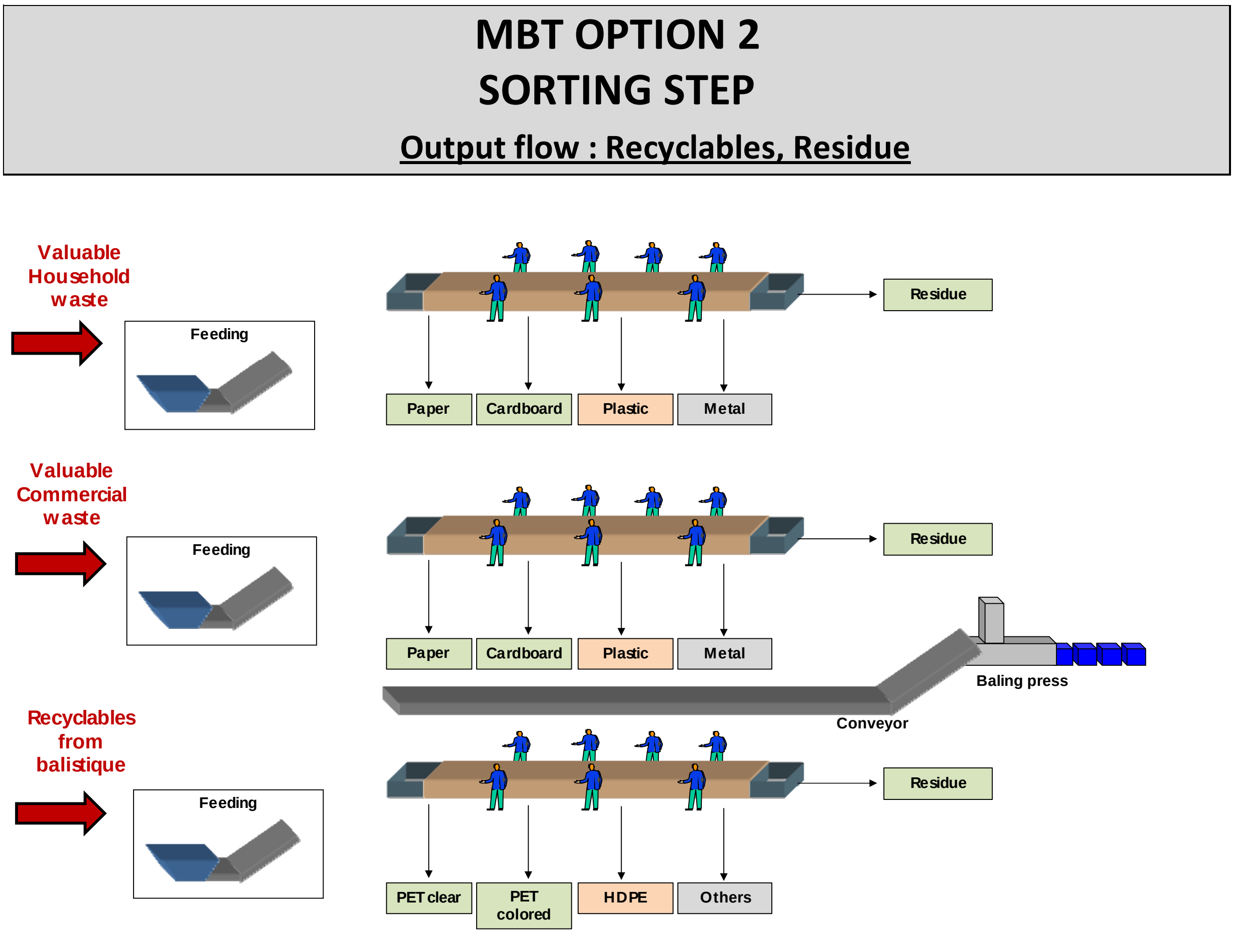
The bales and other recyclables will then be stored before being sent to recyclers.

Process flow sheet

Here under there is a flow sheet diagram of the sorting process for MBT with RDF.

The process will be similar for the 3 lines for Household waste, for commercial waste and for recyclables coming from balistique.

Figure 22: Flow sheet diagram of sorting process



Mass balance

From this sorting step, it can be estimated that from input of the sorting line:

Table 50: Estimated mass balance form the sorting step MBT with RDF production

Destination	Valuable material from Household waste	Valuable material from Commercial waste	Sorted material from optical sorting form pretreatment process
Recycling (Fe and NFe)	≈ 1%	≈ 2%	≈ 0%
Recycling (Paper and cardboard)	≈ 1%	≈ 20%	≈ 0%
Recycling (Plastic and others)	≈ 3%	≈ 3%	≈ 80%
Residue to be sent back to pretreament process	≈ 95%	≈ 75%	≈ 20%

Destination after sorting	Household waste		Commercial waste		Total (in t/a)
Recycling (Fe and NFe)	≈ 1%	400 t/a	≈ 2%	300 t/a	700
Recycling (Paper and cardboard)	≈ 1%	300 t/a	≈ 20%	3,000 t/a	3,300
Recycling (Plastic and others)	≈ 3%	1,000 t/a	≈ 3%	1,000 t/a	2,000
Total (of overall household and commercial waste)	≈ 0.3%	1,000 t/a	≈ 10%	5,000 t/a	6,000

Sorting Building

The sorting step is located after the pretreatment step.

The estimated dimensions of the building are 2,000m².

4.4.4 Biological treatment step

Technical specification

According to the assumed mass balance after pre-treatment the input to the biological treatment is about 213,000t/a.

The design specifications are the following:

Table 51: Technical specification for composting step process

Criteria	Fines fraction <80mm
Throughput Capacity of waste	220,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	710 t/d
Capacity per hour (t/h)	47 t/h
Capacity per hour with availability and safety factor	52 t/h
Density of waste	0,5 t/m³
Capacity per hour (m³/h)	104 m³/h

The process should be able to receive some additional fraction like fiber residue if needed (in case of lack of structuring material). This fraction may come from the refining process or residue from the Green waste and Biowaste composting plant, this residue coming on Sadinata after refining compost. The used safety factors are necessary to cover changes in the waste amount and in the waste composition

Volume of Composting Units

The treatment within the intense composting will occur over a period of 4 weeks.

As assumption, a unit has the following height: 2.5 to 2.7 m for the feeding of organic matter.

Based on 4 weeks capacity and with the safety factor, it means a capacity of 38,000 m³. It means a necessary surface of box of about 13,000 to15,000m² whatever the size of supplier of technology.

For calculation of space demand, there are additional areas for take-over of the material. An additional 1,000 m² for the input material and 1,000 m² for takeover are taken into account.

Process description

The fraction below 80 mm after sieving (see 4.4.2) will be conveyed to the intense composting area located in a closed building consisting of a system with closed boxes.

The waste will be transported with a wheel loader into the composting units. The wheel loader will fill up the units with an average material height of 2.5 to 2.7 m. Alternatively, it is possible to use instead of the wheel loader an automatically conveying belt system for filling the composting units. The treatment duration will be 4 weeks.

An automatic or semi-automatic system will be used on each box in order to turn once a week each box (or less if biodegradation is acceptable)

After the composting process, the material will be discharged and dropped to the separation step.

Mass balance

During the intense composting step, biodegradation will occur. Consequently, some water will be evaporated from the waste flow and biodegradation will transform organic matter in CO2 going to air.

After 4 weeks, the following assumptions can be taken:

- Input material: ≈ 213,000 t/a
- Output material: ≈ 165,000 to 175,000 t/a
- Losses (water and CO2): ≈ 40,000 to 45,000 t/a

Composting Building

The building mainly consists of the composting units and the roof for enclosure. The assumed dimensions of the building are for the compost units 15,000 to17,000m².

Each compost building may consist of 2 rows of units. Between the units is the driving area for the wheel loaders and turning systems. This area will be roofed.

For the treatment of waste, the individual size of each unit is dependent on the later chosen technology of the contractor. Additionally, space for material handling is necessary estimated around 25% of the composting units. So the overall dimensions of the compost building(s) are estimated to be 19,000 to 21,000m². If necessary, this can be split in 2 buildings depending on the sizing on the facility.

These units are mainly made of concrete. In the floor of every unit, aeration and drain systems will be integrated. Between the units, an underground tunnel is arranged. Within this tunnel, there is the collection system for all the leachate and condensate water and the pipeline for the aerations system.

4.4.5 Post biological treatment separation step

Technical specification

According to the assumed mass balance after pre-treatment the input to the biological treatment is about 170.000t/a.

The design specifications are the following:

Table 52: Technical specification for post biological treatment step process

Criteria	Organic fraction
Throughput Capacity of waste	170,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	550 t/d
Capacity per hour (t/h)	37 t/h
Capacity per hour with availability and safety factor	40 t/h
Density of waste	0,5 t/m³
Number of lines	2 lines

Process description

The different steps of the post biological treatment step process are:

1. The material will be sieved within a trommel. The sieving gives two fractions below and above 30 mm. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and quality of end products.

2. The fraction above 30 mm will be treated with so called ballistic separators. With this treatment, it is possible to separate the waste fraction into three fractions:

   a. a light, flat fraction: the light fraction coming out of the ballistic separation system will be conveyed to the RDF-processing building. The description of RDF-production will follow after the description of the composting process (see 4.4.8). An additional air separator may sort out the very light material (mostly plastic films to high Calorific Value).

   b. a heavy spherical fraction (hard fraction) : this hard fraction will be treated with:

i. an over-belt magnet to separate ferrous metals transported to a storage area

ii. a non-ferrous separator to sort out non-ferrous metals transported to a storage area.

iii. an optical sorter to blow residual RDF fraction like paper, cardboard, other plastic, synthetic textiles, … which will be conveyed to the RDF processing building.

iv. the residual fraction will be transported to a storage area or a container to be sent to landfill

c. a fine fraction: the fine fraction < 30 mm will be added to the fraction below 30 mm.

3. The fraction below 30mm will pass through:

a. A first densimetric table/screen in order to eliminate inert and heavy fraction like glass

b. A so called “flip flop” separator, to screen the fines fraction (<10 to 15mm) and separate residual fraction

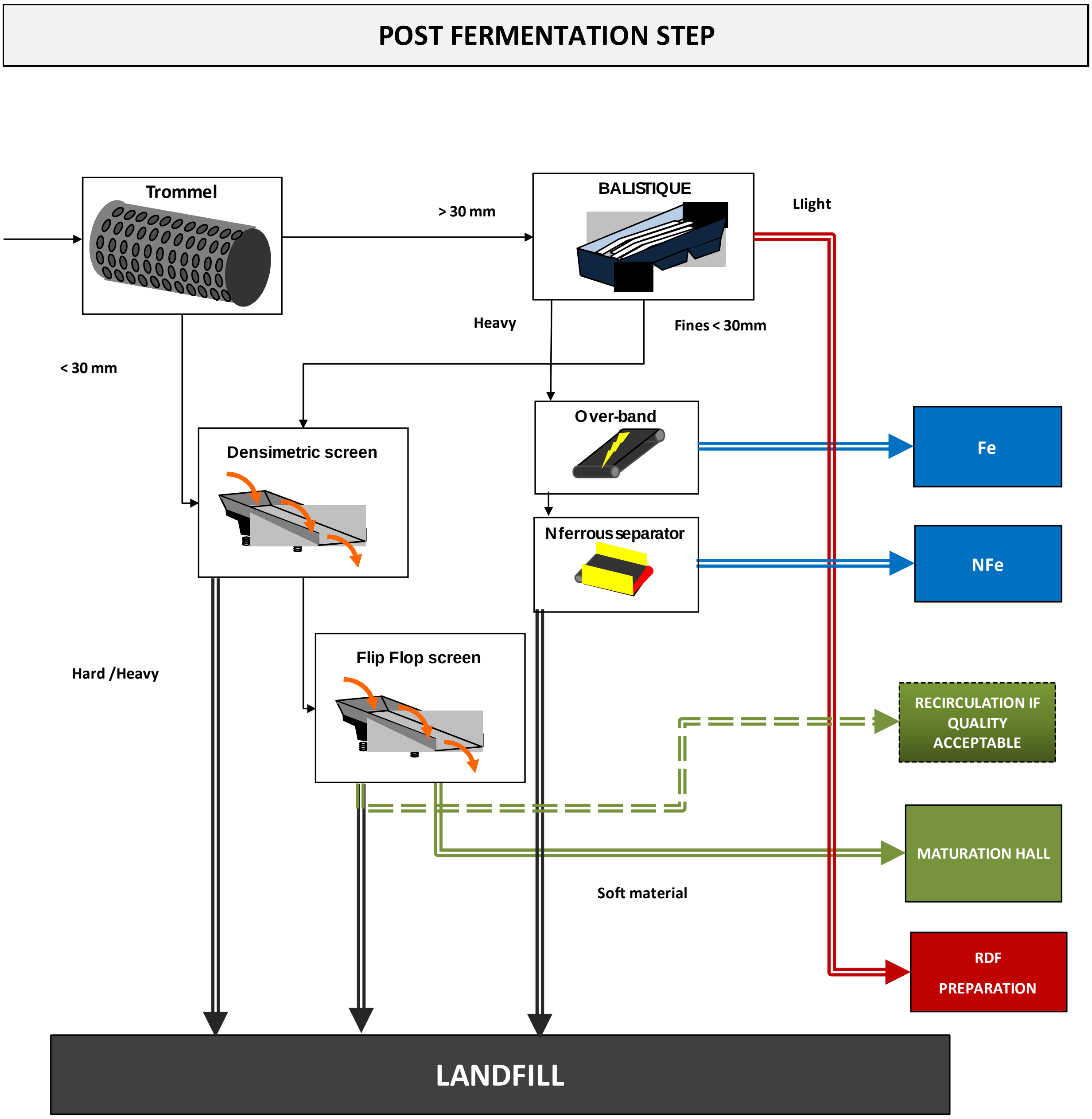
c. If necessary a second densimetric table/screen in order to eliminate inert and heavy fraction like glass

d. The remaining fraction, mostly organic fraction, will be transported to the maturation hall.

Process flow sheet

Here under there is a flow sheet diagram of the post biological treatment process for MBT with RDF.

Table 53: Flow sheet diagram of post biological treatment process



Mass balance

From this post biological treatment step, it can be estimated that:

Table 54: Output from post biological treatment step

Destination	Organic fraction	Total in t/a
Recycling (Fe and NFe)	≈ 0,4%	1,000
Maturation hall (fine fraction)	≈ 60 - 65%	106,000
RDF Process	≈ 15 - 20%	33,000
Landfill	≈ 15 - 20%	30,000

Post fermentation treatment Building

The post fermentation treatment building is located between the intense composting and the maturation. It can be combined with the pretreatment building.

The estimated dimensions of the building are between 2,500 to 3,000m² depending on the suppliers.

4.4.6 Biological treatment step - Maturation

Technical specification

According to the assumed mass balance after post separation the input to the biological treatment is about 106,000 t/a.

The design specifications are the following:

Table 55: Technical specification for maturation step process

Criteria	Organic fraction
Throughput Capacity of waste	106,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	340 t/d
Capacity per hour (t/h)	23 t/h
Capacity per hour with availability and safety factor	25 t/h
Density of waste	0,45 t/m³
Capacity per hour (m³/h)	55 m³/h

Volume of Composting Units

The treatment within the maturation step will occur over a period of 8 weeks. As assumption, a unit has the following height: 2.5 to 2.7m for the feeding of organic matter.

Based on 8 weeks capacity and with the safety factor, it means a capacity of 40,000 m³. It means a necessary surface of box of about 13,000 to 16,000m² whatever the size of supplier of technology.

For calculation of space demand, there are additional areas for take-over of the material. An additional 1,000 m² for the input material and 1,000 m² for takeover are taken into account.

Process description

The fine fraction will be transported via conveying belt to the post composting section. As described in the intense composting, the material will be rewetted if necessary and mixed again to ensure enough biological activity for final decomposition of organic matter.

The waste will be transported with a wheel loader into the composting units. The wheel loader will fill up the units with an average material height of 2.5 to 2.7m.

An automatic or semi-automatic system will be used on each box in order to turn regularly each box, especially in the first stage of maturation (about 4 weeks)..

After biological treatment (8 weeks), the material will be transported via conveyor to the refinement building.

Mass balance

During the maturation step, biodegradation will occur. Consequently, some water will be evaporated from the waste flow and biodegradation will transform organic matter in CO_2 going to air.

After 8 weeks, the following assumptions can be taken:

- Input material: 106,000 t
- Output material: 85,000 to 95,000 t
- Losses (water and CO_2): 15,000 to 20,000 t

Maturation Building

The building mainly consists of the maturation units and the roof for enclosure. The assumed dimensions of the building are for the compost units 15,000 to 18,000m².

Each compost building may consist of 2 rows of units. Between the units is the driving area for the wheel loaders. This area will be roofed.

For the treatment of waste, the individual size of each unit is dependent on the later chosen technology of the contractor. Additionally, space for material handling is necessary estimated around 25% of the composting units. So the overall dimensions of the compost building(s) are estimated to be 18,000 to 22,000m². If necessary, this can be split in 2 buildings depending on the sizing on the facility.

These units are mainly made of concrete. In the floor of every unit, aeration and drain systems will be integrated. Between the units, an underground tunnel is arranged. Within this tunnel, there is the collection system for all the leachate and condensate water and the pipeline for the aerations system.

4.4.7 Refining step

Technical specification

According to the assumed mass balance after post separation the input to the biological treatment is about 90,000 t/a.

Table 56: Technical specification for refining process

Criteria	Organic fraction
Throughput Capacity of waste	90,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	290 t/d
Capacity per hour	20 t/h
Capacity per hour with availability and safety factor	25 t/h
Number of treatment line	1 line

Process description

The different steps of the refining step process are:

1. The material will be sieved within a trommel. The sieving gives two fractions below and above 20 mm or 10mm depending on local market and quality requirement. It might be possible to change the sieve hole size to larger or smaller dimensions to influence the percentage distribution and quality of end products.
2. The fraction above 10-20 mm will be treated with so called air or ballistic separators. With this treatment, it is possible to separate the waste fraction into two to three fractions:
    a. a light, flat fraction: the light fraction coming out of the air or ballistic separation system will be conveyed to the RDF-processing building. The description of RDF-production will be detailed in 2cd interim report.
    b. a heavy spherical fraction (hard fraction) : this hard fraction will be transported to a storage area or a container to be sent to landfill
    c. in case of ballistic a fine fraction: the fine fraction < 10-20 mm will be added to the fraction below 10-20 mm.
3. The fraction below 10-20mm will pass through:
    a. A first densimetric table/screen in order to eliminate inert and heavy fraction like glass

b. A so called "flip flop" separator, to screen the fines fraction (<10 mm) and separate residual fraction

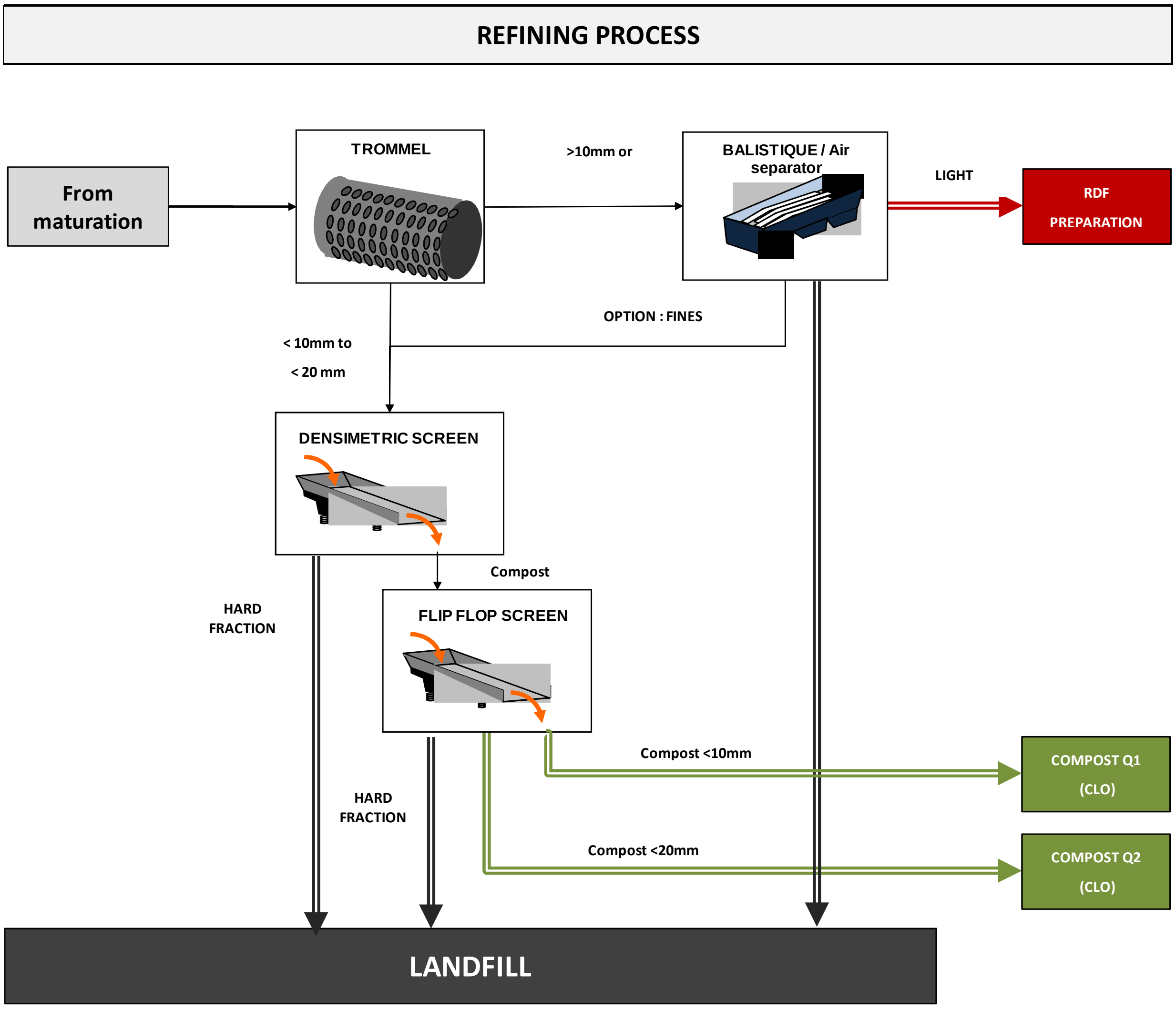
c. If necessary a second densimetric table/screen in order to eliminate inert and heavy fraction like glass

d. The remaining fraction, mostly organic fraction, will be transported to the storage hall.

Process flow sheet

Here under there is a flow sheet diagram of the refining process for MBT with RDF.

Figure 23: Flow sheet diagram of refining process



Mass balance

Refining step, with an input of 90 000 t/year, the output can be estimated as follow:

Table 57: Output from refining step

Destination	Organic fraction	Total in t/a
Storage hall (fine fraction)	≈ 75 - 80%	69,000
RDF process	≈ 10%	10,000
Landfill	≈ 10 - 15%	11,000

Refining Building

The refining building is located after the maturation building.
The estimated dimensions of the building are 1,000m².

4.4.8 RDF preparation step

Technical specification

According to the assumed mass balance after the different separation, the input volume of RDF to the preparation line is about 154 000 t/year.

Table 58: Technical specification for RDF preparation

Criteria	RDF fraction
Throughput Capacity of waste - Light fraction >80mm - RDF from heavy fraction>80mm - Light fraction from post biological treatment step - RDF from heavy fraction from post biological treatment step - Light fraction from refining process	154,000 t/a inc. ≈ 111,000 t/a ≈ 33,000 t/a ≈ 10,000 t/a
Number of shifts	2 shifts
Working days a week	6 days
Working days a year	310 days
Hours per shift	8 h
Working hours per shift	7.5 h
Capacity per day	500 t/d
Capacity per hour	33 t/h
Capacity per hour with availability and safety factor	36 t/h
Number of treatment line	2 lines

Process description

As mentioned before, the RDF-Treatment will be more described in interim report 2. The inputs for the treatment are:

- the light fractions produced in the ballistic separators with particle size 80-200 mm.
- the fiber and plastic fraction from the heavy fraction after optical sorting with particle size 80-200 mm
- the light fraction from 30-80mm from the post biological treatment step
- the fiber and plastic fraction from the heavy fraction after optical sorting with particle size 30-80 mm
- the light fraction from the refining process

These fractions will be directed to the RDF building.

After having the specification of RDF for the District Heating plant, then the process will be defined

Up to now, it is not possible to definitely specify in which form the RDF will be transported.

In this planning it therefore makes sense to have both alternatives: on one hand the containers, on the other hand the baler press with wrapping unit. The pressed and probably wrapped bales will be stored on floor and loaded with a fork-lift to a truck. Both options should be cost as they will apply to different markets.

Process flow sheet

The design process flow sheet will be describer in interim report 2.

Mass balance

The mass balance will be updated in the second interim report.

RDF Building

The RDF production building is located between the reception building, the intense composting and the mechanical treatment plant.

The estimated dimensions of the building are 2,000m².

4.4.9 Storage step

Technical specification

According to the assumed mass balance after the different separation, the volume of material to be stored is:

Table 59: Technical specification for storage step

Criteria	Recyclables	Compost	RDF fraction	Residue
Throughput Capacity of waste	Ferrous : 5,000 t/a Plastic : 6,000 t/a Paper : 3,000 t/a	69,000 t/a	154,000 t/a	113,000 t/a
Number of days of storage	–	1 month minimum	6 days	Delivered to landfill
Minimum quantities of storage	For baling, 40 t per quality For loose, 100m3			
Capacity of storage (t)	300 t	6,000 t	3,000 t	
Capacity of storage (m3)	600 m3	12,000 m3	6,000 m3	
Quantity (m3/m²) inc. safety factor	2 m3/m²	4 m3/m²	3 m3/m² (bales)	
Necessary surface	500 m²	3,000 m²	2,000 m²	

Process description

Recyclables will be stored by category (ferrous, non-ferrous, plastic (PET per color, HDPE, ..), paper, cardboard…). For each category, it will be necessary to have at minimum one truck (24t) in stock. With the safety factor, the capacity is estimated to be 300t.

Compost should be stored and cannot be sent everyday (even for land remediation, weather conditions is a constraints which should be taken into account). A minimum capacity of 1 month has been taken as assumption, meaning 6,000t to be stored.

RDF will be stored in bales before delivery to the District Heating plant.

Building

The Storage building is located between the post composting building and the RDF building.

The estimated dimensions of the building are 5,000 m².

4.4.10 MBT with RDF main data

4.4.10.1 Global mass balance

Table 60: Global mass balance option MBT with RDF production

Input	
Household Waste	360,000 t/y
Commercial Waste	50,000 t/y
TOTAL	410,000 t/y

Output			
Recycling	Metals	5,000 t/a	1.2%
	Plastics	6,000 t/a	1.5%
	Paper	3,000 t/a	0.7%
Compost		69,000 t/a	16.1%
Losses		59,000 t/a	14.4%
RDF		154,000 t/a	37.6%
Residue		113,000 t/a	27.8%
TOTAL		410,000 t/a	100%

4.4.10.2 Surface of the buildings

Table 61: Summary surface of building option MBT with RDF production

Building	Maximum surface
Reception Hall	4,000 m²
Pretreatment building	4,000 m²
Sorting building	2,000 m²
Biological treatment hall	19,000 m² - 21,000 m²
Separation post biological treatment	3,000 m²
Maturation building	18,000 m² - 22,000 m²
Refining building	1,000 m²
RDF Hall	2,000 m²
Storage building	5,000 m²
Total	**56,500 m² - 64,000 m²**

4.4.11 RDF utilisation

4.4.11.1 Brief review of the New CHP project: the overall arrangement for the Heat generation and adequacy of proposing a RDF CHP as base provider

1. The District Heating system has been rehabilitated and modernized. The overall efficiency of the energy chain (starting from fuel input to heat supply to the buildings) is decent and amounts to approx. 82%. This is composed by an average heat generation efficiency of 90% and a distribution efficiency of similar magnitude (90% * 90% = 81%). The distribution losses are higher than in Nordic countries, but similar to those in Germany and neighbouring countries. Heat generation efficiencies could be higher, but this is prevented by some outdated boilers and a CHP plant. The whole system is metered, so these numbers should be reliable.

2. The DHC intends to replace the equipment in the CHP Plant Sofia, i.e. an old 50 MW CHP facility by a new gas-RDF fired one. The steam generators have already achieved the end of their technical lifetime and require relative high maintenance and repair costs. Moreover, there are some problems with emissions. The turbines will have reached the end of normal technical lifetime in a couple of years (3-4 years). Lifetime could be prolonged by proper upgrading measures, but the total efficiency is low and does even not reach the minimum requirements of the EU directive.

3. The new CHP plant will be a Combined Cycle Plant, which combines a gas turbine and a RDF-fired steam boiler. The main fuel for the steam boiler will be RDF with the addition of 7% of natural gas to allow a smoother start-up and more stable operation. Typically, in such plants 20%-30% of gas is supplemented. DHC management believes that +/- 10% would be sufficient. However, the share of gas can easily be increased, but, of course, at the cost of RDF consumption (which would go down accordingly).

4. The electricity output of the plant will amount to 50 MW, whereby about half of it comes from the gas turbine and the other half from the steam turbine. The own consumption will be 5%.

5. The thermal capacity (supply to the network) is planned to amount to 50-85 MW depending on the amount of RDF (firstly estimated between 150,000 t/y to 190,000 t/y). From this, 10 MW is steam delivered and 40-75 MW is hot water. The 40 MW equals the average daily summer load. That would allow operating the plant all-year with full/optimal capacity. The summer load is mostly caused by domestic hot water consumption. The overall efficiency is assumed to be about 80%.

6. During the day, the domestic hot water consumption varies significantly. As the CHP facility shall be operated with equal load all day, the produced hot water has to be stored. The water could either be stored in the existing network or a heat accumulator. Using the existing network would not cause additional costs, while additional storage facilities would cause relative high investment costs. The DHC has decided to install an accumulator with a volume of 20.000 m³ after having performed an investigation including a hydraulic network analysis.

7. The share of domestic hot water load in the total heat load (peak load) is with 40 MW or 20% (average heat consumption during summer period) relatively high. Typically, this number is 10% or less. Increasing heat prices could induce a reduction of domestic hot water consumption and in such case the summer load could go down even if the number of connected customers increases. However, as the plant is connected to the networks of the other service areas, a heat surplus could be delivered to them thus reducing the consumption of fossil fuel.

8. The principle design of the plant is based on a previous estimated RDF quantity of 150,000 t/y and 190,000 t/a for a final stage. The consultant first estimated this number to be around 154,000 t/a in 2020. Accordingly, the energy content would be lower and assuming the same basic design parameters the share of gas (or other fuels) would have to increase. The increase of potential volume in the DH plant gives opportunity to improve separation in the MBT plant and increase RDF volumes.

9. According to the documents delivered by the District Heating Company, the calorific value of RFD is assumed to be 14-17 GJ/t in the FS. However, as the plant runs with about 8.000 h/y (8.760-750 hours per year) and the RDF load would be 65 MW, the heating value would be only 12.5 GJ (As the documents are based on a heating value of 14-17 GJ/t it is assumed that the energy balance has to be corrected). In Mannheim/Germany, a plant with a capacity of 600.000 t/a uses RDF with a calorific value of 11 GJ/t. The initial reasons for this in the FS was linked to the initial destination of fuels (Cement plants) where their need are with highest CV than CHP plant. Other sources argue that the typical RDF CV is in the range between 12 and 26 GJ/t. The RDF boiler will be designed for a certain calorific value, e.g. 15 kJ/kg within a typical range from 11 to18 kJ/kg.

10. There is the risk that the plant could be oversized:
    a. The current design is for a quantity of 154,000 t/y res. 190.000 t/y, but according to the estimation the amount would be around 154,.000 t/y (in 2021).
    b. Paper, cardboard, and plastic constitute most of the composition of the RDF material. The development of source selective collection can have an impact on quantities and quality.

11. In line with legal requirements, the DHC will need RDF storage equal to the consumption of 7 days. With an annual consumption of 150,000 t/y resp. 190,000 t/y, the storage volume would be approx. 2,900 t res. 3,700 t. The DHC intends to use the existing HFO-tanks with 2*10.000m³ and 2*5.000 m³. According to the DHC, the tanks need still to be checked whether they are suitable for this purpose.

4.4.11.2 Brief review of the New CHP project: pre-selected technology for combustion and flue gas treatment and adequacy with the applicable regulations and EU directives

1. The chosen technology is a combined cycle CHP plant which corresponds to the state of art. This is also true for the chosen boiler technology.

2. There are basically two alternatives for the RDF boiler, (i) a fluidized bed boiler or (ii) stoker fired boiler. The DHV considered both options and decided eventually for the stoker-fired boiler because of easier operation and maintenance works. The stoker-fired boiler will be supplied by packaged (baled) RDF. Depending on the bale size, the

bales will have to be cut before going to the stoker. In contrast, the fluidized bed boiler would be fed by loose RDF material.

3. The stoker-fired boiler could also be supplied unpackaged RDF provided that it will be delivered with right particle size. The disadvantage would be higher transport costs and higher CO2 missions. Moreover, baled material allows a much better control and measurement of the RDF consumption in the boiler, as unpackaged material is difficult to measure.

4. Environmental norms/standards can be achieved provided that they will be enforced. There are examples of bigger plants close to cities. E.g., in Mannheim (located within a region of more than 1 million inhabitants) such plant is operated close to the city centre.

4.4.11.3 Detail assessment of the RDF characteristics in accordance with the MBT project in order to ensure the compatibility with the CHP plant

1. The specific requirements regarding the properties of RDF materials and typical characteristics are described in the table below.

Table 62: Information about the RDF fuel, derived from MSW, envisaged for combustion in plant for combined production

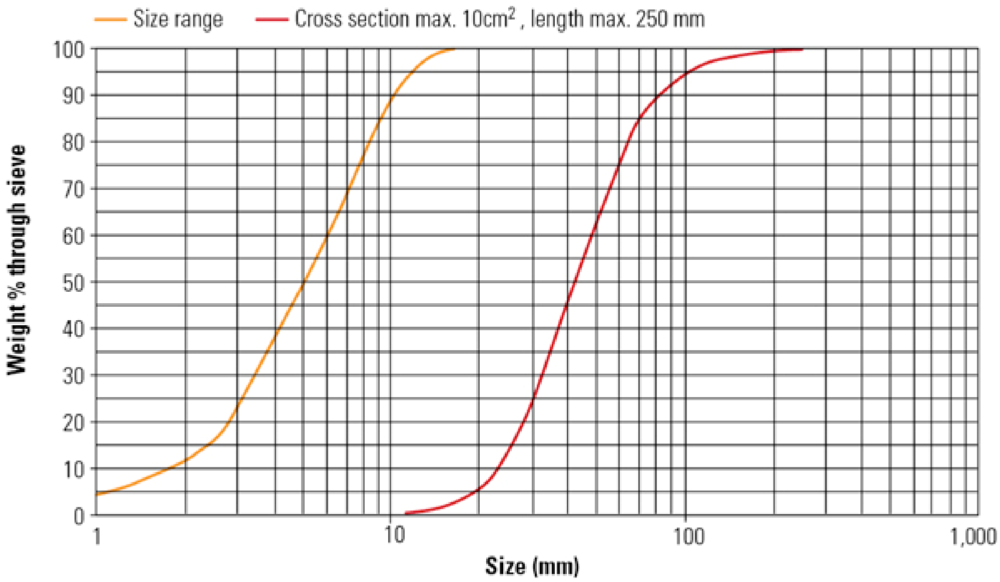
Characteristics		Fuel, derived from MSW (RDF) for the plant	Coals for plants in the energy sector	RDF as per standard RAL-GZ 724
Size of the material	mm	35 ÷ 200	10 ÷ 20	
Harmful substances				
Calorific value	MJ/kg	14 ÷ 21	13 ÷ 22	> 16
Humidity	weight %	< 25	< 15	
Ash	weight %	< 20	< 12	
Average value of harmful components				
-Chlorine(CL)	weight %	0,75	1 ÷ 1,1	
-Sulphur (S)	weight %		0,75 ÷ 1	
-Fluor (F)	weight %		0,05 ÷ 0,1	
-Cadmium (Cd)	mg/kg CB	4,0	3 ÷ 4	4,0
-Mercury (Hg)	mg/kg CB	0,6	0,6	0,6
-Thalium (Tl)	mg/kg CB	1,0	1,0	1,0
-Arsenic (As)	mg/kg CB	5,0	5 ÷ 9	5,0
-Cobalt (Co)	mg/kg CB	6,0	6 ÷ 8	6,0
-Nickel (Ni)	mg/kg CB	25	50 ÷ 80	25
-Lead (Pb)	mg/kg CB	70	50 ÷ 190	70
-Chlorine (Cr)	mg/kg CB	40	40 ÷ 125	40
-Cooper (Cu)	mg/kg CB	100	100 ÷ 350	100
-Manganese (Mn)	mg/kg CB	50	50 ÷ 250	50
-Antimony (Sb)	mg/kg CB	25	25 ÷ 50	25
-Vanadium (V)	mg/kg CB	10	10	10
-Tin (Sn)	mg/kg CB	30	10 ÷ 30	30
-Zinc (Zn)				
-Aluminium (Al)				

Notes:

1. The data in column „RDF for the plant" are given as a requirement to the plant for Mechanical-Biological Treatment of the wastes.
2. The data in column "Coals for the plants in the energy sector" are given for comparison.
3. The data in column „RDF as per standard RAL-GZ 724" are in force for the federal community for the quality of RDF in Germany.

2. According to the DHC, RDF will be delivered in sizes from 35 to 200 mm. Such sizes can be handled (with the help of conveyors) like in coal-fired plants. Boiler manufacturers and standards organizations have developed particle size curves to identify fuel requirements for circulating fluidized bed boilers (CFB). The figure below illustrates the typical acceptable size range of biomass fed to a CFB, Austrian standard

ÖNORM M 7133, “Chipped Wood for Energetic Purposes—Requirements and Test Specifications.” Particle mass, size, shape, and volatile content are key parameters considered in developing the acceptable fuel supply size curves. The fuel particles fluidize and combustion characteristics establish the shape and characteristics of the curve. The curve can be read that no more than 4% of the fuel supplied can be less than 1 mm. At 80%, the size distribution should have 80% of the particles between 5 mm and 63 mm; 95% of the particles should be no more than 100 mm. The cross-section maximum is 10 square centimetres, and maximum length is 250 mm. (Source: ÖNORM M 7133



Source: Designing Fuel Systems for Large Biomass Plants, Daniel Mahr, 2011

3. Boiler manufacturers may impose distinct fuel requirements to meet contract performance guarantees and warranties, depending upon the design fuel and contract terms. This could also refer to the decomposition of RDF material sizes.

4. Combustion products from municipal waste are very corrosive. The corrosion is usually caused by chloride compounds which deposit on the furnace, superheater and boiler tubes. Corrosive affects comprise:

   - corrosion by hydrochlorides (HCl) in the combustion gas,
   - corrosion by NaCl and KCl deposits on tube surfaces,
   - corrosion by low melting point metal chlorides (mainly ZnCl2 and PbCl2),,
   - out-of-service corrosion by wet salts on the tube surface.

   Waste boilers operating at higher steam pressures (the proposed boiler has 110 bars) have higher temperature saturated water in the furnace tubes resulting in higher tube metal temperature. These higher tube metal temperatures will increase the corrosion rate. Accordingly, materials containing chlorine such as PVC should be removed in the RDF. Removal of paper will reduce the chlorine content at the cost of the heating value of RDF.

5. The production of dioxin is correlated with the pressure in the RDF boiler. The preliminary design shows a relatively high pressure of 110 bars which allows a high efficiency of the electricity generation in the turbine.

6. Melted aluminium can accumulate on the grate. The best solution is to completely remove all aluminium from the RDF.

7. Another serious problem refers to the production of dioxin. The question arises whether chloride materials should be removed to the extent possible before combustion. Experience from decades of research have been summarized as follow (see Incinerator Design and Operation: The Robust Approach to PCDD/F Minimization, William F. Carroll, 2003):

   > "If there is any general conclusion to be drawn from twenty-five years of research into dioxin generation in combustion, it is that combustors vary. Similarly, emissions from combustors vary, even with respect to dioxin emissions and correlation with chloride. Carefully chosen literature can demonstrate that there is a positive correlation between input chloride and PCDD/F (e.g., more chloride = more dioxin); similar care can find experiments showing negative correlation (e.g., more chloride = *less* dioxin). Conversely, if the correlation is correct, reducing chloride from the input to these two sets of combustors would yield two different results: less dioxin emission from the first set, but *more* dioxin emission from the second. Adjusting the chloride content of the combustor fuel is clearly not a robust PCDD/F reduction policy."

8. Other key risks identified can be:

   - high mercury input, leading to high raw flue-gas concentrations
   - high iodine or bromine input, leading to high raw flue-gas concentrations
   - high variability in moisture content or CV, leading to combustion irregularities
   - high chlorine loading exceeding flue gas treatment (FGT) capacity
   - high sculpture loading exceeding FGT capacity:

   1. rapid change in flue-gas chemistry that effects FGT function• physically large items blocking feed systems - leading to an interruption of regular operation
   2. excessive slagging/fouling of boiler components when certain types of waste are being fed e.g. high Zn concentration sources (contaminated wood waste) have been reported to cause abnormal slagging in the first boiler pass

9. The calorific value is a crucial issue for a stable combustion. In the documents supplied, there is no evidence that the CV of the RDF material has ever been analyze. The number used in the various studies (14-17 GJ/t) is high and the calculated value is relatively dependant on the composition and moisture content, which are both estimated.

10. As the composition of the RDF material is not homogenous, the CV will vary. Only to certain content it can be compensated by regulating the natural gas supply. Therefore, ensuring a stable CV within a narrow bandwidth.

11. To optimize the operation of RDF production and consumption (firing in the CHP plant), the final detailed design should be tuned together with the CHP Consultant and boiler supplier. This could help avoiding costly modifications of the RDF production process.

Biomass content

Today, CEN 15747 is the standard being used by the European Union Emission Trading Scheme to monitor refuse-derived fuels. The CEN/TS 15747:2008 is a published standard that outlines carbon 14-based methods for the determination of the biomass content of solid recovered fuels. Applying this method will not be possible under this project. There are alternative methods available, but with a high degree of uncertainty compared with the carbon 14 method.

The biomass could also be determined by applying the definitions of solid biofuels according to CEN/TC335:

- products from agriculture and forestry,
- vegetable waste from agriculture and forestry,
- vegetable waste from the food processing industry,
- wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood
- waste originated from construction and demolition waste
- fibrous vegetable waste from virgin pulp production and from production of paper from pulp, and cork waste.

For the avoidance of doubt, demolition wood is not included in the scope. Demolition wood is defined as “used wood arising from demolition of buildings or civil engineering installations”.
In accordance with this definition, the amount of bio-based fuels is approx. 3,000 t/y. In case of wood it has been assumed that 50% of the wood can be defined of bio-based fuel. The amount is small as most bio-based materials have been removed before producing the RDF.

5 Content of the second interim report

5.1 Detailled RDF process

5.2 Financial and economic analysis of the two options, comparison

Methodological remarks

Least Cost Analysis and Average Incremental Cost (AIC) approach

Key assumptions adopted in AIC comparisons

Investment costs

Investments in MBT Plant

Investments in landfill

Operating and maintenance (O&M) costs

O&M Costs of MBT Plant

O&M Costs of Landfill

Landfill charges

RDF off-take arrangements

RDF price

Temporary measure – sending RDF to cement plants

Other by-products

Compost-like Output (CLO)

Recyclables

Average Incremental Cost (AIC)

AIC of option 1: No-RDF production

AIC of option 2: RDF utilised by Toplofikatsia Sofia

Sensitivity analysis

Identification of key variables

Sensitivity of AIC to changes in key variables

5.3 Proposition of the most suitable option for waste treatment in Sofia

Technical arguments

Economical and financial arguments

Environmental arguments

5.4 Comparison between the most suitable MBT plant proposed in 1st interim report and the MBT plan of the tender

Technical comparison

Economical and financial comparison: Pertinent recommendations towards achieving better value for money

How far is the design of the original funding from the chosen treatment option?

Delivery time: End of June 2011.